Environment, Climate Change & Water

Effluent reuse management

Strategic environmental compliance and performance review

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The *Strategic environmental compliance and performance review: effluent reuse management* was undertaken by the Compliance and Assurance Section, Department of Environment and Climate Change and Water NSW.

More information
For technical information on the matters discussed in this paper contact
DECCW Compliance and Assurance Section on (02) 9995 5000.

Cover images
Main photo: Sprinkler in operation in irrigation area (N Wilmot/DECCW). Other images, left to right: Anaerobic pond with synthetic liner (R West/DECCW); a DECCW soil scientist taking a sample from an effluent reuse area (R West/DECCW); flood irrigation channel (R West/DECCW); effluent reuse area with irrigator (N Wilmot/DECCW).

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Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

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1 Executive summary

The Department of Environment and Climate Change and Water NSW (DECCW) has reviewed effluent reuse management to help improve environmental performance.

This review focused on requirements for effluent reuse in environment protection licences across various industry types within NSW. The review process combined compliance audits with research into best environmental management practices.

The objectives of the review were to:

- assess the level of the licensee's compliance with effluent reuse requirements attached to environment protection licences
- assess the adequacy and appropriateness of the licensee's current management practices, procedures and monitoring activities that relate to effluent reuse
- assess the licensee's use of monitoring data (including soil, effluent and groundwater) to identify and manage any adverse impacts of effluent reuse on the irrigation area
- use monitoring data and information on effluent reuse practices and procedures to provide comments on licensees' performance that relates to the long-term sustainability of effluent reuse activities.

About this report

This report summarises the findings of the compliance audits completed by DECCW. It also:

- guides licensees undertaking effluent reuse activities how they can improve their environmental performance by implementing best environmental management practices
- informs licensees how they can use effluent/soil/groundwater monitoring data to improve the long-term sustainability of effluent reuse practices
- informs other initiatives to help licensees improve their environmental performance.

Key findings

The results of the audits and review of best environmental management practice demonstrate that licensees can improve their environmental performance and reduce the potential for environmental harm by:

- developing irrigation schedules to ensure the right amount of effluent is applied at the right time to meet crop requirements – and also minimise runoff
- managing wet-weather storage ponds to ensure they have adequate residual capacity for effluent during conditions where irrigation is not possible
- maintaining effluent irrigation areas so they provide adequate assimilation, percolation, evaporation and transpiration of the irrigated effluent
- properly maintaining plant and equipment – including irrigation pipes, tailwater dams, and storage and treatment ponds – to ensure effluent is effectively treated
- ensuring that analysis results are accurate by using specified methods and procedures when conducting effluent, soil and groundwater sampling
- using the data collected from effluent quality, soil, groundwater and crop monitoring to improve environmental performance and minimise environmental impacts.

A systematic and rigorous process of follow-up actions has been completed. This will ensure any issues identified at the audited sites are being addressed.

Valuable information for licensees

The review findings provide valuable information to help licensees use monitoring data about effluent quality, soil and groundwater to improve the long-term sustainability of effluent reuse practices. Several initiatives were identified.

Beneficial reuse practices included:

- undertaking additional effluent, solids, soil, groundwater and crop monitoring over and above that required by environment protection licences to improve environmental performance
- undertaking trials of a broad range of crops to identify those best suited for the purpose of nutrient removal, having regard to soil type, climate and water quality
- using analysis results for treated effluent to make decisions about the most efficient way to blend treated effluent with stormwater prior to reuse on the irrigation area.

Long-term sustainability measures included:

- using sustainability indicators as triggers for further action where monitoring indicates potential problems with current effluent reuse practices
- preparing nutrient balances, including nitrogen and phosphorous, to identify trends in nutrient uptake for each effluent application area and using the information to rectify any observed adverse trends
- using mass balances for the hydraulic load applied to each irrigation area to ensure the volumes of effluent applied are taken up by the crops, minimising any potential increase in runoff or percolation
- using the analysis of soil salinity in each irrigation area to manage any potential leaching of salt below the root zone by introducing salinity control measures
- using soil-exchangeable sodium percentage analytical results to manage any potential sodicity issues
- using the analysis of the phosphorus sorption capacity in soil to manage any repeated addition of phosphorous and to ensure that leaching of phosphorous through the soil profile does not occur through time.

The findings of this review will also be used to inform DECCW's ongoing review of licences and help assess applications for new licences. DECCW will also continue to work with the licensees undertaking effluent reuse at sites in NSW to help them improve their environmental performance and the long-term sustainability of effluent reuse practices in general.

Related initiatives

The following related initiatives may also assist relevant stakeholders – such as local government, industry and licensees – to identify ways in which wastewater can be more effectively reused to reduce the impact on the environment.

- DECCW's Sustainability Advantage program helps medium to large organisations and businesses assess their resource use and waste generation. It assists in devising strategies such as reusing wastewater in order to improve environmental performance and bring about cost savings.

  See the *Achieve a sustainability advantage brochure* available at: www.environment.nsw.gov.au/resources/sustainbus/09189SustainabilityAdv.pdf or obtain a copy by email: sustainbus@environment.nsw.gov.au

- The load calculation protocol sets out a range of methods to calculate pollutant loads under the load based licensing (LBL) scheme. DECCW is undertaking a review of this protocol with the aim of introducing expanded opportunities to achieve weighted load discounts, including discounts for effluent reuse. See www.environment.nsw.gov.au/licensing/lblprotocol/index.htm.

- The Hawkesbury–Nepean River Recovery Project aims to save over 11 billion litres of water per year and stop over 48 tonnes of nutrient pollution per year from entering the river. Its measures will help distribute and supply recycled water for irrigation to more potential users. See www.environment.gov.au/water/policy-programs/water-smart/projects/nsw27.html.

The *Draft lower Hawkesbury–Nepean River nutrient management strategy* (DECC 2009) provides a clear direction and overarching framework for current and future nutrient management initiatives, such as reuse of effluent for irrigation. See www.environment.nsw.gov.au/resources/water/09157drafthnnutmgmtstrat.pdf.

Effluent irrigation

Effluent is wastewater from the collection or treatment systems associated with sewerage works, processing industries (livestock, wood, paper or food), intensive livestock, aquaculture or agricultural industries. Effluent irrigation may be defined as the application of wastewater to soil for the purpose of supplying the moisture and nutrients essential for plant growth. Effluent irrigation plays a vital role in increasing crop yields and stabilising production.

2 Strategic compliance and performance reviews

In addition to its other regulatory activities, DECCW undertakes an ongoing program of strategic environmental compliance and performance reviews. Their aim is to encourage industry to improve its environmental performance. The reviews combine compliance audits (i.e. assessing compliance with environmental legislation) with research into best environmental management practices. Industry, licensees, state agencies, local government, the community and other stakeholders provide input into various stages of the review process.

Selecting activities and sectors for review

The reviews focus on priority environmental issues. Previous reviews looked at:

- the wood preservation industry
- liquid chemical storage, handling and spill management practices
- preventing contaminated sites
- environmental impacts of industrial estates
- industry monitoring.

Industry sectors and activities targeted for strategic environmental compliance and performance reviews are chosen by assessing major environmental and community concerns alongside DECCW's corporate objectives and strategies.

Criteria considered include:

- the likelihood of harm to human health and the environment from an activity
- the complexity of the activity
- emissions and wastes from the activity
- gaps in understanding the activity
- environmental performance
- location of the activity
- community concern
- the opportunity to make significant environmental gains in relation to the activity
- opportunities to integrate with other DECCW programs.

Further information

For more information on these reviews, see www.environment.nsw.gov.au/licensing/complianceaudit.htm

Relevant legislation

Protection of the environment operations Act 1997

The *Protection of the environment operations Act 1997* (POEO Act) allocates responsibilities for pollution prevention and control to the Environment Protection Authority (EPA), local councils and other public authorities. EPA is the appropriate regulatory authority for:

- regulating activities listed in Schedule 1 of the POEO Act
- premises where scheduled activities are carried out
- ensuring compliance with environment protection licences
- regulating activities carried out by the state or a public authority.

EPA and DECCW

Although the Environment Protection Authority (EPA) is part of DECCW, certain statutory functions and powers (such as the determination of licence applications and other licensing functions under the POEO Act), are exercised in the name of the EPA by DECCW.

In nearly all other cases the appropriate regulatory authority is the local council. A local council may exercise its powers under the POEO Act *only* in – or in relation to – the local council's area.

Premises that undertake scheduled activities and meet the licensing threshold are licensed and regulated by DECCW. Activity types include coal mines, livestock intensive industries, waste facilities, petroleum works and sewerage treatment systems. For a full list of all the scheduled activities and the classifications under them, refer to Schedule 1 of the POEO Act – see www.legislation.nsw.gov.au/fragview/inforce/act+156+1997+sch.1+0+N.

Environment protection licences issued under the POEO Act set environmental performance requirements. Licences may specify a required performance outcome or a specific environmental management practice. Licence conditions take into account factors such as the surrounding environmental conditions, the type of activity and the available technology. Pollution-reduction programs and pollution studies are often attached to licences, requiring licensees to carry out work within a specified timeframe to comply with environmental requirements. Depending on the type of activity carried out, licensees may be required to undertake monitoring for water, noise or air, for example.

The POEO Act prohibits certain actions that may pose a risk to the environment, including polluting waters (section 120) and leaks and spills of substances (section 116). These restrictions apply to industries and activities whether or not they are licensed.

Under the POEO Act, officers are authorised to exercise regulatory functions including:

- powers of entry and search
- powers to question and identify persons
- powers to issue notices.

The principal types of notices are:

- notices to provide information and records
- clean-up, prevention, prohibition, compliance cost and noise-control notices (see Chapter 4 of the POEO Act, 'Environment protection notices')
- penalty notices.

Environmental planning and assessment Act 1979

All development proposals in NSW – including proposals for the reuse of effluent – must be assessed to ensure they comply with relevant planning controls and, according to their nature and scale, that they are environmentally and socially sustainable. State and local plans and policies indicate the level of assessment required, along with who is responsible for undertaking the assessment – either the local council or the Minister for Planning (the Department of Planning assesses proposals for the Minister).

The development assessment system in NSW is set out in the *Environmental planning and assessment Act 1979* (EP&A Act). The Act provides for public participation in planning decisions that shape a community's future. The Department of Planning primarily administers the Act, including associated regulations regarding planning and development. Environmental planning instruments (state environmental planning policies and local environmental plans) are legal documents that regulate land use and development.

Local environmental plans guide planning decisions for local government areas. Through zoning and development controls, they allow councils to determine the ways in which land is used. Development control plans, prepared according to the EP&A Act, are also used to help achieve the objectives of the local plan. They do so by providing specific, comprehensive requirements for certain types of development or locations. For most types of development proposals, a development application needs to be lodged with the local council to determine if the proposal is permissible on the site and which planning controls may apply.

3 Effluent reuse review

The importance of managing effluent reuse

Effluent is the wastewater arising from certain collection or treatment systems. The systems are associated with such activities as sewerage works, processing industries (livestock, wood, paper or food), intensive livestock, aquaculture or agricultural industries. Reusing effluent by irrigation can significantly help to integrate water resource management. Effluent reuse is encouraged whenever it is safe and feasible to do so and where it provides the best environmental outcome.

Effluent contains valuable resources (water, organic matter and nutrients). However, in excessive amounts these can be detrimental to soils or plant growth. It can also contain chemical contaminants, salts and pathogens. They can pose a risk to the wider environment or public health, or they may cause pollution. These risks can be minimised by careful site selection, design and operation of the effluent irrigation system.

Best management practices that optimise the use of the water, nutrients and organic matter and reduce the potential for harm from other contaminants are also critical. For an effluent irrigation system to be sustainable in the long term, it is important that the correct amount of water, nutrients and chemicals is applied. The amount of effluent applied should be carefully determined to ensure that it is the optimum for the crop, the agronomic system employed, and site-specific factors such as climate, topography and soil. Adjustments to the amount of effluent – or the area over which it is applied – can then be made to ensure that irrigated plants and environments are not stressed by water or by organic material, nutrients or chemicals.

DECCW's 2004 environmental guideline, *Use of effluent by irrigation* (available at www.environment.nsw.gov.au/resources/water/effguide.pdf) sets out a range of environmental performance objectives that apply to the sustainable use of effluent by irrigation.

To achieve sustainable effluent reuse and maximise the value of the effluent resource, licensees conducting effluent reuse activities should meet the following objectives.

1. Protect surface waters

Effluent irrigation systems should be located, designed, constructed and operated so surface waters do not become contaminated by any flow from irrigation areas. These include effluent, rainfall runoff, contaminated sub-surface flows or contaminated groundwater.

2. Protect groundwater

Effluent irrigation areas and systems should be located, designed, constructed and operated in ways that do not diminish groundwater use, either now or in the future. Diminishment can occur from groundwater contamination caused by effluent or runoff from the irrigation scheme. It can also be due to the water tables changing because of over-irrigation.

3. Protect lands

An effluent irrigation system should be ecologically sustainable. In particular, it should maintain or improve the capacity of the land to grow plants. There should be no deterioration of land quality through soil structure degradation, salinisation, waterlogging, chemical contamination or soil erosion.

4. Protect plant and animal health

The design and management of effluent irrigation systems should not compromise the health and productivity of plants, domestic animals, wildlife and the aquatic ecosystem. Risk-management procedures will help avoid or manage the impacts of pathogenic microorganisms, biologically active chemicals, nutrients and oxygen depleting substances.

5. Protect public health risks

The effluent irrigation scheme should be sited, designed, constructed and operated so as not to compromise public health. Give special consideration to providing barriers that prevent human exposure to pathogens and contaminants.

6. Resource use

Identify any potential resources in effluent – such as water, plant nutrients and organic matter – and develop and implement agronomic systems to effectively use these resources.

7. Community amenity

The effluent irrigation system should be located, designed, constructed and operated to avoid unreasonable interference with any commercial activity or the comfortable enjoyment of life and property outside the site. Give special consideration to odour, dust, insects and noise.

The need for a sustainable irrigation system is essential. A program of continuous monitoring and progressive modification is necessary to correct design flaws and deficiencies. It is important to adjust the system as more complete information about the site becomes available, and to accommodate changes in operation over time.

To identify trends, analyse and assess effluent monitoring results on an ongoing basis against previous results and relevant criteria. Effluent irrigation management plans should be tailored specifically for each site. They need to outline the actions, responsibilities and timeframes for monitoring how data is to be collected and analysed. They must specify what information is needed to make informed decisions about effluent reuse activities. These include irrigation scheduling, hydraulic and nutrient loadings, and cropping.

Scope of this review

A range of factors were considered in selecting premises for the effluent reuse review. Various scheduled activities were included across a number of the categories in Schedule 1 of the POEO Act. The selection process also focused on premises that were generating high strength and/or high volumes of effluent, premises that had a higher level scale of operation and those that also conducted soil, effluent and/or groundwater monitoring.

The review examined the following activities:

- managing stormwater
- managing effluent utilisation areas
- maintaining plant and equipment
- assessing data and information including effluent, groundwater and soil monitoring
- quality assurance procedures.

Activities within the review scope were assessed against the audit criteria (i.e. the required performance standards) as follows:

- 24 hours prior to the end of the audit inspection – to assess ‘operating’ conditions relating to effluent reuse
- 12 months prior – to assess ‘monitoring’ conditions
- 12 months prior – to assess ’limit’, ’pollution studies and reduction programs’ and ‘special conditions’ relating to effluent reuse.

In conjunction with the audits, three years of effluent, soil and groundwater monitoring data was collected, and the relevant information was reviewed by DECCW. This information was used to identify issues relating to the long-term sustainability of effluent reuse activities at each audited premises.

Premises audited

The review included 15 premises conducting effluent reuse activities licensed by DECCW under the POEO Act (see Appendix A). The audited premises undertook the following activities:

- agricultural processing – general
- agricultural processing – grapes
- livestock intensive industries – cattle, dairy, sheep, horse and pig accommodation
- livestock processing industries – slaughtering, rendering, tanning, composting, fleece processing.

The audits examined each premises' compliance with their environment protection licence limit, operating, monitoring and recording requirements, and any pollution-reduction programs or special conditions relating to effluent reuse.

Where to find licences

DECCW's public register contains details of all licences issued under the POEO Act. It is available at www.environment.nsw.gov.au/prpoeoapp/searchregister.aspx.

Audit methodology

The compliance audits followed the procedures and protocols in the *Compliance audit handbook*. See www.environment.nsw.gov.au/resources/licensing/cahandbook0613.pdf. Following an audit, the findings are presented to the audited organisation as an individual compliance audit report. Individual compliance audit reports are publicly available in DECCW's Library on Level 15, 59–61 Goulburn Street, Sydney, phone (02) 9995 5000.

The audits were limited to a review of each licensee's compliance with the legislation or statutory instruments administered and issued by DECCW relating to effluent reuse. Audit findings were based on information from DECCW files, information supplied by site representatives and observations made during site inspections.

The audit reports contain an action program outlining any non-compliance, recommended actions and agreed timeframes for compliance. DECCW staff follow-up on compliance audits to ensure the organisation is both implementing the actions required and doing so by the target date outlined in the report. DECCW has a systematic and rigorous monitoring program that tracks these follow-ups to ensure the licensee completes all the required actions.

The findings presented in this report are a collation of those presented in the individual compliance audit reports.

Analysing the risks

The risks associated with the non-compliances identified were assessed and coded according to their environmental significance.

Non-compliances were assessed against two criteria: the likelihood of environmental harm occurring and the level of environmental impact. The likelihood of environmental harm was determined by assessing:

- past environmental performance
- current environmental performance
- potential contributing factors.

The level of environmental impact was assessed by considering such factors as the quantity and toxicity of the material and the sensitivity of the receiving environment.

After these assessments were made, information was transferred into the risk analysis matrix shown in Table 1.

Table 1 Risk analysis matrix

		Likelihood of environmental harm occurring		
		Certain	**Likely**	**Less likely**
Level of environmental impact	**High**	Code red	Code red	Code orange
	Moderate	Code red	Code orange	Code yellow
	Low	Code orange	Code yellow	Code yellow

A non-compliance assessed as 'code red' suggests it is of considerable environmental significance and therefore must be dealt with as a matter of priority. A non-compliance assessed as 'code yellow' suggests that it could receive a lower priority but still must be attended to.

There are also a number of licence conditions such as those relating to administration, monitoring and reporting requirements that do not have a direct environmental significance, but are still important to the integrity of the regulatory system. Non-compliance with these conditions is given a blue colour code.

4 Review findings

This section collectively summaries the various issues identified and reported on in the individual compliance audits conducted by DECCW.

Risk analysis of non-compliances identified

Non-compliances identified during the review were categorised using the risk-analysis matrix illustrated in Table 1.

The percentages of non-compliances found in each category during the audit process are shown in Table 2. This review focused on limit, operating, monitoring and recording requirements and any pollution-reduction programs or special conditions relating to effluent reuse.

Table 2 Percentage of non-compliances found in each risk category

Colour code of issue	Code red (high risk)	Code orange	Code yellow	Code blue	Total
Percentage of issue	1%	1%	24%	74%	100%

Wet-weather management

Stormwater runoff diversion measures are necessary to prevent uncontaminated runoff (originating from outside the irrigation area) from entering the irrigation area. These include adding banks, gutters and drains. Another measure is strategically locating irrigation areas in relation to natural land slopes so that external runoff drains away from, rather than towards the irrigation area.

Runoff diversion should be considered if the local terrain directs uncontaminated runoff onto the irrigation area. Stormwater collected on the site must be regularly used to maintain sufficient storage capacity for future storm events.

Irrigation activities may need to be suspended during wet-weather events. This makes it essential to have adequate storage for the treated effluent until irrigation activities can be resumed.

The following non-compliances with licence requirements were identified:

1. Stormwater diversion

- not effectively separating contaminated and uncontaminated stormwater
- not ensuring contaminated stormwater cannot leave the site before its treatment.

2. Wet-weather storage

- not ensuring sufficient capacity of ponds used to store treated effluent during wet-weather conditions, making overflows and water pollution more likely.

This pond has sufficient residual capacity to store effluent during wet-weather conditions (photo: M Hatzakis/DECCW)

Effluent management

Effluent generated from on-site processes must be effectively collected using properly constructed drainage systems. The major risks associated with human or animal contact with effluent are from infection by microorganisms, such as bacteria, viruses, protozoa or helminths. Populations of microorganisms and nutrients in wastewater are reduced through treatment processes, which may include screening, solids removal, ponding, filtration, chlorine, ozone and ultraviolet treatments.

The level of effluent-treatment required depends on the end-use of the plant crop being irrigated, whether or not humans or animals can be excluded from the irrigation area for a period of time and the potential for pathogens in the effluent to infect humans or animals.

Effluent undergoing treatment or storage should be contained in structures with sufficient capacity to contain the volume generated. They should not leak or overflow and should be capable of effectively treating the effluent to the required standard.

The following non-compliances with licence requirements were identified:

1. Collection

- not maintaining effluent collection drains in a proper and efficient condition – the failure to control the vegetation growth caused blockages in the effluent collection drainage system.

2. Treatment

- not maintaining effluent treatment ponds in a proper and efficient condition – the failure to control the vegetation growth on anaerobic ponds, along with failure to operate maturation ponds in an aerobic state, resulted in ineffective treatment

- not excluding blood and paunch from the wastewater treatment and disposal system – this resulted in an increased level of nutrients and solids entering the treatment system
- not conducting regular desludging of effluent treatment ponds to maintain storage capacity.

3. Storage

- not maintaining effluent treatment ponds in a proper and efficient condition – resulting in reduced storage capacity
- not maintaining effluent storage tanks in a proper and efficient condition – resulting in leaks.

Effluent reuse

The irrigation methods used depend on many aspects: site topography, soil type, species of plants to be grown, cost, effluent quality, labour availability, power requirements, and public health and environment considerations. Effluent may be applied to a site by trickle, spray, drip, furrow or flood irrigation systems. Infiltration rates of soil should be considered when determining the type of irrigation method to be used and the way it is operated. To avoid surface runoff, effluent should be applied uniformly and at a rate less that the nominal infiltration rate.

Scheduling irrigation is one of the irrigation manager's most important functions. Excessively long intervals without irrigation can lead to water stress and crop loss. Irrigating too often can waterlog the soil and allow excess effluent to runoff or percolate to groundwater, resulting in water pollution. To avoid overloading the application site, an irrigation schedule should be based on knowledge of the water content of the soil and the water requirements of the cultivated crop. The quantity of effluent being applied to the application area should not exceed the area's capacity to effectively use the nutrients, salt, hydraulic load and organic material.

In certain circumstances, irrigation can be applied evenly and at a rate that does not result in surface ponding and runoff. However, for some irrigation systems, a tailwater collection system is necessary to ensure tailwater is effectively collected and stored so it can be applied later. The collected tailwater should be regularly reapplied to the irrigation area. This ensures the tailwater system retains sufficient capacity to contain any runoff from future irrigation activities.

The following non-compliances with licence requirements were identified:

1. Irrigation area

- not maintaining flood irrigation channels in a proper and efficient condition – failing to control vegetation growth impeded the flow of water through channels
- not maintaining a tailwater dam in a proper and efficient condition – failing to control vegetation growth, resulting in a reduced capacity
- not maintaining irrigation pipes in a proper and efficient condition – resulting in leaks in the pipes and ponding on the irrigation area
- not ensuring the irrigation area was able to effectively utilise the quantity of effluent that had been applied – resulting in surface water, ponding and runoff on the reuse area
- not ensuring effluent irrigation was carried out at least 50 m from a watercourse – increasing the potential for water pollution
- conducting irrigation activities on paddocks not specified on the licence
- applying effluent without an irrigation schedule in place – resulting in the effluent being over-applied and unevenly distributed over the reuse area
- conducting unsupervised irrigation activities at night – resulting in the potential for spray drift or effluent discharges from the reuse area.

Good effluent reuse practices increase crop health and prevent soil contamination
(photo: J Ramadan/DECCW)

Monitoring and recording

Monitoring is an important management tool that helps minimise the environmental impacts of activities. In industry, it means collecting information that characterises changes in environmental emissions. Careful monitoring warns if appropriate action is required, when the data indicates the quantity and /or nature of discharges are changing.

Effective monitoring requires the ongoing analysis and assessment of measurement results. To identify trends, the results need to be compared with previous results and relevant criteria.

Collecting and recording data

Collecting data following strict procedures is important to ensure its integrity and accuracy. Rigorous data collection is the foundation for assessing environmental impacts.

Improperly collected data can compromise effective site-operations management and potentially harm the environment.

Samples collected should represent the condition being investigated, and taken in a manner consistent with the relevant standards for water (AS/NZS 1998 and DEC 2004).

It is important to systematically record any monitoring information and observations collected during sampling and analysis. Good record keeping will ensure all supporting documentation and observations are kept for future reference.

The following non-compliances with licence requirements were identified:

- not keeping records of the times and dates the samples were taken, the name of the person who collected the samples and the point at which the samples were taken

- not monitoring the volume, mass or concentration of all pollutants specified by the licence at the required frequency, not using the correct units of measure and not using the correct sampling method to ensure the accuracy of data collected
- not monitoring the concentration of pollutants at the correct location specified by the licence
- not keeping monitoring records in a legible form and not keeping records for the specified time period required by the licence
- not monitoring weather parameters and not using the correct units of measure or the averaging period specified by the licence
- not conducting monitoring of all pollutants using the correct sampling method.

Analysing and converting data

Environment protection licences require licensees to analyse samples collected according to DECCW's approved methods (DEC 2004). By doing so, DECCW is assured the samples are quality control tested to provide accurate and reliable data. Analyses should be undertaken by an independent accreditation body acceptable to DECCW, such as the National Association of Testing Authorities (NATA), or equivalent.

Data analysis may include consideration of data quality, validity and adequacy to ensure that reliable information is produced.

The following non-compliances with licence requirements were identified:

- not undertaking the analysis of the concentrations of discharged water pollutants according to the methods specified in the *Approved methods for the sampling and analysis of water pollutants in New South Wales* (DEC 2004a)
- not undertaking the analysis of the concentration of pollutants in solids and soils according to DECCW-approved methods
- laboratories commissioned to undertake the analysis of water samples were not accredited by a certifying authority, such as NATA, to undertake the analysis of certain pollutants, therefore the data collected may not be accurate and reliable
- water-quality samples were not correctly handled and preserved during transport to the laboratory for analysis, resulting in potentially inaccurate results.

Assessing information

The data from the analysis process is used to determine if limits specified by environment protection licences are exceeded, and to compare them against historical data.

Where licence limits are exceeded, licensees should ensure that site operations are reviewed and practices implemented to improve the level of environmental performance and compliance.

The following non-compliances with licence requirements were identified:

- concentration limits for effluent discharged to utilisation areas were exceeded, potentially increasing the risk of harm to the environment.

Special conditions relating to effluent reuse

The following non-compliance with licence requirements were identified:

- not submitting a report with the annual return that analyses and interprets the groundwater monitoring results, and lists actions to correct the identified adverse trends.

5 After the review

Follow-up by DECCW

DECCW's follow-up confirms any issues identified during the compliance audits are being dealt with by the licensees to improve environmental performance. These include:

- ensuring uncontaminated and contaminated stormwater is properly segregated and preventing contaminated stormwater from leaving the site before it has been treated
- ensuring the site has enough wet-weather storage to hold effluent throughout the wet-weather period and until conditions are suitable for irrigation
- maintaining the storage capacity of the treatment ponds by regularly desludging them
- ensuring any nutrient-rich materials, such as blood and paunch, are separated and prevented from entering the effluent stream so the amount of solids and nutrients requiring treatment is reduced
- undertaking regular maintenance of the effluent reuse system, including collection drains, treatment and tailwater dams, storage tanks, flood irrigation channels and transport system pipes
- monitoring the volume, mass and concentration of pollutants in effluent applied to each irrigation area – this is to ensure the crops' effective use of effluent does not cause ponding or contaminated runoff from the irrigation area
- undertaking effluent irrigation and monitoring as required by the licence and at the locations the licence specifies
- ensuring effluent is applied only on those paddocks the licence specifies and at least 50 m from any watercourse to reduce the risk of water-pollution
- undertaking irrigation activities at night only where adequate measures are in place to prevent spray drift or effluent runoff from the reuse area
- keeping relevant records of any samples collected and ensuring they are collected in the location specified by the licence
- keeping all monitoring records in a legible form and for the time period specified by the licence
- ensuring that weather parameters are monitored and reported in the units of measure specified by the licence
- using the correct sampling method to collect samples for analysing all pollutants
- having samples analysed for pollutants at laboratories accredited by a certification authority, such as NATA
- meeting the methods specified in the approved methods manual (DEC 2004a) or as approved by the DECCW to provide confidence that results accurately reflect what is occurring onsite
- correctly handling and preserving water samples before transporting them to the laboratory to ensure the results are accurate
- submitting the annual return – including a monitoring report that analyses and interprets the groundwater monitoring results – along with a list of actions that will be taken to correct any adverse trends, as specified by the licence.

Integration with licence reviews

The findings of this review will be used to guide the review of environment protection licences. Section 78 of the POEO Act requires DECCW to review environment protection licences once every five years. These licence reviews:

- focus on desired environmental outcomes
- enhance consistency between licences issued to an industry
- improve the effectiveness of the licensing system
- strengthen DECCW's accountability to stakeholders.

Integrating these reviews with other regulatory activities, such as compliance audit programs, results in a holistic approach to licensing.

This review's findings will help DECCW assess any future applications for new licences. They will also make sure the monitoring requirements effectively deal with any potential environmental impacts.

6 Best environmental management practices for effluent reuse

Using recycled water to irrigate crops is beneficial to the environment because it draws on a resource that would otherwise be discarded and wasted. It also reduces environmental water usage, thereby further easing environmental pressure. However, some things need considering before reusing effluent. These include the presence of chemical contaminants, along with salinity and the potential impact on soil structure. Generally these can be controlled by using best environmental management practices.

This section of the review promotes the use of best management practices in planning, design, construction, operation and management of effluent irrigation systems to achieve a beneficial environmental outcome.

Guidance materials and standards

While reviewing the best environmental management practices for effluent reuse, DECCW researched current environmental management standards and guidance in the Australian Standards and codes of practice, along with guidelines addressing environmental risk. DECCW also identified best environment management practices from other jurisdictions and operations that could further enhance the effective management of effluent reuse activities.

The following guidance material is particularly relevant to effluent reuse activities:

- DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004), available at www.environment.nsw.gov.au/resources/water/effguide.pdf.
- *Resource manual of development of indicators of sustainability for effluent reuse in the intensive livestock industries: piggeries and cattle feedlots* (McGahan E & Tucker R 2003).
- *Environmental best practice guidelines for the red meat processing industry* (Meat and Livestock Australia Limited, 2007).
- AS/NZS 5667.1:1998 provides general principles to apply in the design of sampling programs, sampling techniques and on the procedures to be taken to preserve and transport samples.
- *Approved methods for the sampling and analysis of water pollutants in New South Wales* (DEC 2004a) lists the sampling and analysis methods to use when complying with a requirement by, or under, the environment protection legislation, or a licence or notice under that legislation, to test for the presence or concentration of matter in water and the volume, depth and flow of water or wastewater; see www.environment.nsw.gov.au/resources/water/approvedmethods-water.pdf.

In NSW, DECCW and other government agencies and industries have produced other guidelines to help organisations deal with environmental impacts (see reference list). They will help organisations plan for potential environmental events by:

- identifying and understanding statutory compliance obligations
- identifying and ranking environmental issues specific to each site
- preparing a monitoring and reporting plan.

DECCW has produced a valuable resource, *Environmental management planning*. It aims to help industries build more sustainable organisations, including a commitment (policy and strategy) to drive environmental improvement, see www.environment.nsw.gov.au/sustainbus/envmgtplanning.htm.

The following best environmental management practices on effluent reuse have been extracted from the research of the standards, codes of practice and guidelines.

Effluent quality

Effluent contains valuable resources, such as organic matter and nutrients. However, it also can contain concentrations of chemical contaminants, salts and pathogens. These may be potentially detrimental to soils or plant growth. Some may pose a risk to the wider environment or public health. Determining effluent quality is vital when planning and designing sustainable effluent reuse systems.

Generally effluent contains dissolved mineral salts, including sodium, calcium, potassium, magnesium, boron, chloride, sulfate, carbonate and bicarbonate. Most salts are present in effluent as dissolved ions (charged particles), which can conduct an electric current.

Effluent can often contain significant concentrations of organic and inorganic nutrients; for example, nitrogen and phosphate. Where these nutrients are present in effluent, they could potentially be used as fertiliser when the effluent is irrigated for agricultural purposes.

The concentration of pathogens will also affect effluent quality. So consider public health risks when reusing effluent or managing it on site.

Depending on the concentrations of mineral salts, nutrients other potential contaminants, effluent is classified into high, medium or low strength. The classification of effluent for environmental management is found in Table 3.1 ‘Classification of effluent for environmental management’ in DECCW’S environmental guideline, *Use of effluent by irrigation* (DEC 2004). www.environment.nsw.gov.au/resources/water/effguide.pdf.

Determining the effluent’s quality is also important to ensure that its application:

- is proven to benefit both soil and plant growth
- will not harm the quality of the soil, ground or surface water.

Knowing the quality of effluent helps the user decide on the design of the effluent irrigation system including the level of treatment needed, the land area required for irrigation, the plants that may be grown and the appropriate application rates.

Site considerations

There are important considerations when selecting land for effluent reuse. These include the characteristics of an effluent irrigation area and its location relative to neighbouring properties, creeks, and groundwater. Assessing these characteristics will help reveal constraints to effluent irrigation and indicate which irrigation system best suits the site.

The key factors governing the suitability of a site for irrigating effluent are:

- topography (land conditions and land slopes)
- soil considerations
- proximity of surface and groundwater
- climate
- land-use conflicts (proximity of neighbours)
- availability of sufficient land for irrigation.

Topography (land conditions and land slopes)

In order to avoid effluent entering the waterways after it has been applied to land, sites with the following characteristics should be avoided:

- slopes running toward a watercourse, spring or borehole
- areas likely to flood
- drainage lines and incised channels
- areas that freeze over
- sites that have recently been cleared of trees, or have been similarly disturbed.

Guidance on selecting land suitable for irrigation with effluent is in Table 2.1 'Landform requirements for effluent irrigation systems' in DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004). See www.environment.nsw.gov.au/resources/water/effguide.pdf.

Soil considerations

The characteristics of the soil profile under a particular site are very important. They help determine the site's suitability for effluent irrigation as well as the application methods. The quality of effluent used for effluent irrigation may contain high concentrations of nutrients and possibly salts, which could degrade the soil. So it is vital to analyse the soil's physical and chemical properties. This will determine what needs to be done to protect the soil.

Degradation could result in:

- soil structure breakdown
- restricted plant growth
- erosion
- salinity
- release of contaminants to surface- or groundwaters.

When assessing potential sites for effluent irrigation, get a qualified soil scientist to conduct a preliminary soil survey or soil investigation. They can identify potentially suitable sites for effluent irrigation.

Based on the preliminary survey, a detailed survey should be undertaken of the selected sites. Its aim is to:

- confirm the suitability of each proposed site
- identify any soil limitations that will require special management practice
- collect baseline data for any future soil monitoring programs

Soil characteristics relating to their suitability for effluent irrigation can be found in Table 2.2: 'Typical soil characteristics for effluent irrigation systems' in DECCW's environmental guideline, *Use of effluent in irrigation* (DEC 2004). See www.environment.nsw.gov.au/resources/water/effguide.pdf.

Proximity to surface and groundwater

It is important to identify where the surface water and groundwater systems are in relation to the effluent irrigation area. If the groundwater is shallow (less than 0.5 m below the surface), effluent irrigation is generally not possible because there is a very high risk the groundwater will get contaminated.

In some circumstances a very high level of protection is required. Runoff from the irrigation area needs to be captured and prevented from entering the surface water system. For example, if the local creek or groundwater system forms part of a drinking water supply catchment, then the restrictions on runoff and infiltration will be more stringent.

Generally stormwater runoff capture will not be required if the receiving environment is less sensitive, and the potential for contamination is very small.

To minimise the risk of runoff from the effluent irrigation area, it is necessary to ensure that:

- any irrigation systems in close proximity to surface waters are well-designed and managed
- the nutrient loading is appropriate for the soil and plants being irrigated so that contaminants are not mobilised
- an adequate buffer zone is provided between the irrigation area and any surface water body.

When assessing the impact of effluent irrigation on groundwater, it is important to consider the existing groundwater quality and the site's proximity to groundwater discharge sites or water supply wells. Also implement these measures:

- establish baseline groundwater monitoring to detect deterioration of groundwater quality
- protect groundwaters by avoiding areas where there are existing shallow or rising groundwater tables, perched water tables, groundwater recharge areas or where groundwater is already polluted
- maintain a minimum groundwater depth to promote aerobic conditions in the soil and prevent surface waterlogging
- protect groundwater from contamination by irrigated effluent (of particular concern is the potential contamination by nitrogen compounds, salts and toxic contaminants)
- develop a program to monitor soil water content, and combine this with strategies to suspend irrigation when soil moisture content is high
- measure rainfall and pan evaporation and conduct occasional checks against soil moisture.

Climate

Local climate determines which plants can be grown and how much irrigation water can be applied. During those times of the year when rainfall exceeds evaporation, or soil temperatures are low, spreading effluent is inadvisable, so it needs to be stored. Choosing a site that has the required climatic conditions for effluent irrigation is one of the best ways to prevent effluent from entering waterways.

Land-use conflicts (proximity to neighbours)

When selecting a site for effluent irrigation, consider the potential impacts on surrounding land uses and sensitive environments. These include neighbouring properties, public roads, surface and groundwater and environmentally sensitive areas such as drinking-water catchments, wetlands and native vegetation.

Some sensitive areas, along with general impacts of concern, are listed in Table 4.8 'Sensitive receptors of effluent irrigation schemes' in DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004), see www.environment.nsw.gov.au/resources/water/effguide.pdf.

Availability of sufficient land for irrigation

When selecting the areas on a property to use for effluent irrigation, remember to obtain regulatory approval for land space sufficient enough to carry out irrigation.

The effluent reuse review highlighted a case when the area available for effluent irrigation was insufficient to take up the effluent irrigated. This caused runoff, which could lead to water pollution.

If there is not enough suitable land, arrangements must be made to apply the excess effluent on suitable land elsewhere. Alternatively, have a back-up effluent treatment and disposal system.

The area required for sustainable irrigation should be calculated based on the sustainable load of water, nutrient and effluent contaminants that can be applied to land without any of these nutrients, salt, metals etc. degrading or contaminating the surrounding environment. Also consider whether full or partial reuse of effluent is appropriate, along with any requirements for wet-weather storage when rainfall events prevent irrigation activities (DEC 2004).

Irrigation management

Good irrigation management will ensure effluent reuse operations are sustainable. Any effluent irrigation operation should employ best management measures to ensure its long-term sustainability.

Effluent irrigation management plans

Anyone using irrigation is encouraged to make and use a plan that ensures the irrigation system is sustainably managed.

This plan should help identify potential environmental impacts from the operation and also incorporate ways to minimise these impacts, including:

- quantity and quality of the effluent being applied
- characteristics of the soil underlying the irrigation area
- depth and quality of groundwater beneath the irrigation area
- how the effluent will be applied
- controls to collect tailwater and stormwater
- how effluent will be stored (including wet-weather storage)
- the water balance for the irrigation area
- the irrigation system's hydraulic loading rate
- irrigation scheduling
- types of crop or pasture that could be grown to assimilate nutrients being applied
- the nutrient balance for the irrigation area
- a sampling and monitoring program of soils, vegetation and groundwater to monitor the fate of the nutrients applied during irrigation
- how the monitoring data will be recorded and interpreted to ensure long-term sustainability of effluent reuse.

An annual review of the performance of the irrigation management system using data collected on the operation and environmental performance should be conducted. Plans should also be reviewed regularly and updated when circumstances change.

Managing irrigation areas

It is essential to manage irrigation areas to minimise the environmental impact of effluent irrigation. Effective management of an effluent application area should aim to:

- maximise the removal of nutrients in the crops harvested
- balance, on an annual basis, the amount of nitrogen spread with the amount removed
- prevent runoff of nutrients
- prevent loss of nutrients below the root zone of the crop or pasture
- minimise disease risks to humans and livestock.

The review highlighted cases when the rate of effluent application was too high for the irrigation area to effectively use the effluent. It caused ponding and runoff on the reuse area.

When applying effluent, it needs to be spread over sufficient area to avoid concentrating nutrients and water in one location. Allowing for rest periods between applications lets the bacteria in the soil to break down the effluent's organic matter. This prevents a decline in the soil infiltration rates. To avoid surface ponding in the irrigation area, it is good practice to apply effluent in several low-volume applications rather than a large volume at once. The quantity of nutrients applied in the effluent should be closely matched to the nutrient requirement of the pasture or crop to obtain the best value from the irrigated effluent and ensure minimum nutrient loss.

The review highlighted cases when flood irrigation channels were not maintained in a proper and efficient manner. This was because vegetation growth had not been controlled and it impeded the flow of effluent. It also showed that some licensees were irrigating effluent unsupervised at night time, increasing the risk of spray drift or effluent discharges from the irrigation area.

Adopting the following measures will help sustainably manage effluent reuse:

- do not allow irrigated effluent to escape to any watercourse
- do not apply treated effluent to land if soil moisture conditions mean surface run-off or ponding is likely to occur
- regularly inspect and maintain diversion banks, drains and holding dams
- control spray irrigation so the spray does not drift beyond the site boundary
- do not carry out irrigation of treated effluent to land within 50 m of any major watercourse
- maintain the irrigation area in a proper and efficient condition to provide adequate assimilation, percolation, evaporation and transpiration of the irrigated effluent.

The effluent reuse review highlighted cases when effluent was being irrigated within 50 m of a watercourse, increasing the risk of water pollution.

Providing screening and buffer zones

Screen the effluent irrigation areas and irrigation infrastructure, such as storage ponds, from neighbours and sensitive environments. Screening protects local amenities, surface and groundwaters.

The size of the buffer zone will depend on the sensitivity of the receiving environment, the strength of the effluent, the extent and method of effluent application, irrigation management practices (such as irrigation scheduling) and proposed impact-mitigation strategies.

The recommended buffer distances to water resources and public areas are given in Table 4.9 'Recommended buffer distances to water resources and public areas' of DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004). Generally a buffer of 50 m is recommended to prevent spray drift near houses, schools, playing fields, roads, public open space and waterbodies. Narrower buffers may be appropriate where high-quality effluent or a low volume of effluent is used or vegetated filter strips are applied. Wider buffers may be necessary where there are limiting site characteristics, such as issues with soil type or land slope.

Managing runoff

Manage runoff on site to ensure the ground- and surface waters do not become contaminated by any flow from irrigation areas.

To effectively manage runoff, adopt these measures:

- use diversion banks to prevent all uncontaminated stormwater from entering the irrigation area
- direct all tailwater and stormwater from the irrigation area to the tailwater dam
- maintain all bunds, supply channels and drains in good condition, especially at the end of the wet season
- inspect all bunds, supply channels and drains at least once a month.

The review highlighted one instance when a licensee was not segregating contaminated and uncontaminated stormwater. Contaminated stormwater was also not being collected effectively. This gave it the potential to leave the site before it was treated. Also, some licensees were not maintaining tailwater dams in a proper and efficient manner, ultimately reducing the capacity of their dams.

DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004) has measures for managing runoff from irrigation areas.

Maintaining drains and channels in good condition helps minimise the risk of uncontrolled runoff and overflows to adjacent watercourses (photo: A Ronpage-Drabe/DECCW)

Selecting the type of irrigation method

The selection of the method of irrigation depends on:

- site topography
- soil type
- crop types
- effluent quality
- capital and operating costs.

The infiltration rate of soil is an important consideration when choosing the type of irrigation method to use and how it will be operated. Effluent should be applied uniformly and at a rate less than the nominal infiltration rate to avoid surface runoff.

There are three basic methods of irrigation: surface, spray and micro irrigation.

1. Surface irrigation

Generally surface irrigation allows water to be applied rapidly and evenly over the application area. It best suits crops that are not damaged by short periods of flooding and on soils where infiltration rates are neither extremely low nor high. The potential disadvantage of surface irrigation is that over-application of effluent can lead to runoff into waterways. Land levelling can improve irrigation uniformity on non-uniform slopes and prevent runoff or deep percolation. Proper maintenance of the transport channels and drains will ensure seepage losses do not occur.

The review highlighted an instance when the poor maintenance of irrigation transport channels resulted in seepage and waterlogging of the irrigation area.

2. Spray irrigation

Water is applied in the form of a spray and reaches the soil very much like rainfall (e.g. portable and solid set sprinklers, travelling sprinklers, spray guns, centre-pivot systems, etc). The application rate should be adjusted so that ponding of water on the surface is not created and so that application rates are consistent with infiltration rates and the slope of the soil. High application rates can result in surface runoff or ponding and deep percolation losses. Low application rates can be inefficient due to excessive evaporation.

3. Micro irrigation

Water is applied around each plant or group of plants so it only wets the local area and the root zone (e.g. drip irrigation, bubblers, micro-sprinklers, etc.) Adjust the application rate to meet evapotranspiration needs and minimise percolation losses. Micro-irrigation systems, such as drip or micro-sprinklers, offer the advantage of precise nutrient and effluent management. Fertilisers and some pesticides can be injected near the end of the irrigation application with uniformity and minimal leaching. Although these systems provide uniform application rates, are efficient, and have low labour requirements, they do have high installation costs as well as the potential for clogging.

A travelling sprinkler – the irrigation method selected depends on how much effluent is available for irrigation, the climate, the soil, which crops are to be grown and the potential environmental impact (photo: R West/DECCW)

Irrigation scheduling

One of the most important best management practices for irrigating effluent is appropriate scheduling, based on timely measurements or on estimates of soil moisture content and how much water the crop needs. Irrigation scheduling allows operators to make decisions about when to irrigate and how much effluent to apply. By knowing how much moisture is in the soil and how quickly the crop is using it, irrigation times can be planned in advance.

The review highlighted instances when applying effluent without an irrigation schedule resulted in its over-application on the reuse area. It was also unevenly distributed.

Irrigation scheduling of effluent depends on three main factors:

- the quality of the effluent and the impact it will have on the nutrient balance for the site
- the moisture content of the soil and the amount of water for the root zone
- weather considerations such as wind, rainfall and temperature.

The limiting factor for most effluent irrigation sites is the nutrient load applied to the site. Where higher strength effluent is used, the most appropriate strategy is to maintain a soil water deficit. This aims to stress the crops at specific stages in their growth cycle, and maintain a high yield. It ensures the soils and cropping regime have the capacity to use available nutrients.

Irrigation scheduling also needs to take into account the level of moisture stored in the soil. If the soil is saturated, excess water can leach into groundwater, pond on the surface or run off.

It is also important to consider the climate of the effluent irrigation area when designing the irrigation scheduling system. The regional climate and annual water deficit (the difference between rainfall and evaporation) should be used to determine the irrigation requirements and the most suitable method of irrigation.

For an effective effluent irrigation system, the right amount of effluent must be applied at the right times to meet the crops' requirements, while also ensuring that increases in runoff and percolation are minimised.

Consider these best management practices for irrigation scheduling:

- understand the water storage (holding) capacity of soil in the root zone of plants (know how much water to apply to the site and keep records)
- match the application rate (or the discharge and duration for flood irrigation) to the rate at which water is absorbed (know how long to irrigate)
- understand when to schedule irrigation by measuring soil moisture or analysing weather (e.g. comparing evaporation and rainfall) and/or plant requirements (know how often to irrigate)
- apply water evenly with an irrigation system designed to match soil types and use well maintained irrigation equipment
- for flood irrigation, use level surfaces and adopt an automated system
- analyse irrigation water quality periodically, and assess how the amount of nutrients in the effluent can be used for crop requirements
- seek expert advice to help schedule irrigation activities and determine the application efficiency of your system.

Effluent treatment and storage

Ponds are the most commonly used system for the treatment and storage of effluent, including the storage of tailwater, in irrigation areas.

Effluent treatment ponds

A common pond system used for effluent treatment involves anaerobic ponds followed by aerobic ponds. Sometimes a facultative pond may be placed between the anaerobic and aerobic ponds to ensure better treatment of the effluent in the aerobic pond.

When storage ponds are used to treat effluent, sedimentation systems should be designed to settle solids prior to entry into ponds. This ensures ponds are not overloaded with nutrients and prevents excessive build-up of sludge.

The effluent reuse review highlighted a case when the poor separation of blood and paunch from the effluent stream caused increased levels of nutrients and solids to enter the treatment system. In other cases, excessive vegetation growth caused blockages in the effluent collection drainage system. This impeded the smooth flow of effluent to the treatment ponds.

Settleable solids reduce a treatment ponds' capacity. Operators need to set up and follow maintenance plans and schedules that include regular sludge level monitoring and removal.

A properly functioning effluent treatment system will have negligible odour (although all ponds have some smell due to the nature of the treatment processes). When performing correctly, a pond will also have a typical colour and appearance. Several things can cause offensive odours or a change in the pond's appearance and health, including:

- algal growths and decomposition of algal matter
- low light intensity coupled with reduced algal growth can cause septic conditions in the ponds
- high temperatures stimulating anaerobic bacteria at pond floor, which result in increased loadings and possible anaerobic conditions
- pond overloading.

If odour is a problem, it is important to establish the reasons and source of the pond's poor performance, then deal with the cause to remedy the issue.

The effluent reuse review highlighted cases when the uncontrolled growth of vegetation in both anaerobic and aerobic ponds impacted the treatment system's effectiveness, causing odourous emissions.

Effluent storage ponds

When a storage pond will be used to store untreated effluent, the sedimentation system must be designed so the solids settle before the effluent enters the pond. This ensures the pond is not overloaded with nutrients and prevents excessive build-up of sludge.

It is important to develop and implement maintenance plans and schedules for effluent-storage ponds.

The effluent reuse review highlighted cases when effluent storage ponds/tanks not being maintained in a proper and efficient condition resulted in reduced storage capacity and leaks.

Storage ponds need to be monitored and managed to ensure they have the capacity to store wastewater in order to:

- equalise daily variations in flow from the effluent treatment system and to store excess effluent when average effluent flow exceeds irrigation demands
- meet peak irrigation demands in excess of the average effluent flow
- minimise the effects of any disruptions to effluent treatment and irrigation system operations and to provide additional time to resolve temporary water-quality problems.

Storage of effluent during wet weather

Managing wet weather storage is an important way to help minimise an irrigation system's environmental impact. Because climate and weather patterns vary, there will be periods of wet weather when irrigation is not possible. This means effluent needs to be stored until conditions are suitable for irrigation.

The review highlighted one case where a licensee did not have adequate wet-weather storage capacity in their storage ponds. This increased the risk of the ponds overflowing and polluting nearby waters.

Wet-weather storage needs to be sized to match the rate of effluent produced and the regional climate of the site. Storage ponds must be managed so they have the capacity to store effluent during wet-weather conditions. This means irrigation needs to be carefully scheduled and carried out to make sure the maximum amount of effluent is applied. This in turn helps ensure the availability of adequate wet-weather storage capacity.

General design and maintenance of treatment/storage ponds

All ponds must be designed to prevent any uncontrolled discharge of untreated or partially treated effluent to adjoining land, soils, groundwater or water bodies. The base of the storage pond must be higher than the highest seasonal groundwater level. Design the embankments to prevent inflow of stormwater/surface runoff or outflow of effluent and to prevent overtopping. In areas with potential for flooding, the embankment of the pond must be above the 'one in 25-year' flood level for that area.

Line effluent ponds with an impervious material (e.g. compacted clay and/or a synthetic membrane to prevent seepage). If clay is used, it should be sufficiently thick. It must also have an in-situ coefficient of permeability no greater than 1×10^{-9} m/sec (EPA 1996).
A geotechnical engineer can test the material's permeability and its optimum moisture for compaction. The clay lining should be protected from desiccation during the pond's construction.

If synthetic membranes are used for lining ponds, they should be uniform in thickness across the entire area of the lining. They must be free from pinholes, blisters and contaminants. Joints and seals should be tight to ensure they are watertight.

Consider, where applicable, these pond management and maintenance measures:

- reduce the potential for solids and fibrous material to enter the ponds
- check pond banks for evidence of erosion (or indications that erosion will take place)
- check all inlet and outlet pipework and structures regularly to ensure they are operating effectively
- check all pumps to ensure they are working
- check for any weeds on pond banks, and the water surface and waterline for vegetation and weeds
- plant vegetation such as pasture on the upper banks to prevent erosion or collapse of pond edges from wave action (trees are unsuitable)
- design ponds so they are easily cleaned and desludged
- desludge the ponds to ensure that sludge levels do not severely reduce the pond's capacity
- check the clay lining of a pond after desludging to ensure its structure and integrity has not been damaged or compromised – any damage to the lining will need to be repaired before effluent can be reintroduced into that pond.

Monitoring effluent reuse activities

Over time, the ongoing monitoring of effluent reuse activities will give the operator enough information to help them manage the environmental risks and impacts on the receiving environment.

Effluent quality monitoring

Regularly analyse the effluent to quantify the mass of nutrients applied. The results should be matched to the expected or measured nutrient uptake by crops, plus nitrogen volatilisation losses and phosphorus storage. Do this at least annually and also when irrigation is about to start. If consistent results are obtained over several years, less frequent sampling may be appropriate.

Use effluent analysis results to match the rate at which the effluent can be applied with the rate of nutrient removal from the application area. If the effluent is diluted with fresh water, conduct the effluent quality sampling *after* dilution *and* at the final storage point *before* applying it to the land. This helps accurately determine the quantity of nutrients being applied to each irrigation area. It will assist in effectively calculating the nutrient balances.

Beneficial effluent reuse practice 1

Use analysis results for treated effluent to make decisions about the most efficient way to blend treated effluent with stormwater before reusing it on the irrigation area.

Effluent volume monitoring – hydraulic loading

Measure – or estimate – the amount of effluent applied to the irrigation area. Use weirs or flumes to measure the water flow in open channels. Flow meters can be used to measure the volume of effluent irrigated in pump systems. Alternatively, volume can be estimated by recording the number of hours of operation multiplied by the pump rate. Once the application rate is known, the volume of effluent that can be applied to the irrigation area can be calculated.

By recording the individual volumes of effluent being applied to each reuse area at the site, it is possible to determine the nutrient and hydraulic load for each area. This will help reveal if an area has too many nutrients being applied.

The amount and timing of effluent applied – and the area over which it is applied – needs to be monitored and adjusted to ensure that irrigated plants and the environment are not stressed by water. Crop irrigation often requires a leaching fraction to manage salts in the effluent, which accumulate in soils. However, excess application of effluent to surface soils can result in various on-site and off-site environmental consequences. These include surface water runoff, excess groundwater recharge, waterlogging, ineffective phosphorus sorption and 'secondary' salinity.

Undertake a water-balance calculation – which includes rainfall, evaporation and irrigation scheduling – to calculate the requirements for irrigation and wet-weather storage.

Models can be used to predict sustainable land areas and wet-weather storage requirements.

The DECCW model, effluent reuse irrigation model (ERIM), can be used to calculate water balances. Copies of the ERIM model on CD can be requested from DECCW's Environment Line: 131 555. Other relevant models could also be used.

Monitoring effluent parameters

A summary of general recommended effluent monitoring requirements can be found in Table 5.1 'Recommended effluent sampling frequency' in DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004). It includes the types of analytes that may be monitored for a range of different strengths of effluent being irrigated. It shows how often sampling is required. See www.environment.nsw.gov.au/resources/water/effguide.pdf.

Beneficial effluent reuse practice 2

To ensure treatment processes are working effectively, conduct additional process monitoring for a range of pollutants that are not required under the licence.

Solids and sludge quality

Soil monitoring

Soils in the irrigation area need to be monitored regularly to ensure crops are assimilating the nutrients being applied and no nutrient build-up is occurring. Generally, annual sampling should be carried out at a time that fits in with production or cropping requirements, or as specified by the licence requirements. Samples need to be taken at about the same time each year. Topsoil samples are usually taken to 10–20 cm depth and deep-soil cores are taken to 1 m or the bottom of the root zone. Deep-soil samples can help monitor the potential for nutrient leaching.

When selecting the number of soil-monitoring sites at each area, consider the size of the effluent reuse area. Monitoring each paddock or effluent reuse area provides more accurate data, as effluent application can vary in volume, quality and frequency across each paddock. Samples should be collected from all the soil types on the paddock, and from areas growing different crops.

Further information – including recommended parameters, frequencies and depths – can be found in Table 5.2 'Recommended soil monitoring strategy' in DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004). See www.environment.nsw.gov.au/resources/water/effguide.pdf.

Monitoring crop yield and nutrient content

Each year, measure the dry-matter yield and nutrient content of crops or pasture harvested from the irrigation area. Estimate the amount of nutrients removed by grazing animals. This information can then be used to fine-tune the application rate of effluent and solids.

Beneficial effluent reuse practice 3

Undertake trials of a broad range of crops to identify those best suited for nutrient removal. Take into account the soil type, climate and water quality.

The quantity of nutrients removed during harvesting from the irrigation area can be increased by selecting appropriate crops; for example, sorghum is excellent for taking up phosphorus and potassium (photo: A Ronpage-Drabe/DECCW)

Keeping records of solids/effluent applied

Maintain records, showing how much effluent was irrigated and solids were applied on each irrigation area. The records must be sufficiently detailed to determine how much can be applied over the lifetime of each area.

Each year, collect and analyse samples of stockpiled or composted solids, or sludge. If results are consistent over several years, less-frequent sampling may be possible. Use the results to find out the rate at which the solids can be applied to match the rate of nutrient removal from the application area.

Beneficial effluent reuse practice 4

Monitor the moisture content of manure before applying it; coupled with other relevant information this will provide accurate information on how much solids/liquids need to be applied to irrigation areas. This enables accurate nutrient budgets to be calculated over the lifespan of the activity.

Monitoring surface water

When water is available, monitor the water quality in watercourses or creeks near the effluent irrigation area and the solids application area. Collect samples both upstream and downstream from where runoff is likely to enter a watercourse.

Depending on how often the effluent is discharged and how strong it is, an appropriate sampling program will need to be developed to determine and manage any potential environmental impacts on nearby waters. Try and align this program with any licence sampling requirements.

Conduct monitoring in a manner consistent with the sample collection, handling and preservation principles outlined in *Standard methods for the examination of water and wastewater* (APHA 1998). Analyse samples for water pollutants using the methods set out in *Approved methods for the sampling and analysis of water pollutants in New South Wales* (DEC 2004a). *Australian guidelines for water quality monitoring and reporting* (ANZECC 2000) provides detailed information on appropriate monitoring methods.

In general, water monitoring must provide data that is representative of the waterbody. It needs to indicate the contribution of any pollutant resulting from the effluent irrigation practices (compared to contributions of similar pollutants from upstream sources).

Beneficial effluent reuse practice 5

Conducting additional soil sampling and surface and groundwater monitoring above what is required in the licence provides licensees with additional information that can help them better manage their irrigation activities.

Monitoring groundwater

For those areas where effluent and solids are applied to land, soil monitoring generally provides an early detection system, enabling correction. However, groundwater monitoring may be warranted to detect nutrient leaching from facilities at vulnerable sites, or where site design is likely to result in leaching. Groundwater quality monitoring is essential where effluent reuse activities pose a high risk to groundwater, such as effluent delivery drains and effluent storage ponds that are inadequately sealed.

Ideally, groundwater monitoring includes sampling and analysis from bores up-gradient and down-gradient from the ponds and/or areas where effluent and solids were applied. Also, consider the size of the effluent reuse area when selecting the number of groundwater monitoring sites at each reuse location. More accurate data comes from monitoring each individual paddock or effluent reuse area. This is because when effluent is applied it can vary in volume, quality and frequency across each paddock.

Knowledge of the site's hydrogeology is important in planning a groundwater monitoring program. The formation, depth, direction of flow and connectivity of groundwater aquifers underlying the site will determine if there is any value in monitoring groundwater in the first instance. These characteristics also indicate where to locate any piezometers so they will provide meaningful data.

Conduct groundwater sampling on established irrigation areas before crop planting, during the middle of the crop growth and quarterly or yearly thereafter. Where the depth is shallow or where the soils are highly permeable, monthly monitoring may be appropriate. Consider hydraulic gradients when establishing groundwater monitoring. Monitoring any potential impacts on groundwater drinking-water supplies may also be required. On sites with identified risks to groundwater, establish baseline groundwater chemistry as a basis for assessing the extent of potential impacts. This can help when developing a monitoring program, if one is required. Regular groundwater monitoring is required for effluent irrigation systems that operate in a location where they pose a threat to groundwater. The parameters to be measured in groundwaters are generally included in regulatory instruments.

Monitoring weather

Monitoring weather parameters – such as, rainfall, evapotranspiration and wind direction – is important in managing the environmental impacts of effluent reuse activities. Weather data can be used to help make decisions on effluent scheduling, and in managing effluent storage to ensure that effluent holding ponds do not overflow.

The review highlighted cases when licensees were not recording continuous weather data, such as daily rainfall and wind direction to inform any required changes to site operations or to minimise offsite impact on the surrounding environment.

A solar-powered automatic weather station provides site-specific, accurate and continuous monitoring of weather data to inform decisions on effluent irrigation (photo: W Wickremeratne/DECCW)

7 Long-term sustainability of effluent reuse activities

A sustainable effluent irrigation management system achieves a balance – between the use of effluent for irrigation and the crop's nutrient requirements – while protecting the environment from potential pollution. By regularly monitoring and comparing results to sustainability indicators, operators can identify trends and act decisively when adverse environmental impacts are found. This information can also be used to assess how effective the effluent irrigation management strategies have been.

As part of the effluent reuse review, DECCW collected three years of effluent, soil and groundwater monitoring data from each site audited. The relevant data was reviewed. Comments on the issues that may affect the long-term sustainability of effluent reuse at each site audited were made in individual audit reports. This section of the report summarises these comments.

In general, when developing irrigation practices and procedures, most operators considered a range of factors to make sure they were conducting their effluent reuse activities in a proper and efficient manner. However, some licensees either did not use their monitoring results or had insufficient monitoring data available to be able to effectively assess the long-term sustainability of their effluent reuse activities.

Following are some of the issues relating to the long-term sustainability of effluent reuse activities that were identified at the audited premises.

Water and nutrient balance

Too much effluent applied to land can result in surface water runoff containing pollutants, loss of effluent to groundwater, waterlogging, ineffective absorption of phosphorus, and secondary salinity.

Water and nutrient balances are used to calculate the amount of water and nutrients that can be safely applied, and at what times, so that crop requirements are met while minimising any losses of nutrients offsite or to groundwater.

Nutrient budgets are used to assess whether the loads of nutrients applied in the effluent match the rate of nutrient removal by crops. They take into account any allowed losses (such as nitrogen gas to the air) and safe soil storage (phosphorus storage in the root zone).

Models are used to calculate water and nutrient balances to predict the land area needed to dispose of the amount of effluent generated. They determine the size of the wet-weather storage needed to store water when the soil is too wet to irrigate. Nutrient balance comments are included under each nutrient type outlined here.

What was revealed by analysing the data collected from the audited sites?

- Some licensees had enough area available to effectively utilise the hydraulic load of effluent applied to the irrigation area. Others had no measures in place to ensure the correct volume of effluent was applied at appropriate times to meet crop requirements *and* minimise increases in runoff and percolation.

Nitrate–nitrogen

Nitrates are a form of nitrogen that is readily available to plants as a nutrient (including aquatic plants and algae). Due to nitrates' high mobility in water within the soil profile, they are an important indicator of nitrogen losses below the root zone and their potential movement to surface and groundwaters. Measuring nitrate–nitrogen levels throughout the soil profile will show how much nitrogen is available for crop growth and help when assessing crop sustainability.

Measuring total nitrogen in effluent and soil can be used to:

- calculate nutrient balances
- check the amount of nutrients applied in irrigation water is being removed by the crop and not lost to surface and groundwater.

The sustainability indicator (APL 2003) used in DECCW's assessment states that 'nitrate–nitrogen concentrations ranging from 1.2 to 4.5 milligrams of nitrate per kilogram of soil (at the base of the root zone) would trigger further investigation'. (Soil type and texture determines the trigger value used.) Nutrient balance information, where available, was also collected as part of the audits.

What was revealed by analysing the data collected from the audited sites?

- The level of nitrate–nitrogen reported in the soil analysis results provided by some licensees exceeded trigger values. This indicated the nitrate levels could represent leaching losses below the root zone, warranting further investigation or action.
- Licensees are encouraged to consider preparing mass balances for nitrogen on effluent reuse areas annually, using monitoring data. This data may include: loads of effluent, solids and fertiliser applied, information on crop yield, nutrient uptake and nutrient removal from the application areas.
- In some instances, the concentration of nitrate–nitrogen in surface soil samples and in groundwater samples exceeded the trigger values. In such cases, the licensee needs to investigate if the crops were able to properly use the nutrients being applied as the elevated levels could cause nitrogen to leach into the groundwater.

Phosphorus

Phosphorus moves very little in most soils. However, certain forms of effluent phosphorus can leach through soils more readily than others.

Surface waters can be polluted by phosphorus contained in surface runoff and soil erosion. Soil erosion and crop removal are the major ways phosphorous is lost from soil. Groundwaters can be polluted by applying too much phosphorus to soils that have a low ability to absorb the phosphorus in their surface layers, such as sandy soils resulting in leaching of phosphorous into groundwater. Over-application can also take up the soil's ability to absorb phosphorus – until that capacity is freed up by crop removal. Studies have shown that phosphorus can also move down into soil cracks, wormholes and root cavities.

What was revealed by analysing the data collected from the audited sites?

- Phosphorus levels reported in analysis results at some sites exceeded the suggested trigger values for available phosphorus. So there is a case to further investigate potential phosphorus losses via surface runoff.
- Soil monitoring results revealed nutrient uptake and removal issues relating to irrigation management practices, so they will need further investigation in the future.

Phosphorus sorption capacity

Phosphorus sorption capacity (PSC) measures a soil's capacity to absorb phosphorus and temporarily store it within the root zone. The soil's potential to do so depends on its texture and clay mineralogy. It increases with clay content.

The phosphorus sorption capacity should be assessed at all reuse sites to establish each site's sustainable life.

If the phosphorus stored in the soil is to be taken up by planting crops, this should be regarded as a temporary measure. The soil profile to the base of the crop root zone should be considered the safe storage interval for applied phosphorus. A reuse area should be used to store phosphorus only if it is good cropping land and providing a plan is in place to continually crop the area after effluent or solids reuse has ceased to remove the stored phosphorus as it is released. The ongoing phosphorus storage capacity of an area that is under continuing effluent irrigation should be determined by measuring its phosphorus sorption capacity every five years.

What was revealed by analysing the data collected from the audited sites?

- Repeated additions of phosphorus could expend the soil's phosphorus sorption capacity. Hence there is a need to focus on phosphorus management to ensure leaching through the soil profile would not begin in the near- to medium-term.
- Although detailed cropping regimes were in place at a range of premises, phosphorus additions could exceed crop uptake and safe soil storage. This indicates a need to prepare a mass balance for phosphorus on an annual basis and assess phosphorus storage capacity every three to five years.

Soil salinity

Salinity refers to the presence of soluble salts in soil and/or water. It can result in reduced plant growth or crop failure due to low water availability or toxicity of the salts. The salt concentration in the root zone may progressively increase unless leaching and drainage processes reduce it.

A common method for assessing water and soil salinity is by measuring the electrical conductivity (EC) of the water or a soil extract. Dissolved salts increase the electrical conductivity of water, so a high EC value indicates a high salinity level. Actual salt concentrations, such as total dissolved solids (TDS), are also used to assess effluent.

Saline effluent may raise soluble salt levels to the extent that they impede plant growth and reduce the plant's nutrient uptake. This can lead to a build-up of nutrients at the irrigation site and then losses offsite to surface- and groundwaters. Reduced groundcover from salt-affected land increases the potential for soil erosion and nutrient loss offsite.

What was revealed by analysing the data collected from the audited sites?

- Soil salinity results for some effluent reuse areas revealed a need to assess the overall impact of salt in the root zone at each irrigation paddock. Some of the soil salinity data provided by licensees indicated that sensitive and moderately sensitive crops may not yield satisfactorily.
- The concentration of dissolved solids in effluent analysis results indicate greater salinity control is necessary to support long-term sustainable effluent reuse.

Sodicity

Soil sodicity is caused by sodium attached to clay in soils. A soil is considered sodic when the amount of sodium reaches a concentration where it starts to affect soil structure. Problems include soil dispersion, poor water infiltration, surface crusting, erosion and waterlogging.

Exchangeable sodium (measured as exchangeable sodium percentage [ESP]) can weaken the bonds of soil aggregates. This can impede water and plant root movement into and through the soil. Elevated ESP values (e.g. over six per cent, APL 2004) can indicate sodic soils.

The amount of sodium in effluent compared to other salts (measured as sodium adsorption ratio or SAR) is also used to measure potential sodicity impacts (e.g. effluent with an SAR greater than 6 is likely to raise ESP in non-sodic soils (DEC 2000).

What was revealed by analysing the data collected from the audited sites?

- Exchangeable sodium percentage levels in surface and subsurface soil layers at some premises showed continued irrigation may not be sustainable in the long term without some soil management intervention, such as agronomic advice on the significance of ESP levels and the need for gypsum applications
- The calculated ESP on irrigated areas at some premises exceeded six per cent. This means impacts from sodicity could become a concern in the future. Such impacts include negative effects on soil structure, resulting in soil dispersion, impaired soil drainage and reduced plant growth.

pH

If effluent is very acidic or very alkaline, it may need to be neutralised before it is irrigated, as soil pH affects the availability of nutrients and other elements to the plants being grown. For example, acidity can affect solubility of aluminium and manganese, which can be toxic to plant growth.

Effluent with a pH within the range of 6.5 to 8.5 is acceptable for irrigation. Soil pH should be in the range > 5.0 or < 8.0 throughout the soil profile (based on 1:5 soil : water extract) (APL 2003).

What was revealed by analysing the data collected from the audited sites?

- At some sites, pH levels in both effluent and soil were on the upper limit for sustainable conditions. The high alkalinity in some parts of the soil may have negative effects on certain crop types and influence crop management.

Further information

See DECCW's environmental guideline, *Use of effluent by irrigation* (DEC 2004) for more information on irrigation considerations and effluent and soil quality issues.

8 Related initiatives

These related initiatives also help relevant stakeholders – such as industry and local government – to identify ways they can reduce their impact on the environment and improve environmental performance.

Sustainability Advantage program

Sustainability Advantage is a key and growing DECCW program that helps medium to large organisations and businesses assess their waste generation, water use and energy consumption. It also assists in devising internal strategies that improve environmental performance and bring about cost savings.

Some of Australia's biggest agricultural industries are working together to protect the environment, saving over $2.36 million while utilising waste, energy and water through this program. Businesses from the Riverina, including wine, food and agricultural service industries, have identified dozens of sustainability initiatives and developed approved action plans.

One company involved in the program has completely reused its winery wastewater for growing forage crops. This generates around $200,000 per annum in income on top of the power savings achieved.

Further information

For more information about this program, read the *Achieve a sustainability advantage* brochure, available at: www.environment.nsw.gov.au/resources/sustainbus/09189SustainabilityAdv.pdf.

For further information about the Sustainability Advantage program, contact DECCW Business Partnerships on (02) 8837 6000 or by email at sustainbus@environment.nsw.gov.au.

Strategic environmental compliance and performance review – industry monitoring

In 2009 DECCW (DECCW 2009) completed a review of industry monitoring focusing on monitoring requirements on environment protection licences across various industry types within NSW. A summary report on the review includes:

- guidance on how industry – including those reusing effluent – can improve its environmental performance by implementing best environment management practices for undertaking monitoring, including collecting and recording data, analysing and converting data, assessing information for reporting and communicating results
- information on how industry can use data to manage site operations.

Further information

For further information about this review, see www.environment.nsw.gov.au/resources/licensing/09695indmon.pdf.

Review of load calculation protocol – effluent reuse

The Protection of the Environment Operations (General) Regulation 2009 (the Regulation) was remade on 29 May 2009 and commenced on 30 June 2009. The Regulation establishes the load calculation protocol as the document that sets out a range of methods to calculate pollutant loads under the load based licensing (LBL) scheme.

To further improve the protocol, DECCW is undertaking a review of the document. The review aims to simplify the existing protocol content, such as the appropriateness of emission factors and relevance of production components. It will also consider proposals to introduce new content, such as expanded opportunities to achieve weighted load discounts. The calculation of weighted loads for effluent reuse is part of the review.

Further information

The current version of the LBL load calculation protocol can be downloaded at www.environment.nsw.gov.au/licensing/lblprotocol/index.htm.

Hawkesbury–Nepean River Recovery Project

The Australian Government agreed to give NSW $77.4 million to undertake the Hawkesbury–Nepean River Recovery Project. This project is to save over 11 billion litres of water per year and stop over 48 tonnes of nutrient pollution per year from entering the river. Federal funding will be complemented by funds from the NSW Government, landholders and Hawkesbury City Council, providing a total of $96.8 million to fund this initiative to September 2011.

Components of the project include implementing measures to enable the distribution and supply of recycled water for irrigation to a greater range of potential users. This is to reduce the use of potable water for open-space irrigation.

DECCW is now leading two of the seven sub-projects: a water-licence purchase project and a nutrient-export monitoring project.

Further information

For more information about this project, see www.environment.gov.au/water/policy-programs/water-smart/projects/nsw27.html

Draft lower Hawkesbury–Nepean River nutrient management strategy

This strategy has been identified as an action in the metropolitan water plan for Sydney (Metropolitan Water Planning 2006) and its delivery will be assisted by the Australian Government's $77.4 million funding of the Hawkesbury–Nepean River Recovery Project.

Projects are underway to improve nutrient management on open spaces such as golf courses, parks and playing fields, including improved irrigation efficiencies, soil and fertiliser management, and stormwater harvesting and reuse projects.

The strategy has been developed to help provide clear direction and overarching framework for current and future nutrient management initiatives, aimed at reducing nutrient loads from existing sources and limiting the growth in nutrient loads from changing land uses. The strategy is one component of a package of initiatives underway to improve the health of the Hawkesbury–Nepean.

Further information

To access a copy of the strategy, see www.environment.nsw.gov.au/resources/water/09157drafthnnutmgmtstrat.pdf

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10 Glossary

Aerobic pond	The second pond in an effluent pond treatment system. Effluent entering the aerobic pond from the anaerobic pond is converted into carbon dioxide, water, and new bacterial and algae cells in the presence of oxygen – 'aerobically'.
Anaerobic pond	The first pond in an effluent pond treatment system. Effluent is initially piped to the anaerobic pond from the farm dairy sump. In the anaerobic pond, the effluent begins breaking down in the absence of oxygen – 'anaerobically'. Anaerobic bacteria are involved in these processes.
Analysis	Data analysis is a process of gathering, modelling and transforming data with the goal of highlighting useful information, suggesting conclusions and supporting decision making.
Application rate	The speed at which effluent should be applied to pasture (mm/h).
Appropriate regulatory authority	The Environment Protection Authority (EPA), a local authority or a public authority prescribed for the purposes of section 6 (3) of the POEO Act. This now falls under the umbrella of Department of Environment, Climate Change and Water.
Aquifer	A layer of rock or soil that is able to hold or transmit water.
Authorised officers	A person appointed under Part 7.2 of the POEO Act by an appropriate regulatory authority.
Available water capacity or **available water content (AWC)**	AWC is the range of available water that can be stored in soil and be available for growing crops.
Bedrock	The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.
Biosolids	Organic product that results from sewage treatment processes (sometimes referred to as sewage sludge).
Biochemical oxygen demand (BOD)	Gives an estimate of the amount of oxygen required by bacteria to break down the organic matter in effluent. This oxygen could otherwise sustain aquatic life in a waterway.
Bulk density	A measure of the weight of the soil per unit volume (g/cc), usually given on an oven-dry (110° C) basis.

Cation-exchange capacity	The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.
Clay	Clay is a naturally occurring material composed primarily of fine-grained minerals (soil particle smaller than 0.002 mm or 2 µm), which show plasticity through a variable range of water content, and which can be hardened when dried and/or fired.
Dam	*See* pond.
Data collection	The process of gathering information.
Discharging	Includes 'emitting', 'depositing', or 'allowing to escape' any contaminant into the environment.
Effluent	Means: a. wastewater from sewage collection or treatment plants b. wastewater from collection or treatment systems that are ancillary to processing industries involving livestock, agriculture, wood, paper or food, being wastewater that is conveyed from the place of generation by means of a pipe, canal or other conventional method used in irrigation (but not by means of a tanker or truck), or c. wastewater from collection or treatment systems that are ancillary to intensive livestock, aquaculture or agricultural industries, being wastewater that is released by means of a pipe, canal or other conventional method used in irrigation as part of day-to-day farming operations.
Electrical conductivity (EC)	A measure of the concentration of ions in soil solution (as measured by the conduction of electricity through water, or a soil water extract). The value can reflect the amount of soluble salts in a soil extract – therefore providing an indication of soil salinity.
EPA approved methods	The approved methods for the sampling and analysis of water pollutants in NSW lists the statutory methods that are to be used to sample and analyse water and air pollutants.
Evaporation	The loss of water, from a surface (e.g. soil) to the air, in the form of vapour. Usually expressed in millimetres in a given time period (e.g. mm/day).
Evapotranspiration	The combination of evaporation and transpiration (i.e. the combined loss of water from the soil and from plant surfaces to the air, in the form of vapour). Usually expressed in millimetres in a given time period (e.g. mm/day).

Exchangeable sodium percentage (ESP)	The ESP is the amount of exchangeable sodium in a soil expressed as a percentage of the total exchangeable ions in the soil. An ESP of more than 5 defines a sodic soil.
Groundwater	Subsurface water contributing to the water table, an aquifer or a confined aquifer.
Hydraulic loading	Volume of water applied to an area of land (mm).
Infiltration	The process of effluent entering the soil surface.
Interpretation	The act or process of applying general principles or formulae to the explanation of results obtained from the analysis of samples, observations etc.
Leaching	The removal of soluble constituents (e.g. salts, fertiliser nutrients from the soil by water moving downward through the soil profile.
Licensing threshold	A level of production or processing (or capacity to produce or process), above which an activity becomes scheduled under the POEO Act.
Loam	Loam is soil composed of sand, silt, and clay in relatively even concentration (about 40–40–20% concentration respectively).
Measurement	The act or process of assigning numbers according to a rule. The process of estimating the magnitude of some attribute of an object, such as its length, weight or depth relative to some standard (e.g. a unit of measurement), such as a metre or a kilogram. Also used to indicate the number that results from that process.
Monitoring	To be aware of the state of a system. The process of monitoring involves data collection, data analysis and interpretation of the data to determine the state of the system and how the system is changing.
Monitoring data	Data collected for the purpose of characterising changes in an event as the result of a direct observation or experiment. The facts are usually numbers that reflect the result of a measurement determined from observations or experiments.
NATA	National Association of Testing Authorities (NATA) – Australia's national laboratory accreditation authority.
Nutrient budget	A system of calculating and comparing nutrient inputs and outputs from all or part of the farm system to help select fertiliser rates and management techniques for efficient nutrient use and reduced environmental impact.
Permeable	The property of a soil describing the ability to allow significant movement of water through it.

pH	A way of expressing how acidic or alkaline a solution is, usually measured using a water extract. A pH of 7.0 is neutral whereas lower values are said to be acidic and higher values are alkaline.
Pond	A storage facility usually used for containing treated or untreated effluent or stormwater prior to land application.
Pond system	A constructed ponding system designed for the holding and/or treatment of effluent before discharge to a waterway or constructed wetland, or application to pastoral land. A treatment pond system is composed of an anaerobic pond and one or more aerobic ponds. A holding or storage pond does not treat effluent, but retains it prior to land application.
Quality assurance	A system of procedures, checks, audits and corrective actions to ensure that environmental monitoring and sampling, and other technical and reporting activities, are of the highest achievable quality.
Quality control	The overall system of activities that measures the attributes and performance of a process to verify that they meet the stated requirements established.
Receiving waters	Waters into which water discharges flow from an activity.
Retention time	The average time, in days, that effluent will remain in the storage facility. It is calculated by dividing the volume of the facility by the volume of effluent entering daily.
Sample	A portion, piece, or segment that is representative of a whole.
Saturated hydraulic conductivity	K_{sat} – describes water movement through saturated media.
Scheduled activity	An activity listed in Schedule 1 of the POEO Act.
Secondary salinity	Where water percolates down through the soil (leaching), it can cause 'hydraulic loading' to the extent that local or regional watertables could rise. This upward movement of water can also mobilise salts in the soil profile and bring them to the surface, causing 'secondary' salinity.
Sediment	Solid material (e.g. silt and sand) that is carried in water or effluent that will ultimately settle to the bottom of sumps, ponds, barrier ditches, constructed wetlands or waterways.
Seepage	Loss of effluent through the permeable floor and walls of a storage facility.
Sludge	Effluent exceeding 20 per cent total solids (in this review). Sludge accumulates at the bottom of sumps, barrier ditches or ponds. Sludge will not flow and requires mechanical spreading equipment such as scrapers and front-end loaders.

Soil water deficit	The amount of available water removed from the soil within the crop's active rooting depth. Likewise it is the amount of water required to refill the root zone to bring the current soil moisture conditions to field capacity. Soil water decreases as the crop uses water (evapotranspiration) and increases as precipitation (rainfall or irrigation) is added.
Stormwater	Rainwater that has drained from the irrigation area and collected in guttering/pipes, or has run off from the surrounding land.
Sodicity	The amount of exchangeable sodium cations (Na) in the soil, expressed as the exchangeable sodium percentage (ESP). Soils with an ESP greater than 6 are regarded as sodic.
Suspended solids	Effluent solids that are in suspension within the liquid effluent but are removable through filtering.
Test	A procedure used to establish the presence, quality, or authenticity of anything.
Total solids	The sum of dissolved solids and undissolved solids in effluent or water.
Utilisation area	The area used for the application of waste and/or wastewater.
Waterway	Fresh or brackish surface water in a river, lake, pond or natural wetland.

Appendix A

Premises audited in this review

Individual compliance audit reports for these facilities are publicly available in DECCW's Library on Level 15, 59–61 Goulburn Street, Sydney, phone (02) 9995 5302.

Scheduled activity	Licence number	Accountable party
Agricultural processing – general	11302	Nugan Quality Foods Pty Ltd
Agricultural processing – general	599	Penford Australia Limited
Agricultural processing – grape processing	11733	Casella Wines Pty Ltd
Agricultural processing – grape processing	10801	De Bortoli Wines Pty Ltd
Livestock intensive – animal accommodation	10802	Inverell Shire Council
Livestock intensive – cattle, sheep or horse accommodation	4340	Myola Feedlot Pty Ltd
Livestock intensive – dairy animal accommodation	11557	Leppington Pastoral Co Pty Ltd
Livestock intensive – dairy animal accommodation	7365	Moxley Farms Pty Ltd
Livestock intensive – pig accommodation	3915	Mondoro Pty Ltd
Livestock intensive – pig accommodation	11314	Windridge Farms Pty Ltd
Livestock processing – slaughtering	422	Wollondilly Abattoirs Pty Ltd
Livestock processing – slaughtering, rendering	7538	P&M Quality Smallgoods Pty Ltd
Livestock processing – slaughtering, rendering	3838	Monbeef Pty Ltd
Livestock processing – slaughtering, rendering	11279	Shellden Pty Ltd
Livestock processing – slaughtering, rendering, tanning, composting, fleece processing	5241	Fletcher International Exports Pty Ltd

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