water

Water Quality and River Flow Interim Environmental Objectives

Guidelines for River, Groundwater and Water Management Committees

Border Rivers Catchment (NSW)

How to use these guidelines

1 Background

Tells you why the NSW Government has proposed interim water quality and river flow objectives, how it developed them, and what will be done to achieve them.

2 Community comment on the proposed objectives

Reports back on the community's comments on the proposed objectives for this catchment and lists the major river health issues raised.

3 Interim water quality and river flow objectives for the catchment

Lists the interim water quality and river flow objectives that apply specifically to this catchment. Use the map to guide you as you read.

4 Interim water quality objectives explained

Explains all the water quality objectives used in Section 3 and includes the indicators and numerical criteria applying to each objective.

5 Interim river flow objectives explained

Explains the river flow objectives used in Section 3.

Bibliography

A list of documents referred to in these guidelines, and for further reading.

Glossary

Some definitions you may find useful.

Catchment map and catchment at a glance

Show this catchment in detail and each of the areas where the separate sets of objectives described in Section 3 apply.

water

Water Quality and River Flow Interim Environmental Objectives

Guidelines for River, Groundwater and Water Management Committees

Border Rivers Catchment (NSW)

These guidelines should be read in conjunction with the Support Package for River, Groundwater and Water Management Committees

Published for the NSW Government by:
Environment Protection Authority
59–61 Goulburn Street
PO Box A290
Sydney South 1232
Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (information & publications requests)
Fax: (02) 9995 5999

E-mail: info@epa.nsw.gov.au
Web: www.epa.nsw.gov.au

ISBN 0 7313 0219 2
EPA 99/29
October 1999

Printed on recycled paper

From the Minister for the Environment

Healthy and clean rivers, beaches and harbours are fundamental to the Australian way of life. The NSW Government has made water an essential element of its wide-ranging reform agenda. As part of a comprehensive Water Reform Package announced in August 1997, the Government agreed to develop water quality and river flow objectives for all intra-state rivers.

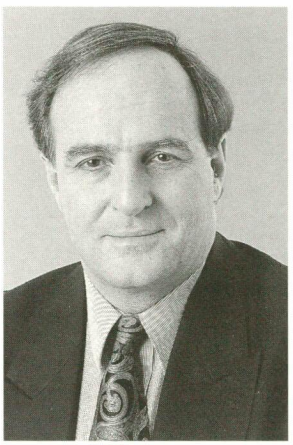
NSW is the first state to propose environmental objectives for all our rivers and the Government is proud of the pioneering work that has been done to develop these tools within the framework of the National Water Quality Management Strategy.

With the publication of these guidelines I am pleased to release interim water quality and river flow objectives for catchments across NSW. The objectives identify the broad goals to achieve long-term river health, maintain biodiversity and secure a sustainable water resource for communities and industries dependent on water of a certain quality. They will guide river, groundwater and water management committees as they develop their management plans.

The guidelines also contain information that will help all of us to better understand the impact of our activities on river health and suggest ways we can all work to achieve cleaner and more natural waterways.

The objectives were developed after consulting with the community across NSW from November 1997 to May 1998 and receiving further feedback from catchment management committees and established river management committees. The advice received during this extensive and, at times, controversial consultation program resulted in significant changes to the original proposals. The recommended objectives now more closely reflect the views of each catchment community.

I urge river and water management committees to use these locally developed targets to develop plans for the immediate and long-term action needed to improve the health of our rivers.



BOB DEBUS

Guiding principles for interim water quality and river flow objectives

The guiding principles for water quality and river flow management are:

- Adapt environmental objectives and river management over time to provide for adjustments based on expanding knowledge, river health monitoring, and changing community and economic values.
- Ensure a catchment focus by tailoring river health provisions to provide the most cost–effective and practical mix of solutions to meet the individual needs of each river system and catchment.
- Recognise the important links between river flows and water quality.
- Consider social and economic impacts.
- Provide water for the environment based on mimicking natural flow regimes as much as possible.
- Protect water quality, river flow regimes and riverine ecosystems that have not been seriously affected by human activities.
- Substantially rehabilitate highly stressed rivers.
- Consider interactions between ground and surface waters for both water quality and quantity.
- New or enlarged instream structures may be undesirable. Such proposals must show that they would provide clear benefits that would outweigh adverse environmental impacts (both at the site and elsewhere, such as downstream), and there are no alternatives.

Contents

1 Background

Why is the NSW Government providing guidelines on interim environmental objectives?

The NSW Government has brought in wide-ranging reforms to ensure the long-term health of all our waterways. We need action now for a healthy future for both our environment and our economy.

Environmental problems are widespread in our river systems and, in many cases, also affect regional economic development. These problems include algal blooms, rising salinity, carp, and declining numbers of native fish. NSW also needs to meet its inter-governmental obligations to improve river health, such as in the Murray–Darling basin.

The community and Government have taken important steps towards attaining healthier rivers. Much has been achieved. Clearly defined, consistent objectives will allow us to direct current actions better and plan for new ones.

The Government has already implemented many of its water reforms, including introducing a better balance in sharing water between users and the environment, statewide groundwater and weir policies, regular monitoring programs, and assessing the stress on each stream and aquifer. The Department of Land and Water Conservation has published detailed material on all the reforms.

Improving river flow and water quality are prime objectives for healthier rivers. Establishing these objectives is a major undertaking if we are to cover all NSW rivers and estuaries and develop and implement mechanisms to achieve the objectives. To meet this challenge, the Government has a complementary, two-part process for developing environmental objectives. One part involves providing interim environmental objectives to guide early river management planning and action. The other involves independent inquiries by the Healthy Rivers Commission in individual catchments to recommend longer-term environmental objectives and practical strategies to achieve them.

What are water quality and river flow objectives?

The interim water quality and river flow objectives set out in these pages have been developed to guide plans and actions to achieve healthy rivers.

Up to eleven *interim water quality objectives* apply. Each is based on providing the right water quality for the environment and the different uses people have for water. They are based on measurable environmental values for protecting aquatic ecosystems, recreation, visual amenity, drinking water and agricultural water. Section 4 gives a more detailed explanation of how to use water quality objectives.

Each of the eleven inland *interim river flow objectives* deals with how water moves down rivers and streams. Each objective aims to improve river health by recognising the importance of natural river flow patterns. The objectives are based on achieving improved environmental results from managing the riverine system. Section 5 gives more detail.

How are these guidelines to be used?

These guidelines on interim environmental objectives are intended mainly for river, water and groundwater committees to consider and include in their river management plans. The committees are responsible for developing the river flow, water quality and groundwater action plans needed to achieve the agreed environmental objectives. The committees have the opportunity to recommend revision, refinement and expansion of the interim objectives to ensure the long-term health of the waterways in their catchment. Any fundamental change will need the NSW Government's approval through the Minister for the Environment and the Minister for Land and Water Conservation.

Integration of the objectives into the planning activities of river management committees means that river management plans will help the community to achieve an acceptable balance between environmental, social and economic needs. These plans will ultimately be the basis for managing water resources for NSW rivers and groundwater systems. The Government will

approve suitable plans, and progress will be audited.

The Government's existing river health programs are helping achieve river flow and water quality objectives. Similarly, individuals, communities and local government are already taking action to achieve healthy rivers. All these groups will continue with their activities, which will be coordinated with actions identified in river management plans.

How long do the interim environmental objectives apply?

Interim environmental objectives will apply until the NSW Government either

- adopts the longer-term objectives resulting from recommendations by the Healthy Rivers Commission, or
- approves a river management plan for the catchment through the Ministers for Land and Water Conservation and for the Environment. In this case, the environmental objectives would apply for the duration of the plan, subject to review and audit.

Developing the guidelines

In late 1997, the NSW Government released discussion papers called *Proposed Interim Environmental Objectives for NSW Waters* (EPA 1997) as the basis for a six-month community consultation. The papers gave options for interim river flow and water quality objectives in each catchment, including broad economic evaluations, as a basis for discussion.

Seeking the opinions of communities was essential. More than fifty community discussion meetings and nine special Aboriginal community meetings were held. More than 4000 people attended. The Government received 810 written submissions, and river and catchment management committees gave valuable feedback on the draft objectives.

These guidelines summarise the community's views about the Border Rivers catchment (NSW).

2 Community comment on the proposed objectives

Overview

The Border Rivers catchment community discussion meeting was held at Inverell on 26 March 1998, and was attended by 100 people. Twenty-one written submissions were received, some of which represented the concerns of several people. Submissions came from individual people (including farmers), community and industry groups and government agencies. The proposed objectives were also discussed at a regional meeting on water reforms held at Moree for Aboriginal people.

The issues raised and comments made will be considered by the local river management committee when developing management plans. The NSW Government will also continue to work with the Queensland Government in relation to management of the streams forming the border and on issues of mutual interest.

At this stage, the NSW Government is committed to action through existing programs (see end of this section). Future priorities will be finalised when a Flow Management Plan for the major regulated rivers is agreed to by the NSW and Queensland governments and when a river management plan for other NSW streams is approved by the Minister for Land and Water Conservation and the Minister for the Environment. River and groundwater management committees need to balance environmental, social and economic issues when developing their plans, to avoid unacceptable consequences at the local level.

Water quality and value of the resource

People identified a range of uses and values of the Border Rivers. Most wanted the rivers to be a source of good quality water for a full range of valued water uses—including drinking water, primary and secondary contact recreation, irrigation, domestic uses and stock watering. The rivers provide a source of financial security for the community, which comes from industry and economic benefits gained from the overall water system, including a secure groundwater supply for bores. Of equal importance was sustaining the rivers' biodiversity, and the value of nature conservation.

People noted their awareness of the rivers' significance in terms of their visual and spiritual amenity for the community, including their importance to Aboriginal people.

Meetings and submissions noted that traditional Aboriginal values of the rivers had not been taken into account as specific objectives, and should be properly recognised in river planning. The Kamilaroi people had specific issues, recommendations and knowledge to contribute. Common concerns included ill health from swimming in and drinking the water, decline in flora and fauna and aquatic food sources; and lack of respect for Aboriginal spiritual, cultural and resource-use values and for places of special significance. Aboriginal communities also requested involvement in water management decisions (which relate to their traditional responsibilities in managing river health), and access to clean rivers for cultural activities.

Some people attending the Inverell meeting commented on the lack of detailed information in the discussion paper (EPA 1997), and felt that not receiving the discussion paper before the meeting was a barrier to making informed choices on environmental objectives. Most people, however, could make a choice at the meeting on what water values and uses they wanted protected, based on what they already use and value the river for in their local area.

There was overwhelming support for good water quality that would support basic river health and advanced human uses. People wanted either to maintain or improve current water quality, but mentioned the need to understand more about related costs.

There was also support for the more limited objective of achieving water quality sufficient for basic river health and basic human uses (either as a preferred choice or an alternative to achieving better quality)—particularly as a goal in the short term for waterways affected by more intense human use.

People who supported these options felt they would benefit from better environmental health, increased biodiversity (in particular, more native fish), cleaner drinking water, improved collection of information on

river health, and enhanced quality of life for the community as a whole.

Riverbank instability, erosion, turbidity and sedimentation were noted as causing concern, as were the issues of illegal pumping and instream obstructions, and the occurrence of blue-green algal blooms. Reference was also made to the temperatures of water releases below dams being too cold to allow fish to breed. People also questioned the quality of drinking water for all sections of the community.

Specific proposals included action to:

- protect riparian zones
- improve distribution of monitoring sites and monitor more water quality indicators
- improve sewage treatment
- impose stricter controls on development near rivers and on floodplains
- increase community education and consultation
- involve the local community in management and make decisions site-specific.

Submissions from several people in the upper and lower parts of the catchment expressed concern about the unsuitability of the water for local ecosystems, safe recreation and drinking.

Some respondents felt that the major threat to water quality in this region was the impact of carp, which are present in large numbers and are seen to cause streambank erosion, deplete river plants and compete aggressively with native fish.

Overall, many people felt that the whole community should share the cost of restoring the river, as the whole community would benefit.

River flows

On the matter of river flows, people expressed concerns about the effects on the Border Rivers and adjacent catchment streams of:

- over-extraction of groundwater, resulting in bores drying up
- perceived over-commitment and inequitable access to water for irrigation
- turbidity, siltation and diminished water holes
- lack of effective monitoring and management of extractions
- lack of sufficient information on which to base river management decisions, particularly regarding 'natural' flows
- diminished low flows
- damage to riverbanks during high flows and flooding
- the presence of illegal obstructions and barriers to fish passage.

There was overall support for all options for river flow objectives. Most support was given to objectives relating to:

- protecting pools in dry times
- protecting natural low flows
- minimising the effects of weirs and other structures.

The next most-favoured objectives were those aimed at:

- maintaining natural flow variability
- maintaining wetland and floodplain inundation
- maintaining natural rates of change in water levels
- minimising the effects of dams on water quality
- making water available for unforeseen events.

Interest was also shown in protecting important rises in water levels, mimicking natural drying in temporary waterways and managing groundwater to support ecosystems.

It was generally agreed that more education, and regularly published information on trends in water quality and river flows, and on the obligations of water users, was warranted.

Specific proposals called for the removal of illegal obstructions, more research into monitoring, strict licensing of extractions, revegetating riverbanks, installing fish ladders, and better management of polluted runoff from urban and agricultural lands. People felt that the government should establish what the different needs of the community were, and ensure these needs were acknowledged and considered fairly. It was felt that all decisions needed to be site-specific.

People indicated that adoption of the objectives would be beneficial in leading to a sustainable water supply—seen as being essential to support farming, domestic and environmental needs. They asked how

actions to implement objectives would be managed, being particularly concerned that there should be equitable access to the resource by all users.

Other benefits mentioned related to improved amenity for recreation, enhanced ecosystems, eradication of carp, increased income to the area, and associated benefits for future generations.

There was concern about the cost of implementing the objectives and managing a reduction in water available for irrigation. It was felt that the latter would adversely affect farm production and cause economic hardship.

Major issues

Major issues that could need action to achieve a healthy and viable river system were identified. Comments on some of these are included in Section 3, as part of the supporting information for the recommended objectives. Proposals for remedial or conservation action were:

- Reduce the loss of native vegetation across the catchment and the resulting land degradation, which is leading to stream and wetland sedimentation and increasing water turbidity.
- Prevent or remove illegal obstructions and barriers to fish passage.
- Reduce turbidity, downstream siltation and the problem of diminishing waterholes. These problems are sometimes associated with upstream land uses, releases from storages that cause artificially high flows, and unseasonal still water or low flows.
- Maintain or restore remnant native vegetation, particularly riparian vegetation, the degradation of which is associated with accelerated rates of river erosion.
- Address the lack of respect for Aboriginal spiritual, cultural and resource-use values, and for their traditional role in water-resource management.
- Improve management of stock access to streams.
- Reduce conditions favourable to the growth of algal blooms in rivers and storages.
- Reduce the presence of exotic plant and animal pests in rivers.
- Reduce the downstream impacts of water storages on river flow and water quality (e.g. manage water releases to avoid lowering water temperature).
- Reduce the downstream impacts of unsewered villages on water quality.
- Improve floodplain management.
- Prevent spray drift of pesticides.
- Prevent pesticides (e.g. endosulfan, atrazine) and other agricultural chemicals from entering surface waters and sediments.
- Control carp and reduce the conditions that favour them.

Additionally, people felt that action was needed to:

- balance the economic benefits of irrigation and other productive water use with a sustainable environment
- ensure an adequate water supply to graziers
- improve management of stormwater runoff from both urban and rural lands
- maintain or improve the cultural and recreational values of the river
- respect Aboriginal spiritual and cultural values associated with rivers, creeks, wetlands and lakes; and traditional Aboriginal management roles in, and uses for, these areas—including as a source of traditional foods that are safe to eat
- improve sewage management in towns and settlements within the catchments
- reduce remaining significant point-source pollution
- collect reliable and valuable scientific data on river health (critical to better decision-making)
- ensure equitable access to water resources.

Existing programs

Some of the above issues already receive considerable attention and resources. Communities, through the Catchment Management Committee, Landcare and other programs, are currently undertaking important on-the-ground projects. The NSW Government has established and funded programs such as Blue-Green Algae Management, Floodplain Management Program, Wetlands Action and the Country Towns Water Supply and Sewerage Program. At the Commonwealth level, programs are being funded through the Murray–Darling Basin

Commission, Landcare and the Natural Heritage Trust.

Significant effort and progress has already made by groups involved in catchment management initiatives. Major water quality management programs now under way for the catchment include:

- North West Catchment Management Committee programs
- Landcare and Rivercare programs that are tackling issues such as soil erosion and runoff, dryland salinity and streambank erosion
- Salt Action
- application of the Catchment Management Support System model and nutrient management plan
- application of the Integrated Quantity and Quality Model for the catchment
- the Key Sites Water Quality Monitoring Program
- the Central and North West Water Quality Monitoring Program
- the Border Rivers Water Quality Monitoring Program
- the Storage Water Quality Program
- the development of best-practice guidelines for cotton farmers by the Australian Cotton Growers Research Association and the Australian Cotton Foundation
- the First National River Health Assessment (a Monitoring River Health initiative)
- rehabilitation of derelict mines
- the Pindari Dam variable offtake and downstream water quality study.

Where management plans and programs such as these already exist, they should be acknowledged and, where possible, incorporated in the river management plan.

3 Interim water quality and river flow objectives for the Border Rivers catchment (NSW)

This section gives the interim water quality objectives (WQOs) and the river flow objectives (RFOs) for the Border Rivers catchment (NSW), which should be used by river management committees and others in developing plans and actions affecting river health. The NSW Government seeks further advice from committees and others on refining and expanding these objectives. Only the priority RFOs are listed in this section but committees still need to consider the remaining objectives when developing flow management plans or dealing with particular local river conditions.

Town water supply subcatchments

Streams within these subcatchments typically feed into a town water supply storage. In some cases the catchment may be declared as specially protected to minimise the land use impacts on water quality.

Map: This category applies to streams running through areas coloured light blue on the map:

Water quality objectives

Protection of:


Aquatic ecosystems


Visual amenity


Drinking water—Disinfection only


Drinking water—Clarification and disinfection


Drinking water—Groundwater

River Flow Objectives


Protect pools in dry times


Protect natural low flows


Maintain wetland and floodplain inundation


Manage groundwater for ecosystems


Minimise effects of weirs and other structures

Supporting information

- This category includes Tenterfield Creek Dam catchment and Beardy Waters Dam catchment near Glen Innes.
- Raw water sourced from the above catchments will need to be of high enough quality for available treatment to be effective in the long term. Existing land management programs aimed at maintaining or improving the drinking water catchments should continue and be reviewed. Work done by Severn and Glen Innes shires on blue-green algal blooms in Beardy Waters and the Severn River is an example of this work. It includes efforts to reduce erosion in the catchments, the frequency of algal blooms in the

dams, and other pollutant sources that reduce drinking water quality.

- All parts of large river systems cannot be protected from human activities that degrade drinking water quality. See 'Uncontrolled streams' and other river categories below for objectives that should apply to surface and groundwater drinking-water offtakes in the catchment.
- Local factors to be considered include maintaining natural flows from springs (groundwater), the effects of land management on volumes and times of runoff, particularly in droughts, the flow needs of ecosystems and people within the area and downstream, and the reliability of town supplies.
- Protection of freshes and high flows does not currently require action but is essential for town water reliability and ecosystems. Minimising any adverse effects of weirs should continue.

Mainly forested areas

Streams in mainly forested areas are often valued for their conservation or recreational values. They usually have relatively natural flows and water quality. Many are in national parks or state forests. Other forests are generally in the upper areas of the catchments.

Map: This category applies to state forests, national parks and nature reserves coloured green on the map. It also applies to other forested areas, if any are defined locally.

Water quality objectives

Protection of:


Aquatic ecosystems


Visual amenity


Secondary contact recreation


Primary contact recreation


Drinking water at point of supply—Disinfection only


Drinking water at point of supply—Clarification and disinfection


Drinking water at point of supply—Groundwater


Aquatic foods (cooked)

River Flow Objectives


Protect pools in dry times


Protect natural low flows


Manage groundwater for ecosystems


Minimise effects of weirs and other structures

Supporting information

- Where the whole catchment of a stream is naturally vegetated, WQOs and RFOs are generally, though not always, achieved. High level protection should be given to flows and water quality in these least affected streams and other streams with high conservation values. Existing management practices in national parks or other reserves may already aim to achieve this. In some streams, local circumstances restrict achievement of objectives; for example, cattle using streams in state forests may conflict with achieving water quality suitable for swimming.

- Some streams flowing from disturbed vegetation, plantations or regrowth may meet all WQOs and RFOs, but streams below or within recently disturbed sites may have increased turbidity and downstream sedimentation. Extensive areas of rapidly growing trees may reduce low flows in adjoining streams. Thick groundcover may absorb storm peaks and increase the duration of some flows.
- Some of the state forests and other reserves marked on the map include streams that start in largely cleared land. The water quality and flow patterns through these forests generally reflect any upstream impacts. There may be a high public expectation for good water quality due to the public accessibility of these areas, particularly for recreation.
- Waters flowing out of naturally vegetated areas, including private forests, can provide clean water for use downstream by homesteads or livestock. These downstream benefits may be defined locally for specific protection.
- Vegetation on stream banks and floodplains can provide good habitats for native fish, other animals and plants. The effective value of these habitats is likely to be limited if the water quality is inadequate or if flow patterns are not sufficiently close to natural to provide correct cues for breeding and enable survival of the young. Returning water quality and flow patterns as closely as possible to natural is therefore desirable.
- The Aboriginal community has identified the consumption of raw aquatic foods as an existing use within the catchment. NSW Health recommends against the consumption of raw shellfish harvested on a non-commercial basis and local communities should be made aware of the risks involved.
- If the catchment or river management committees consider that there are streams outside reserves, with high conservation value and to which a high level of protection should apply, they may seek local views and make recommendations to the Government.

Waterways affected by urban development

Waterways within urban areas are often substantially modified and generally carry poor quality stormwater. Local communities are often keen to see these waterways returned to more natural conditions.

Map: These areas are shown as orange dots on the map.

Water quality objectives

Protection of:


Aquatic ecosystems


Visual amenity


Secondary contact recreation, as a short-term objective, within 5 years


Primary contact recreation: assess opportunities to achieve as a longer-term objective, 10 years or more

River flow objectives


Protect pools in dry times


Protect natural low flows


Maintain natural rates of change in water levels


Minimise effects of weirs and other structures

Supporting information

- This category includes creeks and minor waterways within Glen Innes, Tenterfield and Inverell.
- In some urban waterways aquatic ecosystems are considerably modified. A return to pristine aquatic ecosystems in these areas is unlikely and impractical; however, water quality conditions for existing ecosystems can be improved greatly for the benefit of local species and broader catchment health. Data from other local aquatic ecosystems of similar type, in areas that are not urbanised, may provide achievable criteria for these modified aquatic ecosystems.
- Action is needed to reduce the surface and groundwater quality impacts from stormwater, sewerage discharges and unsewered villages.

- Local councils are required to produce stormwater management plans for urban centres with populations above 1000 people. The Urban Stormwater Management Program has provided a grant of up to $68,470 for stormwater management in Tenterfield.
- The tendency for urban developments to cause rapid rises in storm runoff should be minimised.
- See supporting information under 'Uncontrolled streams'.

Uncontrolled streams

This catgeory covers uncontrolled waterways that are not in the other categories. Their flow patterns are largely natural but may have been partially altered. Flows can occur in these streams from local runoff. They are typically ephemeral (flow only during floods and freshes). Frequently, they open into or flow past wetlands and billabongs.

Map: Uncontrolled streams are shown as blue lines on the map.

Water quality objectives

Protection of:


Aquatic ecosystems


Visual amenity


Secondary contact recreation


Primary contact recreation


Livestock water supply


Irrigation water supply


Homestead water supply


Drinking water at point of supply—Disinfection only


Drinking water at point of supply—Clarification and disinfection


Drinking water at point of supply—Groundwater


Aquatic foods (cooked)

River flow objectives


Protect pools in dry times


Protect natural low flows


Protect important rises in water levels


Maintain wetland and floodplain inundation


Manage groundwater for ecosystems


Minimise effects of weirs and other structures

Supporting information

- This category includes unregulated effluent creeks (for example, effluent streams in the western parts of the catchment, including Whalan

Creek and the Boobera and Morella Watercourse), which are common on the western plains where high flows in the main rivers flow away from the river in natural channels.

- The NSW Border Rivers Unregulated River and Groundwater Management Committee will develop a river management plan to implement the environmental objectives.
- Water drawn from the river or groundwater, at the point of supply, must be of sufficient quality for the available level of treatment to be effective in the long term. Towns on uncontrolled streams that extract water from streams or bores for drinking water include Deepwater and Garah. Delungra and Inverell draw drinking water supplies from Copeton Dam (in the Gwydir River catchment).
- In some areas (for example, around Inverell), where there are more intensive industries and rural residential developments, the water quality in streams can be poor. Primary contact recreation objectives are not currently being achieved at some locations. High bacterial levels have been found downstream of major urban centres.
- Sedimentation and nutrients are major water quality issues in most streams in the Border Rivers. Agricultural chemicals (for example, pesticides) have been commonly detected in some rivers, especially downstream of irrigated cotton and some broadacre crops.
- There is localised contamination of some streams in older mining areas; for example, near Emmaville.
- There are a number of local factors to consider in sharing river flows in dry seasons and protecting inundation patterns of flood-dependent ecosystems, including:
  - strong demand for low flows from some streams; for example, Beardy Waters, Tenterfield Creek and the Macintyre River
  - higher flows are sometimes reduced in some streams; for example, effluent in western parts of the catchment
  - identified conservation values; for example, native fish
  - environmental worth and natural inundation patterns of small wetlands, river red gums, and other riparian or floodplain vegetation; for example, effluent creeks.
- Managing groundwater could affect some stream flows or ecosystems in parts of the upper catchment and this should be managed on a case by case basis. Watertables could rise and threaten ecosystems and agricultural production values in some areas.
- RFO *Minimise effects of weirs and other structures* is an important issue throughout the Border Rivers catchment. Local factors include the wish to restore native fish populations; and preventing sediment filling natural waterholes, which causes increased dependence on weirs to secure stock and domestic water supply.

Major regulated rivers

These rivers have large dams supplying irrigation water (and some town and industrial water) for substantial distances downstream. They are defined as section 22c streams under the Water Act. Flows are typically supplemented by releases from dams during the irrigation season resulting in fairly stable and unnaturally high water levels. River flow is substantially reduced during the non- or low-irrigation seasons. At any time of year in periods which would normally have high or very high flow, flows may be substantially reduced by the trapping of water in a large dam.

Map: These rivers are shown as yellow lines on the map.

Water quality objectives

Protection of:


Aquatic ecosystems


Visual amenity


Secondary contact recreation


Primary contact recreation


Livestock water supply


Irrigation water supply


Homestead water supply


Drinking water at point of supply—Disinfection only


Drinking water at point of supply—Clarification and disinfection


Drinking water at point of supply—Groundwater


Aquatic foods (cooked)

River flow objectives

No RFOs are recommended as river flow management is being planned through interstate processes.

Supporting Information

- The NSW–Queensland border is the middle of the Dumaresq, lower Macintyre and upper Barwon rivers from the western end of Tenterfield Creek to Mungindi. The NSW and Queensland governments therefore liaise and work together in relation to many aspects of managing these rivers. River management is subject to interstate agreements and processes
- While this category applies to the NSW parts of the Severn, Macintyre and Barwon rivers from Pindari Dam to near Mungindi and the Dumaresq River below Mole River, the NSW Government recognises that objectives should meet the needs of people and ecosystems on both sides of the rivers.
- The above water quality objectives are recommended for discussion with Queensland as interim objectives. Achievement of objectives for these streams will depend on continued cooperative efforts of governments and the community in NSW and Queensland.
- Drinking water drawn from the river or groundwater must be of sufficient quality at the point of supply for the available level of treatment to be effective in the long term. Towns on the major regulated rivers that extract drinking water from rivers or bores include Ashford, Boggabilla and Mungindi (rivers) and Toomelah and Yetman (bores).
- Where there are more intensive agricultural industries and rural residential developments, the water quality in streams is often poor.
- Human sources of bacteria, such as sewerage and septic systems, as well as animal sources of bacteria were identified, pointing to problems throughout the catchment. (See the DLWC's *Bacterial Water Quality of the States River System for 1996/97*). Recent monitoring data from similar western streams in north-west NSW suggest that it is possible for the water quality in these rivers to sometimes fail the criteria for primary contact recreation.
- Pesticides have been commonly detected in these rivers, especially downstream of cotton irrigation areas.
- Releases from Pindari Dam should continue to be managed to maximise water quality.
- The DLWC's project, Integrated Monitoring of Environmental Flows, incorporates important indicators of water quality and river health that can be improved with flow management. At this stage, this program is being conducted in regulated streams in other NSW catchments.

- In the regulated streams of the Border Rivers catchment, a joint flow management plan is being developed in consultation with the Queensland Government. RFOs for these streams will be set once this joint plan has been finalised.
- Regulated rivers and adjoining alluvial aquifers need to be managed together. Groundwater levels may affect ecosystems. Action is needed to maintain groundwater within levels critical to ecosystems, protect stream flows and address other local concerns such as the reliability of bore water supplies for stock.

Controlled rivers with reduced flows

This category covers two situations:

1) River reaches downstream of the regulated sections, where the water is extracted or diverted This results in reduced flow throughout the year. Water is delivered from the main stream for stock, domestic use, some irrigation and town water supply several times a year.

2) Sections of rivers immediately below town water supply dams, where water is diverted directly from the dam. In this situation, flows can be substantially reduced throughout the year, though special environmental releases may be possible.

Map: These rivers are shown as red lines on the map.

Water quality objectives

Protection of:


Aquatic ecosystems


Visual amenity


Secondary contact recreation


Primary contact recreation


Livestock water supply


Irrigation water supply


Homestead water supply


Drinking water at point of supply—Disinfection only


Drinking water at point of supply—Clarification and disinfection


Drinking water at point of supply—Groundwater


Aquatic foods (cooked)

River flow objectives


Protect pools in dry times


Protect natural low flows


Protect important rises in water levels


Maintain wetland and floodplain inundation


Mimic natural drying in temporary waterways


Maintain natural flow variability


Maintain natural rate of change in water levels


Manage groundwater for ecosystems


Minimise effects of weirs and other structures


Minimise effects of dams on water quality

Supporting information

- This category applies to the Boomi River (situation 1), and river sections below Beardy Waters and Tenterfield Creek (situation 2).
- Water quality can be affected by the loss of diluting or flushing flows where flows have been reduced.
- Water quality problems, such as those associated with pesticides, are common in the Boomi River.
- Flows in much of the river downstream of Tenterfield Creek Dam and Beardy Waters Dam are often substantially reduced by diversion of water to meet urban and industry needs.
- Landholders downstream of dams depend on the remaining flow and may contribute to further reductions. Augmentation of town water supplies will not be required but the management of these dams should be reviewed, along with the conditions on water licences along these streams. Local factors include support for protection of native fish and landholders' needs.

4 Interim water quality objectives explained

This section explains each of the water quality objectives (WQOs). The WQOs for each part of the Border Rivers catchment (NSW) are listed in Section 3.

In total, there are eleven WQOs. They provide benchmarks or reference levels to guide water quality planning and management.

Achieving each WQO will mean improving poor water quality or maintaining existing good water quality.

Objectives consist of three parts: *environmental values*, their *indicators* and their *numerical criteria*. For example, if the objective is to protect *irrigation water supplies* (environmental value), we need to keep the *salinity* of the irrigation water (the indicator) below a *specified number* (the criterion). The objectives comprise community-based environmental values and their associated national criteria. They provide the statewide context for taking this work forward into the river management process. Many catchment management committees have developed more detailed information on WQOs for their rivers.

Refining numerical criteria to account for local conditions

Local water quality varies naturally because of various factors, including the type of land the waters are draining (e.g. soils, slope), or different rainfall and runoff patterns (e.g. ephemeral or permanent streams). Different land-use and land-management practices also affect water quality. Localised WQOs must take account of these natural variations, particularly for the environmental value of aquatic ecosystems.

The indicators and criteria used here are those provided under the National Water Quality Management Strategy. They are listed in the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992), currently under review. Numerical criteria provide the basis for ascertaining how close current water quality is to meeting desired levels of water quality. Key indicators for each environmental value are listed below. The ANZECC guidelines provide a comprehensive set of indicators and explain how national indicators of water quality may be adapted to establish local reference conditions.

The ANZECC (1992) guidelines need to be adapted to local conditions. Further refinement of the numerical criteria is needed, especially for aquatic ecosystems, and particularly in places, or for issues, requiring priority action. This work will usually be done by government agencies or government agency representatives on river management committees. The committees may recommend local refinements to Government for approval, through the Minister for the Environment and the Minister for Land and Water Conservation.

To establish reference criteria for affected sites, it is best to use the least-affected or best-managed reference sites with similar characteristics. In national parks and similar areas, near-pristine reference sites should be used. Reference sites can be compared with potentially affected sites to help refine management targets.

Information from the National River Health Program (NRHP) provides a starting point for developing local reference water-quality levels in the catchment. These are shown below in the key criteria applying to 'Aquatic ecosystems', under total phosphorus, turbidity and salinity.

Monitoring

State Government agencies, local government, industry and the community are monitoring water in some areas. The State Water Monitoring Coordination Committee is developing a water monitoring strategy that will help to assess progress in achieving the objectives. This process is rationalising and improving the coordination of the monitoring programs and establishing common protocols for those undertaking monitoring for different purposes.

The Department of Land and Water Conservation is coordinating the Integrated Monitoring of Environmental Flows Program, which will result in improved information on the links between river health and flows.

Downstream Impacts

Plans and decisions need to recognise that activities and decisions made upstream affect water quality downstream.

Classified waters

The Clean Waters Regulations 1972 established a system for the classification of waters. Control of discharges to the receiving waters is implemented through the EPA's licensing system. The legally enforceable water pollution standards apply only to an estimated 5% of NSW waterways.

The *Protection of the Environment (Operations) Act 1997* repeals the *Clean Waters Act 1970* and consequently new classifications will not be possible. However, the approval process for discharge into classified waters is retained by saving provisions under the POEO Act until such time as they are varied or repealed by a regulation or by a Protection of the Environment Policy.

Interim Water Quality Objectives

Meeting water quality levels suitable for local ecosystems is generally the basis for protecting water quality for the remaining environmental values, which are the uses people have for water.

Aquatic ecosystems

Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term.

Where the objective applies

- The objective applies to all natural waterways.
- High level protection of aquatic ecosystems applies to waters in and immediately upstream of national parks, nature reserves, state forests, drinking water catchments and high-conservation-value areas. This reflects their largely unmodified aquatic ecosystems, value in providing natural sources of high-quality drinking water, and high levels of recreational use.
- Even in areas greatly affected by human use, continuing improvement is needed towards healthy, diverse aquatic ecosystems.
- Water quality in artificial watercourses (e.g. drainage channels) should ideally be adequate to protect native species that may use them, as well as being adequate for the desired human uses. However, full protection of aquatic ecosystems may not be achievable in the short-term in some artificial watercourses.
- Artificial watercourses should meet the objectives (including protection of aquatic ecosystems) applying to natural waterways at any point where water from the artificial watercourse flows into a natural waterway.

Key indicators and numerical criteria

The following table summarises the specific water quality indicators and related numerical criteria relevant to monitoring the health of aquatic ecosystems in this catchment.

Aquatic ecosystems	
Indicator	Numerical criteria
Total phosphorus	Site- or region-specific information is needed. • Rivers: 10–100 µg/L • Lakes & reservoirs: 5–50 µg/L Understanding different forms of phosphorus is important in managing unfavourable plant/algae responses, e.g. the proportion of phosphorus in water that is available for plant growth. Assessment of the NRHP reference sites in neighbouring catchments and other water quality data gives a starting point for developing locally applicable criteria. Typical numbers are: *Macintyre River* • upstream of confluence with Severn River: 20-50 µg/L • downstream of confluence with Severn River: 50-100 µg/L *Severn River*: 20-50 µg/L *Dumaresq River* • upstream of Mauro: 20-50 µg/L • downstream of Mauro: 50-100 µg/L.
Total nitrogen	Site- or region-specific studies are needed. • Rivers: 100–750 µg/L • Lakes & reservoirs: 100–500 µg/L Based on an assessment of NRHP reference site data in neighbouring catchments and other data on oxidised nitrogen, a region of high levels of oxidised nitrogen could be identified in the central west part of the state. The south coast and most of the Murray had reasonably low levels. The rest of NSW showed a great variation in oxidised nitrogen levels. Understanding different forms of nitrogen in waters is important in different management situations.
Chlorophyll-a	Site- or region-specific studies are needed. • Lakes & reservoirs: 2–10 µg/L.
Turbidity	Common descriptions: < 5 NTU low turbidity (high clarity); 5–25 NTU medium turbidity; 25–50 NTU high turbidity; > 50 NTU very high turbidity. Site- or region-specific studies are needed. < 10% change in seasonal mean NTU Increases in suspended particulate matter should be limited such that the clarity guidelines are maintained. Assessment of the NRHP reference sites in neighbouring catchments and other water quality data gives a starting point for developing locally applicable criteria. Typical numbers are: *Macintyre River* • upstream of confluence with Severn River: 5–20 NTU • between confluence with Severn River and start of Boomi River: 20–100 NTU • downstream of the start of Boomi River : > 100 (range 134–2300, median 271)* * The range and median are based on all NRHP reference data within the region with turbidity levels >100 NTU and not only the data from the MacIntyre downstream of the start of the Boomi River. *Severn River*: 5–20 NTU *Dumaresq River* • upstream of Mauro: 5–20 NTU • downstream of Mauro: 20–100 NTU
Clarity	For waters deeper than 50% of the euphotic depth, the euphotic depth should not change by more than 10% from an established seasonal norm. In water shallower than 50% of the euphotic depth, the maximum reduction in light at the sediment bed should not exceed 20%.

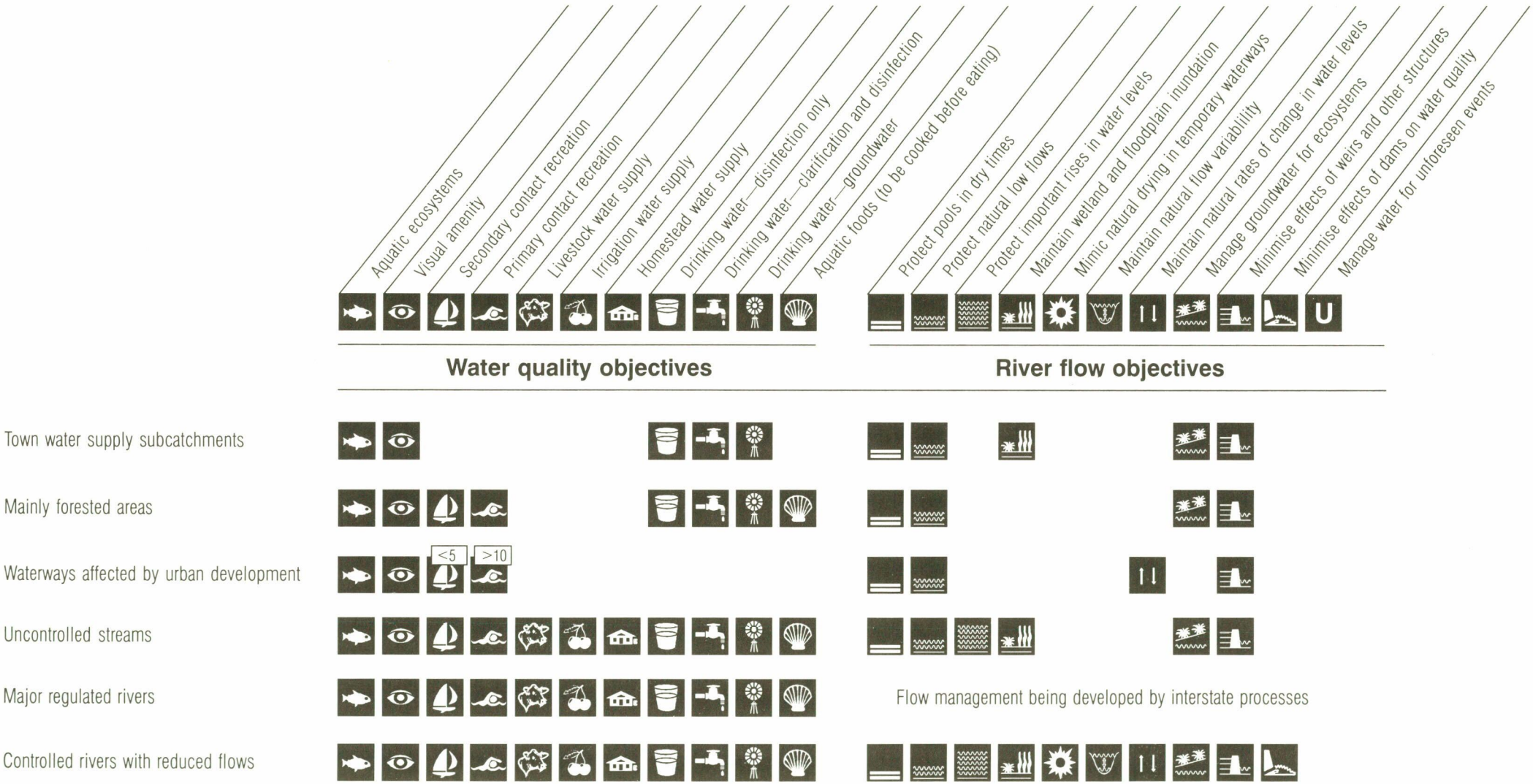
Salinity (electrical conductivity)	Fresh waters: < 1500 μS/cm. Non-degradation of current levels. Assessment of the NRHP reference sites in neighbouring catchments and other water quality data provide a starting point for developing locally applicable criteria. *Macintyre River* • upstream of Holdfast: 150–280 μS/cm • downstream of Holdfast: 280–800 μS/cm *Severn River*: 150–280 μS/cm *Dumaresq River* • upstream of Mauro: 150–280 μS/cm • downstream of Mauro: 280–800 μS/cm
Dissolved oxygen	> 6 mg/L or 80–90% saturation being determined over at least 24 hours and if possible over a few days to establish the diurnal range in concentration.
pH	Fresh water range: 6.5–9.0 Changes of more than 0.5 pH units from the natural seasonal maximum or minimum should be investigated.
Temperature	< 2°C increase in natural temperature levels. No current guidelines for acceptable temperature reductions.
Chemical contaminants	See ANZECC (1992) guidelines, section 2.4 for full details. Summary: 'Waters shall be free from pollutants in amounts or combinations that are toxic to humans, animals, plants and other organisms.'
Fringing vegetation of waterbodies	No specific criteria. One aspect where related guidance is given is under *Ecosystem Function*: "In any waterbody, changes that vary the relative importance of detrital and grazing food chains should be minimised. Production-to-respiration ratios should not vary significantly from those of similar, local, unaffected systems".
Macro-invertebrates	No specific criteria. Species richness of the predominant invertebrate assemblages, as measured by an appropriate biotic index, should not be altered; and impacts that result in significant changes in species composition, compared with those in similar, local, unaffected systems, should not be permitted.
Water plants	No specific criteria. Species richness of the predominant macrophyte assemblages, as measured by an appropriate index, should not be altered; and impacts that result in significant changes in species composition, compared with those in similar, local unaffected systems, should not be permitted.
Fish	No specific criteria. For biological communities including fish: • Communities should be protected such that the species composition, diversity, and functional organisation remain comparable to that of the natural habitat of the region; and • Impacts that result in significant changes in species composition or diversity should not be permitted.

Supporting information

- The approach to protecting the aquatic ecosystem should consider the whole range of interacting factors—such as variability of water quality over time, sediment interactions, river flow, local geology, land use, the needs of sensitive habitats, and people's uses for water.
- Assessing ecosystem health also requires using a range of indicators and considering local modifying factors—such as basalt soils resulting in naturally higher nutrient levels or estuary opening patterns affecting water quality conditions. However, information on a full range of indicators may not be available from regular monitoring.
- Although modified, many non-pristine environments contain important aquatic ecosystems. Well-functioning aquatic ecosystems also provide benefits to people using these waters, such as reducing blue-green algal blooms.
- Nutrient values or concentration are indicative of levels at or above which negative algae and plant growth responses have been known to occur, depending on a range of other factors.
- Reducing pollutant loads during rainfall and runoff periods should be a key focus for improving water quality. It is also important in managing longer term impacts, such as sedimentation and polluted sediments.

Catchment at a glance

Border Rivers Catchment (NSW)



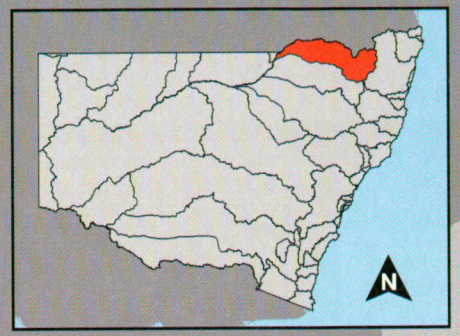
<5 For achievement within 5 years

5-10 For achievement in 5 to 10 years

>10 For achievement in 10 years or more

wtld Includes wetlands

Border Rivers Catchment (NSW)



GOONDIWINDI
BOGGABILLA
TOOMELAH
MAURO
BOOMI
HOLDFAST CROSSING
YETMAN
TEXAS
MUNGINDI
GARAH
CROPPA CREEK
BONSHAW
MOLE RIVER
TENTERFIELD
ASHFORD
EMMAVILLE
DEEPWATER
INVERELL
GLEN INNES
Pindari Dam
Severn R.
MacIntyre River
Barwon River
Boomi River
Whalan Ck.
Gil Creek
Croppa Creek
Yallaroi Ck. Creek
Ottleys Creek
Severn River
Mole River
Tenterfield Ck
Deepwater River
Beardy Waters
Dumaresq River
Morella Watercourse

- Major regulated rivers
- Controlled rivers with reduced flow
- Waterways affected by urban development
- Major weirs, storages
- Major storages
- Town water supply subcatchment
- National Parks, Nature Reserves & State Forests
- Mainly forested areas
- Uncontrolled streams

0 20 40 60 80 100 Kilometres

Prepared by NSW EPA's Remote Sensing / GIS Service

- The choice of toxicant indicators for use in each management situation is related to known past or current activities. Impacts are detected by measuring water, sediment or biota. Natural sources should also be considered.
- Protecting aquatic ecosystems requires mimicking natural river flow patterns as closely as possible (see Section 5).

Visual amenity

Aesthetic qualities of waters

Where the objective applies

- The objective applies to all waters, particularly those used for aquatic recreation and where scenic qualities are important.

Key indicators

Indicators used to monitor visual amenity are summarised in the table.

Visual amenity	
Indicator	Numerical criteria
Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odour. Waters should be free from floating debris and litter.
Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.

Supporting information

- Protecting aquatic ecosystems and improving stormwater management will improve visual amenity.
- Visual amenity protection is also needed to protect water quality for primary and secondary contact recreation.

Secondary contact recreation

Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.

Where the objective applies

- This objective applies to all waters but may not be achievable for some time in some areas. Section 3 indicates the priority sites for early achievement of the objective in this catchment.
- Secondary contact recreation applies in waterways where communities do not require primary contact water quality or where primary contact recreation is only possible in the future.

Key indicators and numerical criteria

Indicators used to monitor water for secondary contact recreation are summarised in the table.

Secondary contact recreation	
Indicator	Numerical criteria
Faecal coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL with 4 out of 5 samples <4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450–700 organisms/100 mL).
Algae & blue-green algae	<15 000 cells/mL
Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membrane are unsuitable for recreation. Toxic substances should not exceed levels given for untreated drinking water.
Visual clarity and colour	Use visual amenity guidelines.
Surface films	Use visual amenity guidelines.

Supporting information

- Water quality tests for faecal coliform bacteria are used as an indicator of the possible presence of human pathogens. Improved tests and indicators for these are being developed.

Primary contact recreation

Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.

Where the objective applies

- In the immediate future the objective applies to waters within and immediately upstream of recognised recreation sites, but for many waters this is a long-term objective.
- Secondary contact recreation levels should apply in other areas where primary contact recreation, such as swimming, is unlikely to be achieved in the immediate future, because of pollution.

Key indicators and their numerical criteria

Indicators used to monitor water quality for primary contact recreation are summarised in the table.

Primary contact recreation	
Indicator	Numerical criteria
Turbidity	A 200-mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 m (approximately 6 NTU).
Faecal coliforms	Median over bathing season of < 150 faecal coliforms per 100 mL with 4 out of 5 samples <600/100 mL (minimum of five samples taken at regular intervals not exceeding one month).
Enterococci	Median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60–100 organisms/100 mL).
Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water.
Algae & blue-green algae	< 15 000 cells/mL
Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
pH	5.0–9.0
Temperature	15–35°C for prolonged exposure.
Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed levels given for untreated drinking water.
Visual clarity and colour	Use visual amenity guidelines.
Surface films	*Use visual amenity guidelines.*

Supporting information

- Maintain water quality in all areas where water quality levels for swimming are currently achieved.
- An immediate focus should be on improving swimming water quality at recognised recreation sites, with an emphasis on meeting targets during the bathing season.
- Over the longer term, water quality will need to improve to meet swimming objectives at more locations.
- Bacterial water quality tests are used to indicate the possible presence of human pathogens. Improved tests and indicators are being developed.
- Achieving water quality levels that are safe for swimming will also result in safer water quality for non-potable uses in homesteads.

Livestock water supply

Protecting water quality to maximise the production of healthy livestock.

Where the objective applies

- This objective applies to all surface and groundwaters used to water stock.

Key indicators and their numerical criteria

Indicators used to monitor water quality for livestock water supply are summarised in the table.

Livestock water supply	
Indicator	Numerical criteria
Algae & blue-green algae	< 10 000 cells/mL. Lower levels may be needed for some algal species.
Salinity (electrical conductivity)	< 3000–9000 µS/cm, depending on the type of livestock and other factors.
Faecal coliforms	Geometric mean: < 1000 faecal coliforms/100 mL, 20% of samples < 5000/100 mL (based on not less than 5 water samples taken per month).
Chemical contaminants	See ANZECC (1992) guidelines, sections 5.2.2 & 5.2.3, and criteria for untreated drinking water.

Supporting information

- Poor water quality can limit livestock productivity.
- This objective is generally attainable if aquatic ecosystems are protected.

Irrigation water supply

Protecting the quality of waters applied to crops and pasture

Where the objective applies

- This objective applies to all current and potential areas of irrigated crops, both small- and large-scale.
- Local requirements for irrigation water quality, such as salinity, apply.

Key indicators and their numerical criteria

Indicators used to monitor water quality for irrigation water supply are summarised in the table.

Irrigation water supply	
Indicator	Numerical criteria
Algae & blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
Salinity (electrical conductivity)	< 280 µS/cm (low-salinity water threshold). 280–800 µS/cm (medium-salinity water threshold).
Faecal coliforms	Geometric mean: < 1000 faecal coliforms/100 mL, 20% of samples < 4000/100 mL (not less than 5 samples taken per month).
pH	4.5–9.0
Chemical contaminants	See ANZECC (1992) guidelines, section 5.1.4.

Supporting information

- ANZECC (1992) guidelines recommend salinity criteria for various irrigated crops; for example, medium-salinity water (< 800 µS/cm) is suitable for most types of crops. The impacts of saline water are influenced by soil characteristics, crop tolerance, climate and irrigation practices.
- Long-term effects of irrigation with saline water on soils need consideration.
- A major consideration for irrigation water supply is the sodium adsorption ratio (SAR), which indicates the level of excess sodium in the water. If the SAR is high, the water may have an adverse effect on soil structure, even though the total salinity of the water may be low.

- A variety of plant pathogens can be distributed by irrigation water—including nematodes, fungi, viruses and bacteria. However, in the absence of sufficient data, there are no guidelines for controlling plant pathogens.

Homestead water supply

Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing

Where the objective applies

- The objective applies to all homesteads that draw water from surface and groundwaters for domestic needs, including drinking water.
- The NSW Health Department advises that water for domestic use in homesteads should comply with the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996) at the point of use, regardless of source.

Key indicators and their numerical criteria

Key indicators for drinking water quality at the point of use in the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996) are set out below. Monitoring should also be considered for health-related parameters of local concern. Communities should refer to the *Australian Drinking Water Guidelines* for information on additional parameters.

Homestead water supply	
Indicator	Numerical criteria
Blue-green algae	No guideline values are set for cyanobacteria in drinking water. In water storages, counts of < 1000 algal cells/mL are of no concern. 1000–2000 algal cells/mL – increase monitoring. > 2000 algal cells/mL – immediate action indicated; seek expert advice.
Turbidity	5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some micro-organisms from disinfection.
Total dissolved solids	< 500 mg/L is regarded as good quality drinking water based on taste. 500–1000 mg/L is acceptable based on taste. >1000 mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste.

Faecal coliforms	0 faecal coliforms per 100 mL (0/100 mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority. Also see the Guidelines for Microbiological Quality in relation to Monitoring, Monitoring Frequency and Assessing Perfomance in the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996).
pH	6.5–8.5
Chemical contaminants	See Guidelines for Inorganic Chemicals in the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996).

Supporting information

- For an individual water supply, the emphasis should be on selecting the best quality source water available, and on protecting its quality by the use of barrier systems and maintenance programs. Whatever the source (ground, surface or tank water), householders should assure themselves that the water is safe to drink.
- Information on the quality of surface or groundwater may be available from state and local governments conducting monitoring programs. If not, individuals should consider having the water tested for any key health characteristics identified as being of local concern. Where raw water quality does not meet the requirements of the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996), a point-of-use device may be needed to treat the water.
- In many cases it will not be possible for water at individual homesteads to comply with the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996) without some form of treatment. Many homesteads traditionally take drinking water untreated from local streams. Even in pristine areas there are health risks associated with this practice. The Government recommends that drinking water, including water for cooking and bathing, is at least disinfected before use.
- Effective communication and education strategies may be needed to ensure that householders understand that when water is not of a potable quality, precautionary measures should be taken (e.g. avoiding ingestion, boiling drinking water). Such water may be of sufficient quality to be used for washing clothes, gardening, toilet-flushing and other non-potable uses.
- Many homesteads rely on tank water for drinking and cooking. The National Environmental Health Forum Monograph, *Guidance on the Use of Rainwater Tanks* (NEHF 1998) is endorsed by the NSW Health Department and provides useful information on the safe operation of rainwater tanks.

Drinking water

Disinfection only, or

Clarification and disinfection

Groundwater

Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment

Where the objectives apply

- These objectives apply to all current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objective also applies to subcatchments or groundwaters used for town water supplies.

Key indicators and their numerical criteria

- Key indicators in the ANZECC (1992) guidelines for raw water for drinking water supply that is to undergo coarse screening only are listed below. Numerical criteria for algae are drawn from the more recent State Algal Coordinating Committee algal management guidelines (SACC 1996).
- Note that a wide range of treatment technologies are available (e.g. coagulation, flocculation, filtration, ion exchange, reverse osmosis, carbon adsorption columns) that enable the production of acceptable drinking water from almost any raw water. The ANZECC (1992) guidelines do not specify criteria for the many types of water quality that could be involved.
- Refer to the NSW Groundwater Protection Policy, (DLWC 1998b) for information on the management of groundwater quality.
- All drinking water should comply with the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996) at the point of use. Refer to the Summary in the Australian Drinking Water Guidelines.

Drinking water	
Indicator	Numerical criteria
Blue-green algae	< 2000 algal cells/mL – water may be used for potable supply. 2000–15 000 algal cells/mL – may be used for potable supply if regular (at least weekly) toxicity testing is being undertaken and no toxins, tastes or odours are detected. >15 000 algal cells/mL – may not be used for potable supply except with full water treatment, which incorporates filtration and activated carbon. *Source:* Appendix 3, *Implementing the NSW Algal Management Strategy,* (SACC 1996). *Note: New information may soon be available which may lead to a revision of these criteria.*
Turbidity	Site-specific determinant.
Salinity (electrical conductivity)	<1500 µS/cm > 800 µS/cm causes a deterioration in taste.
Faecal coliforms*	0 faecal coliforms per 100 mL (0/100 mL)
Total coliforms*	95% of samples should be 0 coliforms/ 100 mL throughout the year. Up to 10 coliform organisms may be accepted occasionally in 100 mL. Coliform organisms should not be detected in 100 mL in any two consecutive samples.
Dissolved oxygen	> 6.5 mg/L (> 80% saturation)
pH	6.5–8.5
Chemical contaminants	See ANZECC (1992) guidelines, section 4.2.2.

* Values given are ANZECC criteria for raw waters before disinfection or clarification. Raw waters can have concentrations of faecal coliforms above the ANZECC criteria, even in pristine ecosystems. Slightly greater faecal coliform or total coliform contamination, may therefore be acceptable in raw waters that are to be disinfected before delivery to the consumer. (Faecal coliform criteria used in Victoria have suggested that for raw waters requiring only low-level treatment, natural background levels of 95% of samples should have <10 faecal coliforms/100 mL. For high-level treatment, 95% of samples should have <100 faecal coliforms/100 mL.) For a full discussion of drinking water system management and criteria, see the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996).

Supporting information

- The focus is on improving the quality of raw drinking water sources to protect public health and minimise treatment costs. In some cases, this will require controlling or removing pollutants from dedicated drinking water subcatchments, from upstream of river offtakes and from groundwater systems used for drinking water.
- Protection of zones upstream of raw water or reservoir inlets is essential, but may be feasible only over limited distances. The location and size of offtake zones will need to be defined based on further local community consultation. Upstream conditions will also need to be considered (e.g. existing land use, pollutant sources, climatic and river flow factors).
- The existence of an offtake zone acts as an indication of the need to protect drinking water at the point of supply and to identify upstream threats to those supplies.
- Some waterbodies used as a raw drinking water source may provide water of high quality that needs only disinfection before use. These waterbodies should be regarded as having a high environmental value and should be protected.
- Many town water supplies rely on pumping groundwater from aquifers or river alluvium.
- Water quality tests for faecal coliform bacteria are used as an indicator of the possible presence of human pathogens. Improved tests are being developed.
- Note that the National Health and Medical Research Council is currently considering the introduction of criteria for *Cryptosporidium* and *Giardia*.

Aquatic foods (cooked)

Refers to protecting water quality for safe consumption of foods taken from natural waterbodies.

(In the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992), this environmental value is called Human Consumers of Fish, Crustacea & Shellfish.)

Where the objective applies

- The objective applies to all waters where aquatic foods are taken for non-commercial harvesting.

Key indicators and their numerical criteria

Indicators of water quality to monitor safe eating of aquatic foods are summarised in the following table. Other indicators are listed in the ANZECC (1992) guidelines.

Aquatic foods	
Indicator	Numerical criteria
Algae & blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
Faecal coliforms	Median faecal coliform bacterial concentration should not exceed 14 MPN/100mL; <10% of samples to be >43 MPN/100 mL i.e. most probable number of organisms ir 100 mL, if eaten raw.
Chemical contaminants	Where criteria for ecosystem protection given in section 2.1 of the ANZECC (1992) guidelines do not provide adequate protection for the human consumer, refer to criteria provided in section 2.5, table 2.11. Tainting substances that may affect the palatability of the food sources are summarised in ANZECC (1992) guidelines, table 2.12.

Supporting information

- Indicators and criteria relevant to protecting the growth and reproduction of fish, crustaceans and shellfish are generally those discussed under WQO *Aquatic ecosystems* (see the beginning of Section 4).
- There is a need to identify all aquatic food sources to ensure that appropriate management is in place to protect the human consumer.
- The condition of the waterway must be suitable for both individual species and their habitats and must protect consumers from chemical

contaminants that may accumulate in the tissues of aquatic foods or from human pathogens. Many waterways in NSW produce aquatic foods that are suitable for eating after cooking.

- NSW Health should be consulted about issues that have a direct public health impact and concerns about the safety of aquatic foods should be brought to the attention of local Public Health Units.
- The potential for members of the public, including those in Aboriginal communities, who gather shellfish for subsistence or non-commercial purposes to be exposed to pathogens by eating raw shellfish needs to be considered.
- NSW Health recommends against the consumption of raw shellfish harvested on a non-commercial basis. All such shellfish should be thoroughly cooked to kill pathogens and minimise the risk of food poisoning. Cooking cannot remove algal toxins or chemical contaminants.
- The potential presence of microbial pathogens (faecal bacteria, viruses, *Cryptosporidium*), algal and biotoxins and chemical contaminants needs to be considered when assessing the risks associated with shellfish consumption. In addition, an understanding of the catchment and actual and potential pollution sources that may impact on the water quality is essential.
- Water quality tests for faecal coliform bacteria are used as an indicator of the possible presence of human pathogens. Improved tests are being developed.

Industrial water supplies

The high economic value of water taken from rivers and lakes for use by industry needs recognition in water quality planning and management. It has been identified as an important environmental value through community consultation. *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992) provides guidance on the water quality needed for various industries.

As industry water supply needs are diverse, relevant water quality criteria are not summarised here. Sources of water used for industry invariably have other environmental values, which mostly need water of a higher quality than that needed by industry. Further, individual industries are more prepared to monitor and treat the available water resources to meet their own needs.

5 Interim river flow objectives explained

This section explains each of the interim river flow objectives (RFOs). The RFOs recommended for the Border Rivers catchment (NSW) are listed in Section 3.

This section does NOT apply to rivers marked in bright yellow on the map: the Dumaresq below Mole River, the Severn below Pindari Dam, the Macintyre below the Severn, and the Barwon River.

In total, there are eleven inland interim river flow objectives, each dealing with a critical element of natural river flows.

Flow patterns in many rivers have been significantly altered and will not return to natural flow regimes. The NSW Government is not attempting to restore completely natural flow patterns where the community significantly benefits from altered flow patterns. Communities and the Government have identified important areas where we can make adjustments to maintain or improve river health while continuing to benefit from water use.

River management plans (RMPs) will contain integrated actions and timeframes to achieve objectives and implement identified actions in consultation with the community. Different approaches and outcomes will apply across the catchment.

Recommending variations to objectives

River management committees (RMCs) may recommend alternative or additional actions and refinements to numerical targets.

Interstate Processes

The NSW–Queensland border divides the Border Rivers catchment. Water management on the shared streams is subject to interstate agreements and processes. The Queensland and NSW governments have been jointly developing a Flow Management Plan for the major regulated rivers within this catchment including the Dumaresq River, the Macintyre River below Pindari Dam and the Barwon River upstream of Mungindi. NSW is therefore not recommending interim river flow objectives for these rivers at this stage – only for other streams entirely within NSW.

Protect pools in dry times

Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows

During dry times, some streams stop flowing and form pools. Pools and wetlands are refuges for aquatic plants and animals. Pumping water from these areas can make it more difficult for many species to recover after a drought.

Measures to achieve objective

- There should be no water extraction from streams or wetlands in periods of no flow.
- If conditions on water licences do not provide for this objective to be met, priority should be given to implementing it by actions appropriate to local circumstances.

Supporting information

- Along with social and economic considerations, the Department of Land and Water Conservation and RMCs need to define when and how to protect specific pools:
  - — in natural wetlands with licensed pumps
  - — in streams where flow occurs under the surface
  - — where these pools have become deeper or shallower.
- Where water extraction for stock and domestic use is high (e.g. in rural subdivisions surrounding large urban centres), RMCs may seek community views and recommend actions to protect the environment in periods of no flow.

Protect natural low flows

Protect natural low flows

Water extraction and storage are high in dry times and impose long artificial droughts that increase the stress on aquatic plants and animals.

Measures to achieve objective

- Share low flows between the environment and water users and fully protect all very low natural flows.
  - — Very low flows: flows below the level naturally exceeded on 95% of all days with flow.
  - — Low flows: flows below the level naturally exceeded on 80% of all days with flow.
- Unless environmental, social and economic evaluations give an appropriate alternative, the following limits on water extraction apply:
  - — Environmental share in high-conservation-value streams: all or most of very low flows. There should be no increase in extraction of low flows.
  - — Environmental share in other streams: all very low flows and 50–70% of daily low levels.
- New or transferred licences should not allow extraction during low flows below the 80th percentile in any.
- In streams with little water use or important conservation values, minimise risks to ecosystems during low flows.
- Review management of town water supplies to assess whether changes may help achieve the objective without significantly affecting reliability.

Supporting information

- RMPs need to identify actions to achieve targets for each stream that balance local environmental, social or economic considerations. Based on such assessments, RMCs may recommend different objectives to the Minister for the Environment and the Minister for Land and Water Conservation.
- In streams where extraction currently exceeds 50% of low flow, RMCs will need to find means to achieve targets, in consultation with water licence holders and others affected. Where extraction is currently below 30% of low flow, it should not be allowed to exceed 30%.
- Town water supplies will not need to be augmented to meet this objective. If augmentation for other reasons is proposed, appropriate levels of protection of low flows will be determined on a case-by-case basis.
- Where extraction for stock and domestic use is high (e.g. in rural subdivisions), RMCs may seek community views and recommend appropriate actions to protect environmental values during low flows.

Protect important rises in water levels

Protect or restore a proportion of moderate flows ('freshes') and high flows

Rain causes peaks in river flows. This 'pulsing' of flows, including their duration, may trigger migration of animals and reproduction of plants and animals; provide over-bank flows to wetlands and floodplains; shape the river channel; and control water quality and nutrients. Water storage and extraction can alter or remove freshes, inhibiting these vital processes. The height, duration, season and frequency of higher flows are all important.

Measures to achieve objective

- Unless local information shows appropriate alternative targets, use the following limits on extraction:
  - — No extraction of more than 30–50% of moderate to high flows on a daily basis. (This means that, for each stream, the RMC should recommend an appropriate limit on the proportion of flows that may be extracted whenever flows are greater than the level that would naturally be exceeded on 80% of all days with flow. For some streams this limit may be 30%; for other streams it may be as high as 50%.).
  - — No increase in extractions in high-conservation streams.
- Where use exceeds the above limit, appropriate ways of limiting the volume or controlling the timing of extraction are needed.

Supporting information

- These targets are currently being met in many streams, particularly those with low water extraction.
- RMPs need to include appropriate actions to achieve this objective that balance environmental, economic or social considerations. RMCs may recommend variations from targets, if there is a demonstrated need.

Maintain wetland and floodplain inundation

Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems

Floodplain and wetland ecosystems develop in response to flow patterns and the nature of the landscape between the river and wetlands or floodplains. Floodplain works can change the flooding patterns, which will lead to changes in habitat and vegetation. These changes can be expected to result in reduced or different species diversity and abundance, particularly reduced numbers of native fish, and water quality problems.

Measures to achieve objective

- RMPs and actions need to include strategies to:
  - — maintain, restore or mimic natural inundation and drying patterns in natural and semi-natural wetlands and remaining native floodplain ecosystems
  - — ensure adequate access for native fish to and from floodplain wetlands.
- Flooding patterns should not be altered without proper environment assessment.

Supporting information

- Property protection issues need to be taken into account.

Mimic natural drying in temporary waterways

Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways

Continuous or seasonal water releases from water storages can mean streams and wetlands can sometimes be 'wetter' than natural. In streams and wetlands that naturally dry out, this can create problems in maintaining habitat, vegetation, nutrient cycling and signals for breeding. It can also lead to a high watertable and associated salinity problems. Natural wetting and drying cycles produce diversity of habitat and, therefore, high species diversity.

Measures to achieve objective

- Identify any unregulated streams where unnatural flows have greatly reduced drying periods. Assess potential short- and long-term environmental, economic and social effects of this change and of possible management alternatives.
- Decisions on what, if any, action is appropriate to implement this objective in streams and wetlands should be worked out on a case-by-case basis after giving due consideration to local views. Where relevant, agreements under land and water management plans should be respected, but this objective should be taken into account, along with WQOs, social objectives and economic objectives, in resolving outstanding or new management issues for drainage water.

Supporting information

- This objective is being met in most streams.
- Continuous or seasonal water releases include irrigation drainage and sewage treatment plant effluent.

Maintain natural flow variability

Maintain or mimic natural flow variability in all streams

Australia's rainfall and river flows are naturally variable. The way we currently store and divert river water can reduce natural pulsing of water down rivers and maintain artificially high or stable river heights. Hydroelectric releases can vary unnaturally between day and night. In urban areas and other places where the ability of the land to absorb or detain rainfall is reduced, more water runs off rapidly, so water levels will rise higher. These changes often create problems with streambank stability, biodiversity and signals for breeding and migration.

Measures to achieve objective

- Identify streams with unnatural flow variability and develop actions to mimic natural variability.
- Identify streams with potential for flow variability problems and take early action.

Supporting information

- This objective applies mainly to controlled rivers but may apply in some locations or situations in uncontrolled streams.
- This objective may also affect the achievement of water quality objectives.

Maintain natural rates of change in water levels

Maintain rates of rise and fall of river heights within natural bounds

Shutting off dam releases, or starting many pumps together, can drop river levels too quickly. If water levels fall too fast, water does not drain properly from riverbanks and they may collapse. Migration of aquatic animals may also be restricted by such sudden falls in river height.

Measures to achieve objective

- Identify locations where water levels often rise or fall faster than they would naturally. Identify the reasons and impacts. Remedial action requires case-by-case assessment.
- Identify potential problems and take early action.

Supporting information

- Local observations, such as bank erosion, may indicate a need for action.
- Solutions may involve slight changes to the operation of larger pumps or diversion works.
- This objective does not usually apply to uncontrolled streams.

Manage groundwater for ecosystems

Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems

Some shallow groundwaters are directly linked to flows in streams and wetlands. They may provide base flows in rivers during dry periods and may be primary sources of water for wetland, floodplain and riparian vegetation. Seriously depleting groundwater in dry times may lead to unnatural recharge of groundwater from surface waters during the next flow.

Measures to achieve objective

- Implement the State Groundwater Policy (DLWC 1997a, 1998b).
- Identify any streams or ecosystems that may depend on high groundwater levels and assess impacts of reduced recharge or excessive pumping.
- Identify where groundwaters may be rising and likely to threaten ecosystems or surface water quality.
- Determine appropriate action to keep groundwater levels within acceptable bounds.

Supporting information

- River and groundwater management committees should identify areas and actions needed, particularly where there are threatened ecosystems.

Minimise effects of weirs and other structures

Minimise the impact of instream structures

Most instream structures (e.g. weirs) convert flowing water to still water, thus altering habitat and increasing the risk of algal blooms or other water quality problems. Barriers prevent passage of plant propagules (e.g. seeds) and animals.

Measures to achieve objective

- Implement the NSW Weirs Policy (DLWC 1997b).
- Identify and take action to improve fish passage on other structures that impede the two-way movement of native fish along streams or natural high-flow channels.

Supporting information

- The NSW Weirs Policy (DLWC 1997b) and weir review process will help set priorities and assess management options.

Minimise effects of dams on water quality

Minimise downstream water quality impacts of storage releases

Many dams release water from the bottom of reservoirs where temperatures and dissolved oxygen are low and nutrient concentrations are high. These changed water quality conditions can affect the river downstream for hundreds of kilometres. For instance, many native fish will not breed in colder water.

Measures to achieve objective

- Determine whether water quality from dam releases limits achieving WQOs in unregulated streams and develop appropriate actions.

Supporting information

- RMPs need to consider this objective only in relation to those streams with large weirs or dams.

U Make water available for unforeseen events

Ensure river flow management provides for contingencies

River systems can sometimes be affected by unforeseen or irregular events—such as algal blooms or the start of bird-breeding seasons. As river flows are a major determinant of many of these processes, we can sometimes alleviate a water-quality or environmental problem by better managing river flows.

Measures to achieve objective

- Current water licence conditions enable pumping to be suspended in the rare event that this may be necessary. RMPs should identify potential situations when action may be warranted and the steps that should be taken to manage flows at these times.

Bibliography

ANZECC 1992. *Australian Water Quality Guidelines for Fresh and Marine Waters,* National Water Quality Management Strategy. Australian and New Zealand Environment and Conservation Council, Canberra.

ARMCANZ & ANZECC 1994. *Policies and Principles: A Reference Document*, National Water Quality Management Strategy, Agriculture and Resource Management Council of Australia and New Zealand, & Australian and New Zealand Environment and Conservation Council, Canberra.

ARMCANZ & ANZECC 1995. *Draft Implementation Guidelines*, National Water Quality Management Strategy, Agriculture and Resource Management Council of Australia and New Zealand & Australian and New Zealand Environment and Conservation Council, Canberra.

DLWC 1997a. *NSW State Groundwater Policy Framework Document*, NSW Department of Land and Water Conservation.

DLWC 1997b. *NSW Weirs Policy*, NSW Department of Land and Water Conservation.

DLWC 1997c. *Environmental Guide for the Management of Local Government Water Supply, Sewerage and Drainage Services*, NSW Department of Land and Water Conservation.

DLWC 1998a. *Aquifer Risk Assessment Report*, NSW Department of Land and Water Conservation.

DLWC 1998b. *NSW Groundwater Protection Policy: A Component of the NSW State Groundwater Policy*, NSW Department of Land and Water Conservation.

DLWC 1998c. *Support Package for River, Groundwater and Water Management Committees*, NSW Department of Land and Water Conservation.

DLWC 1998d. *Stressed Rivers Assessment Report, NSW State Summary*, NSW Department of Land and Water Conservation.

EPA 1997. *Proposed Interim Environmental Objectives for NSW Waters, 1997,* NSW Environment Protection Authority.

NEHF 1998. *Guidance on the Use of Rainwater Tanks,* Monograph: Water Series No. 3, National Environmental Health Forum.

NHMRC & ARMCANZ 1996. *Australian Drinking Water Guidelines, National Water Quality Management Strategy*, National Health and Medical Research Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

NSW Fisheries 1998. *Policy and Guidelines: Aquatic Habitat Management and Fish Conservation.*

SACC 1996. *Implementing the NSW Algal Management Strategy,* State Algal Coordinating Committee.

Glossary

Acid sulfate soils: include *actual acid sulfate soils* and *potential acid sulfate soils*. Actual and potential acid sulfate soils are often found in the same soil profile, with actual acid sulfate soils generally overlying potential acid sulfate soil horizons.

- actual acid sulfate soils: are soils containing highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in iron sulfides, primarily sulfide. This oxidation produces hydrogen ions in excess of the sediment's capacity to neutralise the acidity resulting in soils of pH of 4 or less when measured in dry season conditions. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.
- potential acid sulfate soils: are soils which contain iron sulfides or sulfidic material which have not been exposed to air and oxidised. The field pH of these soils in their undisturbed state is pH 4 or more and may be neutral or slightly alkaline. However, they pose a considerable environmental risk when disturbed, as they will become severely acid when exposed to air and oxidised.

Alien species: *See* Introduced species.

Allocation: The volume of water a licence holder is entitled to extract during a year, subject to licence conditions and availability. Currently, only licence holders on regulated rivers supplied by irrigation dams have an allocation. (*See also* Off-allocation flows)

Allocation reliability: The long-term probability (over wet, dry and average years) of irrigators with 'normal security' water allocations being able to get a certain proportion of their nominal allocation by a specified date.

Alluvial aquifer/groundwater: Groundwater (or sub-surface water) contained in the alluvial deposits near a river. It is usually directly connected to the river and therefore its level is closely related to river levels. Alluvial aquifers can be recharged directly from the river under high-flow conditions. Under low-flow conditions, alluvial aquifers can provide base flow in the river channel.

Anabranch: A stream that leaves the main stream and re-joins it further down.

Anoxic: Containing low levels of oxygen.

ANZECC: Australian and New Zealand Environment and Conservation Council.

Aquifer: An underground layer of soil, rock or gravel able to hold and transmit water. Bores, spear-points and wells are used to obtain water from aquifers.

ARMCANZ: Agriculture and Resource Management Council of Australia and New Zealand.

Bank slumping: The falling or slumping of a riverbank into the river. May occur due to removal of riparian vegetation, erosion or bank destabilisation. The term is used here to denote slumping resulting from a rapid decrease in river height, in which water drains more quickly from the river than it does from the banks, which then collapse under their own weight.

Billabong: A backwater channel, often formed by a cut-off river bend, that forms a lagoon or pool when river levels fall.

Billion: a thousand million.

Bioaccumulate: The process by which chemical substances are taken up by living things and retained and concentrated as they move up through the food chain.

Biodiversity (biological diversity): The variety of all life forms, comprising genetic diversity (within species), species diversity and ecosystem diversity.

Biota: All living things, including micro-organisms, plants and animals.

Blue-green algae (cyanobacteria): Naturally occurring, microscopic, primitive photosynthetic bacteria. Under certain conditions (including high nutrients, warm still water, strong sunlight into the water) they can bloom into a dense and visible growth and may become toxic.

Cap: A limit on the amount of water that may be diverted from the river for human uses, e.g. the Murray–Darling Basin Ministerial Council announced a cap on water use in the Murray–Darling Basin in 1995.

Catchment: The area of land drained by a river and its tributaries.

Channel capacity: The volume of water that can pass along the river channel at a certain point without spilling over the tops of the banks.

Confluence: The place where two or more streams flow together.

Contingency allowance: A volume of water reserved in a supply dam for release if and when needed for ecological and/or water quality reasons. For example, a release may be required to maintain water levels in a wetland to enable waterbirds to complete breeding, or to flush away an algal bloom.

Controlled streams: Streams where flow is usually controlled by upstream dams or diversion works, resulting in major changes to the natural flow patterns. These include regulated streams as defined in the *NSW Water Act 1912*, where water is released from storage to meet downstream irrigation needs.

Criteria: The recommended water quality limits for protecting water uses and values, derived from the evaluation of scientific data. Under the NWQMS, ANZECC criteria are the national reference levels.

Crustaceans: Invertebrate animals that have segmented legs and hard shells, e.g. crabs, yabbies, prawns.

Deoxygenated: With most or all oxygen removed. Water becomes deoxygenated (i.e. loses its dissolved oxygen) for a number of reasons including stagnation, eutrophication and rising temperatures.

De-snagging: The removal of fallen trees and dead branches from a watercourse.

Diatom: A type of very small algae that can be used as an indicator of water quality.

Dissolved oxygen: Oxygen in the water (which may be used by aquatic animals).

DLWC: NSW Department of Land and Water Conservation.

Draw-down(s): Volumes of water released or extracted from a pool or dam, thereby lowering the water level.

Dryland salinity: *See* Salinity.

Ecosystem: Any system in which living organisms and their immediate physical, chemical and biological environment are interactive and interdependent. Examples are ponds, forests and wetlands.

Effluent creek: A creek that leaves a watercourse and does not return to it (the opposite of a tributary). ('Effluent' in this sense has nothing to do with pollution.)

Electrical conductivity (or EC units): A measure of the ability of water to conduct an electric current between electrodes placed in the water; the value obtained relates to the nature and amount of salts present.

Environment: The *Protection of the Environment Administration Act 1991* sets out a meaning of 'environment' as: 'Components of the earth, including:
(a) land, air and water
(b) any layer of the atmosphere
(c) any organic or inorganic matter and any living organism
(d) human-made or modified structures and areas, and includes interacting natural ecosystems that include components referred to in (a)–(c).

Environmental flows: Flows, or characteristics of the flow pattern, that are either protected or created for an environmental purpose.

Environmental impact statement: A document which describes a proposed development or activity, predicts the possible or certain effects of the activity on the environment, and outlines safeguards to mitigate or control environmentally damaging effects.

Environmental standard: A quantifiable characteristic of the environment against which environmental quality may be assessed.

Environmental valuation: Technique employed to estimate the worth of an environmental resource from the perspective of society as a whole in the absence of prices.

Environmental value: A particular value or use of the environment that is conducive to public welfare, safety or health, and which requires protection.

Ephemeral: Temporary or intermittent, for instance a creek or wetland that dries up periodically.

Escherichia (*E.*) *coli*: A type of faecal coliform bacteria (see below) which is found in large numbers in the faeces of humans and other mammals. It serves as a reliable indicator of recent faecal contamination of water.

Estuary: The part of a river in which water levels are affected by sea tides, and where fresh water and salt water mix.

Euphotic depth/zone: The lit region of a body of surface water. This extends from the surface down to the deepest level at which there is sufficient light for photosynthesis to occur.

Eutrophication: Excessive levels of aquatic plant growth (including algae) resulting from raised levels of nutrients and other factors.

Extraction: Water taken from rivers for off-stream use or for consumption.

Faecal coliform: A type of bacteria found in faecal material of humans and other mammals. Faecal coliforms themselves generally do not make people sick. High levels indicate that water is likely to contain other micro-organisms that make people sick.

Fish ladder or fishway: A structure designed to enable fish to move over a physical barrier (dam or weir) in a waterway.

Flood channel: A natural channel in a floodplain, which carries flowing water only during a flood.

Floodplain: Flat land beside a river that is inundated when the river overflows its banks during a flood.

Floodrunners: Channels that run with water only during floods and very high flows.

Floods: Flows that are high enough at their peak to overrun river banks or cause flow through high-level anabranches, floodrunners or to wetlands.

Flow regime: The pattern of flow in a river which can be described in terms of quantity, frequency, duration and seasonal nature of water flows.

Freshes: Flows that produce a substantial rise in river height for a short period, but which do not overrun the river banks or inundate areas of land.

GMC: Groundwater Management Committee.

Great Artesian Basin: A vast, very deep store of underground water below much of the drier regions of eastern Australia.

Groundwater: Underground water filling the voids in rocks; water in the zone of saturation in the earth's crust.

Habitat: The type of environment in which a given animal or plant lives and grows, including physical and biological conditions.

Hard-surfacing: A hard, generally impermeable surface placed over soil—e.g. concrete or bitumen.

Headwaters: The small streams on the higher ground of a catchment, which flow into a river.

High flows: Higher than normal flows, which occupy much of the river channel or which overrun banks. In these guidelines, high flows in the middle and lower reaches of rivers are those that are greater than the level that long-term records indicate would naturally be exceeded 30% of the time (i.e. the 30th percentile).

High-security water use: Licensed entitlement to a more secure water supply than under normal-security licences, e.g. for horticulture and town water supplies.

Hydrographic shape: Describes the flow pattern of water, for example, after a short storm or runoff from prolonged rain.

Hydrology: The study of the distribution and movement of water.

Indicator (e.g. water quality, biological, ecological): Any physical, chemical or biological characteristic used as a measure of environmental quality.

Introduced species: Species of plants or animals that are not native to Australia (also referred to as exotic or alien species).

Invertebrates: Animals without backbones, including worms, insects, shrimps, crabs, snails, shellfish and zooplankton. Macroinvertebrates are large enough to be seen without the aid of magnification; microinvertebrates need to be viewed through a microscope.

Irrigation salinity: *See* Salinity.

Levee: A constructed embankment to prevent a river overflowing.

Low flows: Flows that occupy only a small portion of the river channel. Low flows would normally occur when there is little contribution to the river from

rainfall events. For the purposes of the river flow objectives, the low flow is defined as the flow which occurs less than 20% of the total time that the river is flowing.

Macrophyte: A plant large enough to be seen without the aid of a microscope.

Median: The median is the middle value in a data set ranked from lowest to highest.

Megalitre (ML): One million litres (one Olympic swimming pool is approximately 2 ML).

Microbiological quality: In these guidelines, refers to the quality of water in terms of the level of disease-causing organisms it contains.

Multi-level offtake: An offtake structure within a dam, which can take water from various depths, rather than just one. For instance, if the offtake is only at the bottom of the dam, releases of water may be cold, deoxygenated and nutrient-rich. A multi-level offtake allows releases to be made from upper layers where water quality is often better.

Natural flow regime: The likely pattern of flow before European settlement in Australia. In these guidelines, natural flow regime refers to the flow patterns without any regulation or extraction of water.

NHMRC: National Health and Medical Research Council.

Non-point source pollution: *See* Point-source pollution.

NRHP: National River Health Program.

NTU: Nephelometric turbidity unit (a unit of measurement for turbidity).

Nutrients: Nutritional substances. Unnaturally high levels of nutrients, such as in a river below a sewage treatment plant, can encourage abnormally fast and prolific growth of algae in the water, or weed growth in the bush.

NWQMS: National Water Quality Management Strategy. A joint initiative of the state and federal governments, to pursue sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

Off-allocation flows: Water that has not been released from storage, but comes from dam spills and/or inflows from tributaries below the dam. Licence holders are permitted to extract water from these flows but water so extracted is not debited against their allocation.

Off-allocation period: When access to flows (dam spills or tributary inflows downstream of dams) is permitted by licence holders without debit against their allocated volume. The DLWC announces the start of an off-allocation period, usually when flows are greater than are needed to meet on-allocation orders.

Offtake structure: A structure or point of diversion for water transfer. For instance, water is released from a dam via an offtake structure (*see also* multi-level offtake).

On-allocation: Water ordered by a licence holder and which will be debited against their actual allocation.

Pathogen: Disease-causing organism.

Percentile: In these guidelines, usually refers to flow duration curves. The horizontal scale of the graph is divided from 0 to 100 percentiles (or per cent of time), while the vertical scale is flow rate (often in ML/day). For example, when looking at flow rates, the 90th percentile is the daily rate that is exceeded on 90% of days at a specific location. If the 90th percentile is 13 ML/day, then the stream flow would be *higher* than 13 ML/day for 329 days per year, and *lower* for 36 days per year.

Point-source pollution: A single, identifiable source of pollution, such as a drain from an industrial site or sewage treatment plant (as opposed to non point-source or diffuse-source pollution—coming from many small sources over a large area).

Potable water: Water fit for human consumption.

Propagules: Parts of a plant (such as seeds, roots or stems) from which new plants can germinate.

Precautionary principle: The principle that the lack of scientific certainty should not be a reason to postpone preventive measures to avert threats of serious or irreversible environmental damage.

Pulsing supply: A strategy to reintroduce variability to releases of water from dams; introducing pulses of flow below dams allows a more natural flow pattern.

Ramsar Wetlands: Wetlands of international importance listed under the Ramsar Convention.

To be put on the register, a wetland has to fulfil certain criteria—such as being important to the survival of migratory birds or endangered plant and animal species.

Raw water: Surface or groundwater that has received no treatment to make it suitable for drinking.

Recharge: Water that infiltrates through the soil surface to the watertable.

Recharge in-take bed: Areas like sandstone hills or gravelly river banks, which prolonged rainfall or high flows seep through to refill an underground waterbody.

Regulated: A river or creek where water is released from storage to meet diversion requirements downstream.

Regulator: A structure used to control the flow of water, for example, diverting water away from the main channel down an effluent creek.

Riffle: A shallow area of the river in which water flows rapidly over stones or gravel.

Riparian zone: The area along the bank of a river or a stream, which often has water-dependent vegetation.

River alluvium: Material deposited by a flood.

RMC: River Management Committee.

Sag: 'Dissolved oxygen sag'—a section of the river where dissolved oxygen levels are depleted, often below a pollution source.

Salinity: The concentration of salts in soil or water, including sodium chloride (NaCl). Dryland salinity is caused by clearing deep-rooted vegetation on areas of saline watertables. The uptake of water by plants is reduced, allowing the watertable with soluble salts to rise, killing plants and creating bare areas prone to erosion. Irrigation salinity occurs when irrigation raises the watertable, bringing high concentration of salt within root zones of plants, killing and stunting vegetation. It results from applying more water than can be used by the crop and by clearing of deep-rooted vegetation such as trees. Urban salinity is when rising watertables cause damage to infrastructure such as roads, underground pipes, houses and gardens. Urban salinity has been identified in NSW in 26 inland towns and in western Sydney.

Spear-point: A shallow bore inserted in soft sediments to draw up water.

State Environmental Planning Policy (SEPP) 14: NSW Government policy to ensure that the coastal wetlands are preserved and protected; prepared under the *Environmental Planning and Assessment Act 1979*.

Stressed river: Assessment made by the Department of Land and Water Conservation that determines appropriate management strategies for water allocation and flow management in uncontrolled streams. A classification based on environmental and water-use criteria.

Stratification: Distinct layers of water in a dam or weir pool, formed when there is little movement to cause intermixing—usually in summer when deeper layers of water become cold and deoxygenated. These changes may, in turn, induce other water quality changes.

Surface water: Water on the surface of the land, for example in rivers, creeks, lakes and dams.

Suspended solids: The smaller, lighter material such as clay, silt and fine sand carried in suspension in water.

Sustainable: (As applied to water resource management.) Management that will meet current needs while conserving natural ecosystems so they can also meet future needs.

Target (water quality): A level of water quality to be achieved in a specified time frame as a step towards the desired long-term objectives. It is derived from comparing available water quality data/information with the water quality objectives, and considers social and economic factors.

Top-release (of water): Better-quality water released from the top layers of a dam.

Tributary: A river or creek that flows into a larger river.

Turbidity: A measure of the amount of the light-scattering properties of water. It indicates how much silt, algae and other material is suspended in water. Highly turbid waters may look muddy, stain clothes, block irrigation sprays and pipes or harm aquatic organisms.

Uncontrolled streams: Streams that are largely free of structures that control flow, such as major dams.

Urban salinity: *See* Salinity.

Variability: The likelihood of variation or change. High variability of river flows means that stream height at any one place can change substantially over time. Variability is determined by catchment size, number of tributaries, slope and climate. Overall, Australia has extremely variable rainfall and river flows. River management for consumptive uses has decreased variability.

Watertable: The upper surface of a groundwaterbody.

Water quality goal: A desired water quality outcome to help develop strategies for managing human activities that may affect the environment. Under the NWQMS, a chosen suite of environmental values for a catchment would constitute the water quality goals for that catchment.

Water quality objective: Numerical concentration limits or requirements established to support and protect the designated environmental values of water at a specified site. Under the NWQMS, they are the locally established benchmarks for water quality derived from the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992).

Weir pools: The water held back by a weir, forming a still pool. Where the land is very flat, such as in western NSW, a weir can cause very long pools to form. For example, Maude Weir on the Murrumbidgee River is 6 m high and creates a weir pool 35 km long.

Wetland: Land inundated with temporary or permanent water that is usually slow moving or stationary, shallow, can be fresh, brackish or saline, and where the inundation affects the plant and animal communities and the type and productivity of soil.

WMC: Water Management Committee.

WMP: Water Management Plan.

water

Water Quality and River Flow
Interim Environmental Objectives