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Macro water sharing plans – the approach for unregulated rivers

A report to assist community consultation

Leading policy and reform in sustainable water management

Publisher

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The NSW Office of Water manages the policy and regulatory frameworks for the State's surface water and groundwater resources to provide a secure and sustainable water supply for all users. The Office of Water also supports water utilities in the provision of water and sewerage services throughout New South Wales.

Macro water sharing plans - the approach for unregulated rivers
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Background to water sharing in unregulated rivers

The supply of water in unregulated rivers is not controlled by releases of water from dams but depends solely on rainfall and natural river flows.

Unregulated rivers include all the coastal rivers, except parts of the Hunter River and Glennies Creek, and the rivers downstream of Toonumbar and Brogo Dams in the Richmond and Bega catchments respectively. In inland NSW, unregulated rivers include rivers upstream of the major irrigation supply dams as well as tributaries and effluents of the regulated rivers and also unregulated catchments.

The extraction of water from unregulated rivers has been governed by basic stock and domestic rights and licences that define how and when water can be used. In some rivers, water users' associations roster the timing of extraction to ensure that all users have access to the limited resource during dry periods.

Increased pressure from extraction and the declining health of rivers has highlighted the need to review water sharing strategies in NSW and across Australia. The National Water Initiative requires states to prepare statutory water plans.

In NSW, water sharing plans are being prepared to:

- manage the cumulative impact of extraction
- facilitate the trading of water between users
- clarify the rights of the environment, landholders, town water supplies and licensed users.

The first round of water sharing plans finalised in 2003 covered only 20 of the 600-plus unregulated water sources in NSW. Given the number of water sources still to be completed, a broader approach was required. This macro approach needed to cover much larger areas than the previous single unregulated river water source water sharing plans (hence the term, macro).

Macro water sharing plans will cover the remaining unregulated catchments across the State. The coastal plans will also include the predominantly freshwater parts of estuaries (tidal pools). Alluvial aquifers are included in coastal and inland plans given their proximity and hydraulic connection to unregulated rivers. In some cases, alluvial aquifers connected to regulated rivers inland are included in the macro unregulated plans where the regulated river plan has already commenced.

Macro water sharing plans manage the extraction of water by setting:

- extraction limits to control the volume of water extracted annually
- dealing rules to control the trade of water licences
- daily access rules to specify when extraction is allowed

Macro planning approach

In the Ministerial Statement on Water Reforms (June 2004), the then Minister for Natural Resources outlined the following features of the macro planning approach:

- to adopt some basic water sharing rules to apply across a number of water sources
- to focus additional attention on individual water sources that pose particular environmental or socio-economic issues
- to complete water sharing arrangements quickly, thoroughly and cost effectively.

To achieve these goals, a working group developed the macro approach through a series of workshops with regional and scientific staff from relevant government agencies. The approach developed takes account of economic, social and environmental requirements.

The macro approach

- builds on the knowledge gained from water management committees and community consultation during the first round of water sharing plans
- is a risk-based process
- uses the best available information
- gives a relative assessment across a catchment for rivers, or across a coastal bioregion for estuaries
- focuses the water sharing rules on better management during critical times such as periods of low or no flow
- is based on Australian and international literature

The environment in New South Wales is diverse and includes subtropical rainforests of the north coast, alpine areas in the Snowy Mountains, and the western arid rangelands. The rivers range from permanently flowing rocky streams fed from mountain springs to western wetland systems that are inundated only every few years. Our estuaries range from coastal lagoons that open to the ocean several times a decade to drowned valleys with large daily tidal exchanges. Rainfall patterns also vary, from winter rainfall and dry summers in the south to summer rainfall in the north.

Developing macro water sharing plans for 28 major catchments, covering 773 water sources (including 151 estuaries or parts thereof) across this complex array of different river types required an approach that would consider the amount of water extracted, the impact on rivers and estuaries, the connection with adjoining alluvial aquifers, the associated uses from this extraction and the social and economic impacts of restricting extraction.

To manage the extraction of water we need to estimate

- the amount of water extracted relative to the amount in the river
- the effect on rivers and estuaries and their uses of extracting the water
- the value of extraction and the social and economic impact of not extracting water

The macro approach attempts to develop balanced water sharing rules by considering:

- instream values, such as threatened fish likely to be affected by flow extraction
- risk to instream values posed by the existing or increased extraction
- hydrologic stress, which is the amount of water extracted relative to river flow
- the extraction value, which is the economic value of using the extracted water
- the economic dependence of the local community on water extraction
- the sensitivity of estuaries to freshwater inflows
- town water supplies
- the adequacy of existing water sharing rules to manage the risk to instream values and basic landholder rights
- NSW Government policy.

As required by the *Water Management Act 2000,* macro water sharing plans aim to strike an optimal balance between environmental, social and economic considerations.

The process for the development of the water sharing rules involves weighing up the risk to instream natural values against community dependence on irrigated agriculture. This was done across the State to ensure consistent analysis. The technical assessment was undertaken at the catchment scale for rivers and at the marine bioregion scale for estuaries. Indicative rules for both the trading of rights to extract water (dealings rules) and the extraction of water (access rules) were developed based on the analysis. Interagency Regional Panels interpret the findings and recommend trading and access rules. These rules form the starting point for consultation.

The indicative access rules varied between river type, in recognition of the different ecosystems and dependent communities. They were developed from rules currently in place, both within the water source and in similar catchments already covered by water sharing plans.

The precise assessment of values and risks was not generally possible at the scale required for the development of macro water sharing plans across the State. This process therefore used simple assessments (high, medium and low) to indicate different categories of instream value, hydrologic stress and the other factors used.

The adopted approach helped clarify a range of values and risks, indicating where an optimal balance between extraction and retention of water in a river might be. This allowed the most appropriate water sharing rules to be identified. These broad-scale relative assessments showed where water sharing rules need to strongly protect valuable natural assets or provide equity for extractors.

To overcome some problems with the lack of data or the quality of data, Interagency Regional Panels were convened with regional staff from the erstwhile Department of Water and Energy (DWE), the former Department of Environment and Climate Change (DECC) and the Department of Primary Industries (DPI) with assistance from Catchment Management Authorities (CMAs). These panels reviewed the outcomes of technical assessments, modifying, where required, the instream values, hydrological stresses and economic dependencies; comparing the indicative rules against existing ones; and finally recommending draft water sharing rules for the macro water sharing plans. Public consultation then occurred to allow local knowledge to be sourced and included in the final plan.

In areas and situations where there is only sufficient information to set interim rules as part of this macro process, plans allow for adaptive management. If new information regarding flow requirements for river and estuaries is likely to become available within the life of the plan, the plan can specify circumstances in which changes to the rules can be made and the extent of those changes.

The macro approach builds on basic concepts from a number of sources, including:

- the definition and assessment of ecological values from *Guidelines for Protecting Australian Waterways* (Bennett et al, 2002)
- the inclusion of socio-economic values to develop catchment goals and classifications from *A Decision Support Process for Rapid Assessment of Catchment Goals and Priorities* (Healthy Rivers Commission, 2003)
- the inclusion of an approach to assess socio-economic factors derived from *Development of a Framework for Social Impact Assessment in the Living Murray: Water Recovery in the Murray Irrigation Area of NSW* (Environment & Behaviour Consultants, 2003)
- the use of estuary geomorphic types from the *Methodology for the Determination of the Ecological Water Requirements of Estuaries* by the Department of Water Affairs and Forestry South Africa (2004) and the preliminary evaluation phase of Pierson et al. (2002)
- *Socio-Economic Assessment Guidelines for River, Groundwater and Water Management Committees* (Independent Advisory Committee on Socio-Economic Analysis, 1998).

Consultation

All stakeholders and interested parties have an opportunity to examine and comment on the outcomes of the macro assessment and the Interagency Regional Panel recommended rules before the commencement of the plans.

The classifications and the recommended rules generally undergo targeted consultation with water users and specific interest groups before a plan is drafted. This is done by informal consultation held with key stakeholders to test the suitability of the proposed water sharing rules and provide feedback on the rules potential impacts.

Formal public exhibition of the draft plan ensures wider public consultation. This phase is the formal exhibition of a draft plan where the Minister invites submissions on the draft plan and in particular will seek comment on a range of key issues.

In developing macro water sharing plans, participating agencies identified areas needing better data for future water planning decisions. Similarly, the community might suggest areas where further analysis or data gathering is required. This local input is essential in the finalisation of plans.

Catchment Management Authorities manage the consultation process throughout the State and ensure stakeholders and interested parties have an early opportunity to examine the proposed water sharing rules. In particular, CMAs will be looking for stakeholders to provide:

- local knowledge and expertise to complete existing information sets. For example, there may be natural or socio-economic values that are only known to locals
- feedback on the practical elements of the proposed water sharing rules, to make certain they are easily implemented
- checks to ensure that there are no unintended outcomes from the plans. Local stakeholders have the expertise on how these rules will work on-ground. It is essential that this is given due consideration before the plans are finalised.

Steps used to develop macro water sharing plans

The following 13 steps are used to develop macro water sharing plans. Further details on each step are presented in the respective appendices.

Step 1: Define management units and determine flow dependencies

To account for cumulative impacts of extraction and for practical management, water sharing plans contain a hierarchy of management units.

The largest unit in the plan is the **extraction management unit** (EMU), which may be a catchment or part of a catchment. The EMU is used to manage the average long-term annual volume of water extracted. For most western catchments and some coastal catchments, the EMUs are defined by the first round of water sharing plans.

The EMU may contain one or more water sources. A **water source** is the primary management unit used for defining where water sharing rules apply and is generally based on sub-catchment boundaries. The *Water Management Act 2000* requires a macro water sharing plan to contain two or more water sources.

Water sources can be further subdivided into **management zones**, where finer resolution of rules is required. For each catchment the flow relationships between water sources are highlighted to indicate the flow of water from one water source to the next and hence the possible downstream impacts (i.e. cumulative impact) of extraction.

For more detail on this step refer to Appendix 1.

Step 2: Estimate hydrologic stress

Hydrologic stress (the amount of water extracted relative to low flow) is an important indicator of the likely competition among extractors, the level of usage and the likely stress placed on the instream environment. It is normally calculated as the ratio of extraction (based on peak daily demand) to supply (based on a flow that is available for a percentage of time, generally the 80th percentile on the coastal rivers).

Extraction demand is based on surveyed crop types and an estimate of water use. For each water source extraction estimates are based on all current water licence entitlements accessing either unregulated surface water or highly connected groundwater in the alluvial aquifers. The extraction calculation for coastal sources assumes full development of all access licences, (which is generally greater than the actual volume of water being currently extracted) but reflects potential extraction. For most of inland NSW, however, surface water extraction is limited by the Murray-Darling Basin (MDB) Ministerial Council Cap, which limits diversions to previously agreed limits (average take 1993/94 – 1998/99).

Where flow information is not available or extraction is affecting another indicator (such as depth of water in a lagoon or the change of salinity in an estuary), then alternative estimates of hydrologic stress are made.

Using peak daily demand estimates is not appropriate in many inland ephemeral systems where water is pumped during irregular flow events, stored in farm dams and later applied to crops. Also, there is a paucity of flow data throughout inland unregulated streams, making an assessment of hydrological

stress difficult. Therefore, hydrologic stress is assumed high in all inland ephemeral water sources. High stress is a reasonable assumption for these systems given that most inland unregulated streams have been embargoed since the early 1990s and the Stressed Rivers Assessment (DLWC 1998a), which used an expert panel approach, shows consistent scores of high stress across these inland unregulated streams. If there was sufficient data of reliable quality available to the Interagency Regional Panel to prove that the water source was not highly stressed, then this assumption could be disregarded and the perennial macro approach applied.

Appendix 2 provides details on how hydrological stress is calculated.

Step 3: Determine instream values

This requires the collation of information from a list of attributes important for determining instream values. Macro water sharing plans can influence management relating only to water extraction; therefore, only those values considered vulnerable to water extraction are assessed.

Three different types of values contributing to instream value – ecological (intrinsic), economic (non-extractive use) and cultural (place) are considered in this step. This step also assesses declared special areas (e.g. critical habitat, SEPP 14 wetlands) and threatened or endangered species, ecological communities and populations. Indigenous values, which are part of place value, are not included in the technical assessment but will be considered during Aboriginal consultation meetings.

The attributes are scored for each water source to determine relative instream value. Where information is not available, the Interagency Regional Panel chooses either to proceed without it, to use alternative information, or to make a subjective judgment. The relative assessment is undertaken for each major catchment or, in the case of estuaries, the marine bioregion.

For more detail on this step, refer to Appendix 3.

Step 4: Determine estuary sensitivity to freshwater inflows

This step is undertaken for the coastal catchments only. Freshwater inflows to estuaries are important because the environment of estuaries depends on them. Estuaries vary in shape, size and the amount of freshwater present. All these attributes affect estuary sensitivity to inflows.

Inflow sensitivity was defined as the extent to which reduced freshwater inflows affect the salinity of the estuary. A drowned river valley, such as Sydney Harbour, is open to the ocean, well flushed and generally characterised by marine features. Barrier estuaries are generally long and narrow, water exchange may be slow and a salt wedge may migrate up or down the estuary depending on freshwater inflows. Coastal lagoons have intermittent openings and are generally the most sensitive to changes to freshwater inflow.

To determine the risk to an estuary from changes to inflows, the level of hydrologic stress from extraction in the entire catchment was taken and either increased or decreased depending on the degree of estuarine sensitivity. That is, a high hydrological stress is reduced to medium hydrologic risk if the estuary has low sensitivity to changes in inflows. Conversely, low hydrological stress is increased to medium hydrologic risk if the estuary is considered to be highly sensitive to freshwater inflows.

The hydrologic risk was then used to determine the trading and access rules applicable to the entire catchment area feeding into the estuary.

Attributes from Roy et al. (2001) were used to derive sensitivities to reduction in both low and high flow, as outlined in Appendix 4.

Step 5: Estimate extraction value and community dependence on extraction

The relative dependence of the local communities on water extraction for irrigation is based on:

- the volume and economic value of water extracted
- the social benefit of water extraction.

The economic value of the water extracted is derived from gross margins and licensing information obtained via the volumetric conversion survey undertaken by the former Department of Land and Water Conservation in 2000. The values are adjusted to account for variations in the size of water sources. The Australian Bureau of Statistics Index of Social Advantage and Disadvantage is used to get an indication of a community's robustness for change.
The index includes the following:

- percentage of unemployment
- percentage of low income households
- percentage of single parent households
- the level of post-secondary qualifications
- access to the internet and other services.

Thus, the method estimates community dependence on extraction by considering the dollar value of water extraction and the local community's resilience to change. Interagency Regional Panel members review this information and consider whether local information (both quantitative and qualitative) would provide more about a community's dependence on unregulated river extraction.

More details on community dependence on extraction are provided in Appendix 5.

Step 6: Determine river types

The applicability and implications of access rules vary significantly across river types. For example, water sharing rules for spring-fed mountain streams would not necessarily work for intermittent inland watercourses. Every water source is classified as having either:

- gaining streams, where flow increases downstream can be managed by a rule for the end of system
- connected streams, where there are significant ground and surface water interactions
- losing streams, where flows diminish as it travels downstream, require water sharing rules that aim to ensure water reaches important downstream instream values and basic rights users
- ephemeral streams, where flow is temporary or intermittent; for instance a creek or wetland which dries up periodically
- tidal pools
- estuaries.

The river type determines the suite of water sharing options, so that the rules are appropriate for the river type. Definitions of each river type are provided in Appendix 6.

Step 7: Estimate risks to instream values

This step estimates the risk to instream values from extraction in each water source and involves two factors, assessment of risks and cumulative impacts.

(a) Assessment of risks

Setting water sharing rules requires an assessment of the risks to instream values from water extraction. In some cases, extraction may not significantly affect values.

Risk is generally defined as 'consequence' multiplied by 'likelihood'. In this approach, the consequence can be considered to be equivalent to the value of the asset under threat, i.e. the consequence of losing a high-value asset is more than that of losing a low-value one. The likelihood of impact is related to be the level of hydrologic stress, i.e. if a greater percentage of flow is extracted the likelihood of damage is greater. Thus, the method calculates the risk to instream values as:

Risk to instream value = instream value x hydrological stress

For inland ephemeral water sources where the hydrologic stress is assumed to be high (see step 2), the risks to instream values across the catchment are equivalent to the instream values themselves and thus this step was not required.

(b) Cumulative impacts

The impacts of extraction do not occur just in the water source where extraction takes place, but accumulate downstream. The hydrological stress of lower catchment water sources must therefore consider extraction in all of its upstream tributaries, as well as extraction from within the water source.

For more detail on this step see Appendix 7.

Step 8: Consider policies and river flow objectives

To achieve the effective reform of water management in NSW, the Government has assembled extensive water sharing policy and legislative framework. This provides the administrative basis for macro water plans.

The most important components of this framework are:

- the *Water Management Act 2000,* which provides the legal basis for NSW water sharing plans
- the river flow objectives which represent the key features of flow regimes that support environmental values
- NSW Government policy advice to Water Management Committees, developed during the first round of water sharing plans
- More recent policy water policies put in place for the macro water plans.

More details about this step are shown in Appendix 8.

Step 9: Determine indicative trading rules (dealings)

All or part of the share of water attached to a licence can be traded. Trading within a water source or from one water source into another water source is seen as an important tool for making both environmental and economic improvements.

The goals of the trading rules are to:

- encourage rural/agricultural development through trading of water entitlements and allocations into water sources up to defined limits (boxes d, e, g and h in Table 1)
- reduce entitlement through trading out of high instream value rivers (a, b and c in Table 1)
- prevent any increase in entitlements in highly stressed systems (c, f and i in Table 1).

Hydrologic stress (step 2) and instream value (step 3) are used (see Table 1) to determine the indicative trading rules.

Table 1 is used to guide licence dealing rules. For example, where there is a low hydrologic stress and a high instream value, licences would not be allowed to be traded into this type of area.

Generally, trading can occur within any water source and into any hydrologically connected downstream water source.

Table 1 Indicative trading rules

	Low hydrologic stress or hydrologic risk	**Medium hydrologic stress or hydrologic risk**	**High hydrologic stress or hydrologic risk**
High instream values	**a** Trades are not allowed into or upstream of water source	**b** Trades are not allowed into or upstream of water source	**c** Trades are not allowed into or upstream of water source
Medium instream values	**d** Trades may be allowed into, but only up to a specified % of flow stress (which should be well below 50% hydrologic stress)	**e** Trades may be allowed into, but only up to a specified % of flow stress (which should be well below 50% hydrologic stress*)	**f** No net-gain, trades are allowed into or upstream of water source
Low instream values	**g** Trades may be allowed into, but only up to a specified % flow stress (but no more than 50% hydrologic stress)	**h** Trades may be allowed into, but only up to a specified % flow stress (but no more than 50% hydrologic stress*)	**i** No net-gain, trades allowed into or upstream of water source

* If the hydrologic stress estimate is already 50% or more then trading defaults to no net gain.

For more details on this step refer to Appendix 9.

Step 10: Determine the indicative water access rules

The economic dependence (step 5) and instream risk (step 7) are compared to determine the water access rules, which are based on the goals for each combination as set out in Table 2. Economic dependence is considered important in determining the access rules and an attempt is made to minimise any socio-economic impact. By using instream risk, the water sharing rule could offer strong protection to those water sources where instream values are most at risk from extraction.

The rules are also classified into levels to help assess and manage the impact on existing licence holders, with level 1 being the strongest level of protection and level 4 the minimum. In some areas water sharing rules might need to be made more stringent during the life of the plan. The levels provide a mechanism to increase environmental protection gradually over a period, providing water users with time to adapt to any change.

For inland ephemeral water sources, instream risk (step 7) is not calculated, as this is directly proportionate to instream value (step 3). For these water sources, indicative rules are based on a comparison of the instream value (step 3) and community dependence on extraction (step 5).

Indicative access rules have been developed for each river type described in Step 6, including additional rules for combinations of these types, i.e. ephemeral gaining, ephemeral losing and ephemeral connected streams.

Table 2 Goals and levels for access rules

	Low dependence on extraction	**Medium dependence on extraction**	**High dependence on extraction**
High (risk to) instream values	**A** Rules to protect instream values **(Level 1)**	**B** Rules to encourage extraction to shift from high environmental impact to lower impact **(Level 2)**	**C** Rules to encourage extraction to shift from high environmental impact to lower impact **(Level 3)**
Medium (risk to) instream values	**D** Rule to reduce impacts on important instream values **(Level 2)**	**E** Rules to encourage extraction to shift from high environmental impact to lower impact **(Level 3)**	**F** Rules to encourage extraction to shift from high environmental impact to lower impact **(Level 4)**
Low (risk to) instream values	**G** Stop any further degradation of instream values **(Level 3)**	**H** Stop any further degradation of instream values **(Level 4)**	**I** Rules to encourage extraction to shift from high hydrological stress to lower stress **(Level 4)**

For more detail on this step, see Appendix 10.

Step 11: Determine access and dealings rules for pools

A paper outlines the considerations when setting access and trading rules for pools in unregulated water sharing plans. The approach applies to lentic water bodies (standing water) in or associated with unregulated rivers across NSW, including anything falling within the definition of a lake found in the Dictionary of the *Water Management Act 2000,* except for tidal pools and estuaries. The methods use an assessment of the environmental values of the pools to select rules that adequately protect these values while not having a disproportionate effect on water availability for extraction.

The paper can be found on the NSW Office of Water website, www.water.nsw.gov.au under Water management > Water sharing plans.

Access rules

It is not practical to identify and create site-specific rules for every natural pool in a water sharing plan area. Thus the focus of the policy is to establish a default access rule of no drawdown below full pool capacity for the majority of pools. The default rule may then be modified by Interagency Regional Panels in specific circumstances if it is justifiable and feasible to do so to allow limited access to pools.

Different default rules apply depending on the pool type. The default access rules are summarised below:

Artificial pools created by structures covered by existing approvals

- Existing licence conditions to continue
- Exempt from the 'no drawdown' rule constraints that apply to natural pools
- For in-river dams, consider a dead storage cease to pump rule if there are outlet works lower than the top of the crest of the weir.

Natural pools

- Users must cease to pump when the pool is less than its full capacity

'Full capacity' can be approximated by the pool water level at the point where there is no visible flow into and out of that pool.

Where the default access rule for the water source or management zone is set at a reference point that is not the pump site, for example a rock bar or gauging station, the rule described above may be applied **in addition to** the cease to pump rule at the reference point for pools found within the river channel.

Trading rules

The default trading rules for pools are as recommended for the water source (see step 9). Where trades are allowed into a water source, Interagency Regional Panels are able to set different trading rules to ensure that trades do not increase access to pools or result in third-party impacts to existing licence holders. Trading rules for pools should be selected on a similar basis to the alternate water access rules for pools, that is the rules should protect environmental values, basic landholder rights and minimise trading in areas of high competition.

Step 12: Existing rules

For each water source, existing water sharing arrangements are documented. These include:

- formal or informal water sharing rules used by the NSW Office of Water or other water user groups
- existing licence conditions
- Land Board or Land and Environment Court rulings
- the location of any existing gauges or control points
- whether existing licence conditions reflect different levels of access to flow (e.g. are there currently both high flow and low flow users).

Step 13: Rules recommended by Interagency Regional Panels

Steps 1 to 10 provide a technical assessment for the Interagency Regional Panels. The trading and access rules developed in steps 4, 9, 10 and 11 are indicative and for guidance only.
A comparison of the indicative rules with existing arrangements from step 12 allowed the Interagency Regional Panels to judge the adequacy of the existing rules in terms of protecting values and managing risks. The Interagency Regional Panels were given the task of ensuring that the recommended rules reflected the local situations and documenting reasons for any changes from the indicative rules.

In many inland catchments, the panel must make a choice to use the existing (perennial) approach for hydrologic stress calculations and indicative access and trading rules or the alternate approach for ephemeral streams.

Interagency Regional Panels have flexibility in applying rules to account for specific circumstances, such as retaining current water sharing rules where they achieve at least the same level of environmental protection and provide for basic landholder rights. In all cases, the Interagency Regional Panels need to ensure that, regardless of the water source classification, adequate consideration is given to:

- river flow objectives
- known flow requirements of threatened species, populations and communities
- protection of instream refuge habitats
- specific rules for instream values
- protection of basic landholder rights.

In some instances, indicative rules are refined if site-specific information was available.

Interagency Regional Panels also considered the ability to manage and monitor flow in a water source. In many cases infrastructure limitations determine access rules. For example, in an instance where there was no flow gauging station the panel assessed the risks, and:

- recommended new gauges be commissioned for high-risk or highly stressed water sources, or
- looked at alternatives such as ‘staff' gauges (height but not flow) where the risk to instream values was low.

The panel also considered specific requirements of threatened species in relation to key reproductive needs, migration or other particular ecological activities.

The macro approach contained a mechanism to limit adverse social and economic impacts. Where the existing rules are not consistent with the panels' recommended rules, the degree of immediate change and effect on extractors, was bound to the next higher level of rule as a first step, unless a higher level of protection could be realised by other means with minimal socio-economic impact. The panel then determines a timeframe and the further steps required to achieve the recommended rules during the life of the plan.

In instances where the existing arrangements are clearly unsustainable and the proposed rules not likely to achieve adequate river protection in the life of the plan, the Interagency Regional Panel highlights this for consideration when the plan is reviewed.

Once all the proposed water sharing rules are determined for each coastal water source, they are then compared against the indicative catchment-wide rules derived from the estuary assessment process (Step 4) and where necessary the water sharing rules are adjusted. A check is then completed to ensure the rules are well integrated from a catchment perspective. It is also important to ensure the interactions between the rules are practical, easily understood and implemented.

Other considerations

Local and major water utilities (urban water supplies)

Local water utilities access licences will maintain existing environmental flow and access conditions, when they are specified in the current *Water Act 1912* licences. The licences' share components will be set in accordance with agreements between the NSW Office of Water and the relevant local water utility.

Under Section 66 of the *Water Management Act 2000*, local water utilities servicing areas of rapid population growth may at any time apply to increase their share component in a local water utility access licence. It is expected that a local water utility applying to augment their supplies will:

- take all reasonable measures to implement guidelines for best practice management of water
- meet the environmental flow requirements and access conditions specified in the macro water sharing plan, or adopted environment protection rules based on more detailed impact assessments
- comply with the *Water Management Act 2000* requirements.

It should be noted that local water utilities covered by existing water sharing plans will not be affected by macro water sharing plans.

Long-term average annual extraction limit

Annual extraction limits are defined for each management unit to:

- ensure the reduction of stream flow due to extraction is sustainable
- manage the impacts of extractive users on each other
- provide users with certainty of how much licensed extraction is permitted
- create conditions that allow trade in entitlement or allocation.

In 1995 the Murray-Darling Basin Ministerial Council (MDBMC) established a cap on surface water diversions. The cap applies to each major river valley within the Murray-Darling Basin in NSW (see Appendix 11) and includes regulated and unregulated rivers. In New South Wales, the management of extraction within the MDBMC cap is based on a whole-of-valley cap. Each valley is broken up into one or more unregulated and regulated extraction management units.

Within the Murray–Darling Basin, the long-term average annual extraction limit (LTAAEL) for an unregulated EMU will be the estimated average annual extraction of water averaged over the period from July 1993 to June 1999, plus estimates of domestic and stock and native title rights at the commencement of the plans.

In coastal EMUs, the LTAAEL will equal the sum of all existing unregulated entitlements; located within the surface waters and the groundwaters of the highly connected (upriver) alluvial aquifers, plus an allowance for an increase in entitlement, if conversion from low flow extraction to high flow extraction is applicable or from new entitlements. Some extractors in the tidal pools do not currently require a licence. They will however require a licence once the macro water sharing plans extend into the estuaries. Their annual extraction will be incorporated into the LTAAEL once their volumetric conversion is completed.

The method for determining the LTAAEL for inland alluvial and other highly connected groundwater sources is based on active usage over a specified period, as outlined in the community manual for groundwater *Water sharing plans – the macro approach for groundwater. A report to assist community consultation*, available at the Office of Water website www.water.nsw.gov.au

If long-term annual extractions are assessed as having exceeded their LTAAEL, then available water determinations will be reduced to return extractions to the LTAAEL. If extractions then fall below the LTAAEL, available water determinations will be returned to previous levels.

Indigenous values

Aboriginal people have a spiritual, customary and economic relationship with land and water. These relationships provide important insights into best practice for natural resource management.

Macro water sharing plans will transform the way water is shared between the community and the environment. Aboriginal people in NSW have been actively involved in the development of the first round of water sharing plans, along with landholders, conservationists, industry and government representatives. There will be continuing opportunities for Aboriginal communities to comment on all aspects of the macro water sharing plans now under development, in particular on how well the plans protect Aboriginal values and interests.

Aboriginal interests of particular relevance to water sharing plans include the management of the natural environment, spiritual connection, sites of significance, community water supply and commercial use of water. The NSW Government is determined to ensure that Aboriginal culture is maintained and that Aboriginal communities benefit from the new opportunities the water market brings. To achieve this, macro water sharing plans will feature a new category of licences, – Specific Purpose licences, – which will include, Aboriginal cultural and Aboriginal Community Development licences.

For more information on macro water sharing plans and Aboriginal water users visit the NSW Office of Water website at www.water.nsw.gov.au.

Higher and occasional flow licences

Some existing licences have conditions that prevent extraction during low flows. These are called high flow licences. Many rivers only flow occasionally and access licence conditions reflect this.
As most high flow and occasional flow situations are unique, they are dealt with individually by the Interagency Regional Panels.

In some coastal catchments it may be appropriate to issue additional high-flow entitlements as an incentive for water users to shift from low to high flows extraction and thereby pose a lower risk to instream values. This would be achieved by allowing users to convert their existing licence entitlement to a new licence with increased entitlement that can only be extracted during high flows. This would occur only where any environmental improvement can be demonstrated.

A similar policy for trading into high flows for inland water sources is being considered by the Office of Water, to open up trading in systems where it is otherwise restricted.

Basic landholder rights

All landholders in NSW have rights to access water for some basic purposes. A licence is not required to access water for basic purposes from an unregulated stream. In some areas, basic right usage is a significant proportion of flow and therefore contributes to hydrological stress.

There are three types of basic landholder rights:

Domestic and stock rights: Landholders who own or occupy land on a riverbank or lakefront or overlying an aquifer can take water (without a licence) from the river, lake or aquifer for domestic purposes (e.g. cooking, washing, watering house gardens) and to water stock on the property (but not intensively housed animals).

Draft Mandatory Guidelines for Take and Use of Water under Domestic and Stock Rights have been prepared by the Office of Water. The guidelines will be used to control the total annual volume of water extracted under a basic landholder right. Additionally, during periods of water shortage, these domestic and stock users may also be required, by Ministerial Order, to restrict usage to essential purposes.

The proliferation of new domestic and stock rights through the subdivision of land will be managed through a further regulation to the *Water Management Act 2000*. This regulation, made under section 52(2) of the Act, will limit the growth in basic landholder rights when a landholding is subdivided. Effectively this will mean that the reasonable use for the pre-subdivision landholding will be 'frozen' and the vendor will have to apportion this reasonable use limit between the proposed lots in the subdivision. Although still in development, it is intended that such limitations will be applied only to rivers and aquifers that could be subject to high hydrologic stress or high instream risk.

Harvestable rights: Harvestable rights allow landholders to collect up to 10 per cent of the average regional rainwater runoff on their property and use this water in farms or dams, provided the dams are built on a hillside or minor stream. The harvestable right is intended to satisfy essential farm needs such as stock and household water, but can be used for any purpose, including commercial irrigation.

Farm dams require a licence only if they are located on a 3rd order (or greater) river, irrespective of the dam capacity or purpose, or if they exceed the maximum harvestable right for the property, or if they are on a permanent (spring feed) 1st and 2nd order streams. The provisions relating to harvestable rights are unaffected by any of the rules identified in a macro water sharing plan. The volume of licensed farm dams has been considered in determining hydrologic stress and access rules.

Native Title rights: Anyone with native title to water as determined under the Commonwealth *Native Title Act 1993* can access water for a number of personal, cultural, domestic and non-commercial purposes. Currently no native title rights to water exist in NSW.

New entitlement

New entitlements in any unregulated river or alluvial groundwater source in NSW will only be provided in the following circumstances:

- domestic and stock access licences
- specific purpose 'Aboriginal cultural' licences
- local water utility access licences or town water supply

- for small volume groundwater entitlements (where applicable in the coastal floodplain alluvial aquifers), or
- where provided for, under the macro water sharing plan.

The NSW Government will consider the issue of additional entitlement for development proposals for Aboriginal Community Development access licences in some coastal catchments. These will be high-flow entitlements and will depend on future impact assessments.

Management of alluvial aquifers

The alluvial aquifer systems within an unregulated river catchment are included as part of the macro unregulated water sharing plans. This is because of the hydraulic connection between the alluvial groundwater and the surface waters and for consistency across a catchment where alluvials have not been included in the relevant commenced surface water sharing plan. A range of management rules, including access and trading, are developed in the water sharing plans for the alluvial aquifers. They are detailed in the community manual for groundwater, *Water sharing plans – the macro approach for groundwater. A report to assist community consultation*, available on the Office of Water website www.water.nsw.gov.au. These management rules include key provisions relating to:

- Environmental water – how much water is reserved for the environment
- Limits to the availability of water – how much water is potentially available for extraction and how extraction is managed to these limits
- Rules for managing access licences – how water is managed in accounts and how surface and groundwater connectivity is managed
- Rules for water supply works approvals – how local impacts are managed relating to the volume and quality of water in the groundwater source and how impacts of extraction on the environment and other users are mitigated
- Access licence dealing rules – how licences can be traded to promote sustainable extraction and environmental improvement.

Adaptive management

Adaptive management is an important strategy for macro water sharing plans. The term refers to the practice of changing the management regime in response to new information – either from monitoring or some other improvement in understanding. Adaptive management is a requirement of both the *Water Management Act 2000* and the National Water Initiative.

In some unregulated river water sources, there is insufficient information to develop adequate water sharing rules to manage the risk to instream values and/or protect community dependencies. In these cases, further analysis or data collection may be required during the life of the plan. The macro water sharing plans will include provisions which make allowance for this additional work. Any changes to the water sharing rules that result from new information will be bounded in the plans to give certainty and to ensure that it is clear to water users that the water sharing rules may be varied during the life of the plan.

Appendix 1: Define management units and determine flow dependencies

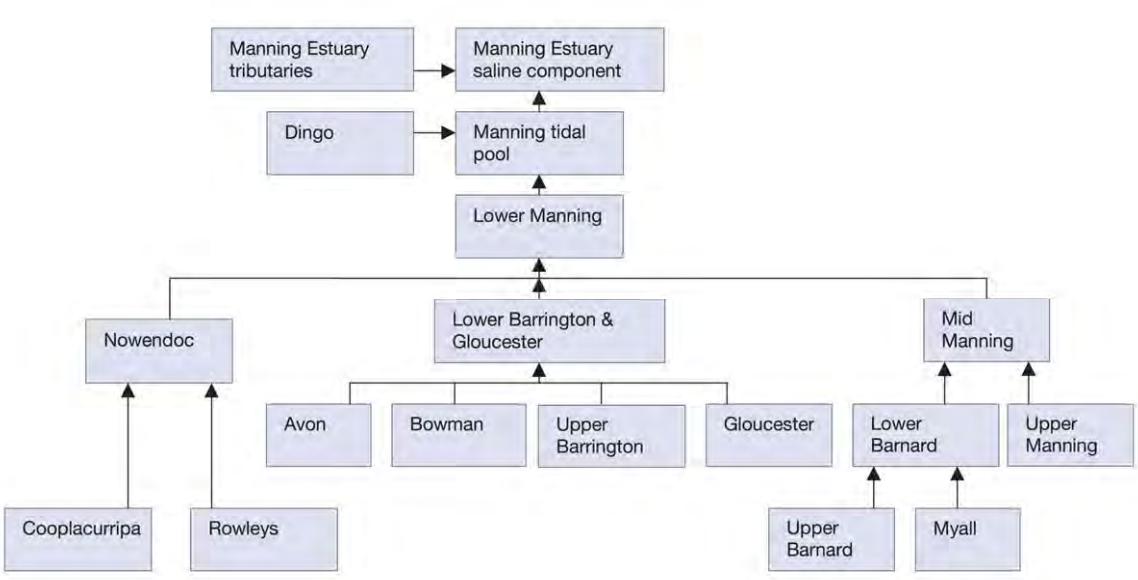
Most water sources were derived from the subcatchment in the Stressed Rivers Assessment Report (DLWC 1998a).

As much as possible, water sources were chosen so that:

- the rules could be sensibly applied across the water source or management zone
- they matched local extraction arrangements, including existing water user groups
- they were based on hydrologic catchments
- they ended at the confluence of major tributaries
- the estuary water body and tidal pools were considered separate water sources and were determined by using the tidal and mangrove limits from Manly Hydraulics Laboratory (2005)
- within these requirements, as few water sources as possible were defined.

A flow diagram depicting how each water source links with the others was required for each catchment. Flow dependencies indicate the flow of water from one water source to the next. This information was entered into a spreadsheet and used to assess cumulative impacts. Figure A1.1 shows an example of a flow dependency diagram for the Manning River catchment.

Figure A1.1 Manning catchment flow dependency diagram



Appendix 2: Estimate hydrologic stress

Hydrologic stress (amount of water extracted relative to river flow) is an important factor and is used to indicate the risks posed to instream values by extraction and as an indicator of the degree of competition between extractors.

Flow and usage information, which forms the basis for estimating hydrologic stress, varies considerably between streams. Regional Office of Water staff are typically aware of which streams are most stressed, because of observations over time and knowledge of the current level of management. Where data was unavailable, or the stress to a water source was difficult to measure (e.g. in a tidal pool), regional staff assigned high, medium or low stress ratings based on their experience. In inland ephemeral streams with unreliable data, a high hydrological stress rating was assumed.

Where adequate data was available, a more consistent and objective approach to estimate hydrologic stress was used, whereby hydrologic stress was calculated using the equation:

Hydrologic stress = peak daily demand / flow

The Stressed Rivers Project Hydrologic Analysis (DLWC 1998b) sets out the basic methodology for the determination of hydrologic stress. In many instances this was modified either to reflect the lack of data or to incorporate new data arising from the volumetric conversion of unregulated licences by the former Department of Natural Resources (currently the NSW Office of Water) in 2000. Both unregulated river and alluvial groundwater access licences (located in the highly connected alluvial aquifers) made up the extraction component of the hydrologic stress calculation. Access licences in the highly connected alluvial aquifers were included due to the hydraulic connectivity between the groundwater and adjacent surface water.

In most coastal cases, hydrologic stress was based on the 80th percentile daily flow for the critical month (the two horizontal rules in Figure A2.1). The critical month is the month when demand is highest relative to river flow. Hydrologic stress for high flows on the coast and most areas inland was based on the 50th percentile flow.

For coastal areas, the peak daily demand for extraction was calculated using the Daily Access Model, which is based on the Integrated Quantity and Quality Model (DNR 2005). The model determined the highest standard evapotranspiration (ETo) for each month from records of ETo from a nearby weather station over the historic period 1885 to 1992. The daily crop demand was calculated by multiplying the ETo with the specific crop factor and the area of that crop irrigated in the catchment. These values are totalled for all crops, giving an estimate of the peak daily demand. It was assumed that all licences were active and that similar crops were grown as in 1998.

For inland areas, the peak daily demand for extraction was calculated using data from the volumetric conversion process. Individual surveyed cropping patterns and usage estimate data for 1994-2000 was extracted from databases and totalled for each subcatchment. This surveyed usage was converted into a peak daily demand estimate and scaled up to cap levels of development for each subcatchment. Where no survey data existed, peak daily demand was copied from a nearby, hydrologically similar subcatchment and scaled to match cap entitlement.

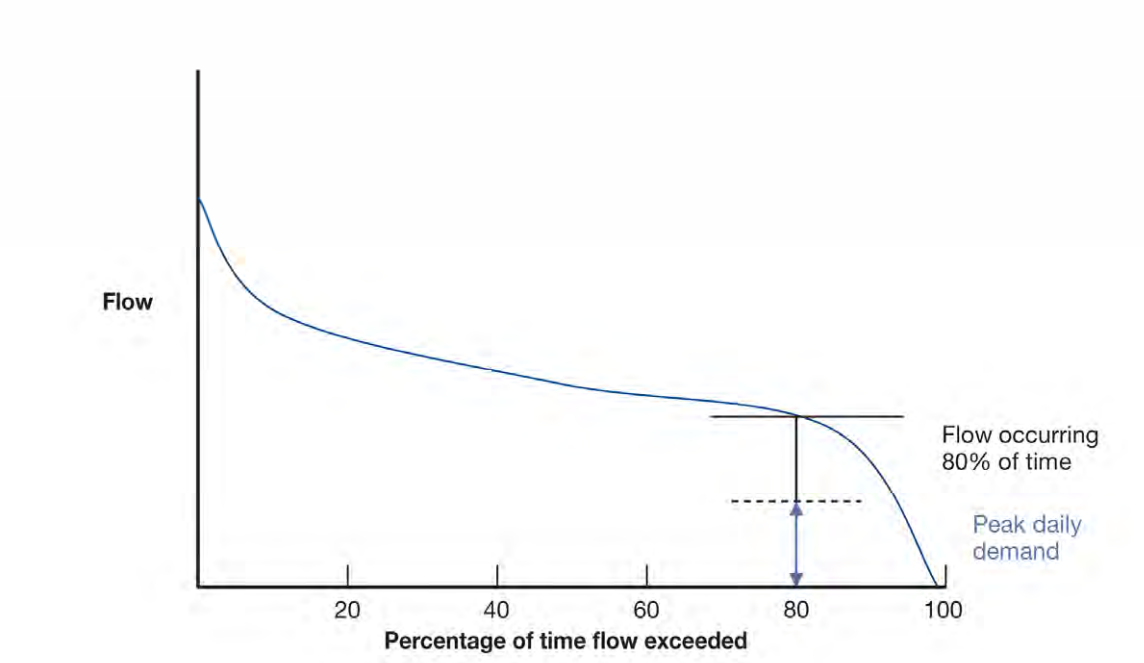
The spreadsheet used in the assessment automatically included the impact of upstream extraction. By using the flow dependency scheme outlined in Appendix 1 for each water source with upstream extraction, the spreadsheet accumulated all upstream extraction to obtain a total extraction for each

water source. The spreadsheet resets to 1.0 any value greater than 1.0, since extraction cannot exceed flow.

Since there is limited historical extraction data available it is difficult to accurately determine natural river flows. Therefore, post-extraction flows were used. This may overestimate the hydrological stress; however, this is compensated by post-extraction flows also being used for the access rules.

The calculation used above is just one of many possible indicators for hydrological stress. For highly intermittent streams, lakes, billabongs and tidal pools, the panel members used their knowledge of the systems in determining the hydrological stress and for inland ephemeral systems assumed high stress unless data was available to prove otherwise.

Figure A2.1 Calculation of hydrologic stress



Appendix 3: Determine instream values

Three different types of values were considered to contribute to instream value:

- ecological (intrinsic) values
- economic (non-extractive use) values
- place (cultural) values.

All three types of value are likely to be influenced by river flow and, potentially, water extraction.

The determination of instream value required the collation of a wide range of information which was then scored and entered into a spreadsheet for calculation of relative value. The assessment of value was based on criteria (for ecological values only) and attributes. Table A3.1 covers how each attribute was scored and Table A3.2 covers the justification and limitations of value attributes. These tables can be found on pages 24-31.

The criteria were consistent across NSW, but attributes varied with availability of data. A consistent set of attributes is used across all regions with ecological values grouped into four criteria:

- naturalness
- diversity
- rarity
- special features.

These criteria have been derived from a larger set of indicators suggested by Dunn (2000) and Bennett et al. (2002).

Estuarine values are determined in a similar manner to that use for other water sources, although some alternative attributes were used (Tables A3.1 and A3.2). Relative estuarine values are determined within each marine bioregion and provided to the Interagency Regional Panels.

Ecological values

Naturalness

Naturalness has been suggested to mean the extent to which a waterway's structure and function are similar to natural (pre-European) (Dunn 2000). This assumes that data are available from 'reference sites' to enable comparison with other altered sites. However, there are no complete or reliable data sets in many catchments to enable this. For macro water sharing plans, naturalness refers to an attribute being least disturbed by human impact.

Diversity

Waterway diversity reflects the behaviour of a river and interaction between the hydrology, geomorphic landscape, processes and biota (Dunn 2000). Diversity operates at micro and macro scales and applies at genetic, species, community and regional levels (Bennett et al. 2002). For the macro water sharing plans, diversity includes the variety of stream-dependent flora and fauna species and communities' instream and riparian habitats.

Diversity is influenced by disturbance to many natural riverine features. Natural diversity of native flora and fauna is also influenced by the presence of exotic species, particularly exotic weeds and fish.

Rarity

Rarity can be defined as natural features that have intrinsic value (e.g. rare or threatened species), regardless of whether they support other values in a catchment (Bennett et al. 2002). A catchment may contain single or a combination of rare or threatened features. Some species are more flow dependent and therefore may be more vulnerable to extraction than others. The relative sensitivity to extraction of an organism type was taken into account.

In NSW, legislation is a key driver for the management of threatened species. For macro water sharing plans, rarity is defined as threatened or endangered water-dependent species, populations or communities as listed under the *Threatened Species Conservation Act 1995* or the *Fisheries Management Act 1994*. In addition, rarity includes the presence of only one species of its kind in a catchment. Limited distribution at the extreme of the known range and endemism may also influence a species rarity. Water sources and management zones with threatened species are specifically identified in this method.

The information provided on the presence of threatened species and other rare species does not take account of whether these species are likely to be affected by the extraction in the locations in which they occur in each water source. The panels were instructed to review the above information and re-score any locations where a threatened species is considered not to be actually threatened by extraction.

Special features

Special features include riverine features within the landscape that are uncommon (e.g. a wild and scenic river), important ecosystems or species (keystone or icon), or features important for river functions (e.g. drought refuge and connectivity) (Dunn 2000).

Non-extractive values

Tourism can be dependent on natural values, particularly in estuaries. For example, reduced flows because of extraction may lead to lower water quality in some coastal areas and therefore reduce water-based recreation. Commercial and recreational fishing are an important part of many local economies and therefore are an important non-extractive instream value.

Place values

These include aesthetic, cultural, historic or other values that relate to people's appreciation of rivers. Locations within national park estates were given special consideration for place value.

Calculation of instream value

The attributes were scored and entered into a spreadsheet. They were analysed to give a score for each criterion, which were in turn analysed to give a relative instream value score for each water source.

All criteria were given equal weighting except for threatened, endangered or vulnerable species, communities and populations. High weightings were given to this group of attributes, as participating agencies agreed that the legislative requirements of threatened flora and fauna provide an objective measure for assessment. High value was assigned where a water source:

a) contains a significant area of 'declared' value (SEPP 14 wetland, etc.) which is threatened by extraction,

b) is important for threatened fish, or other species, populations or communities highly sensitive to flow,

c) is one of only a few locations where a threatened species, population or community is found in that catchment, or

d) is home to a large number of different threatened species.

Table A3.1 Summary of instream values and scoring system

Indicator	Reference or source of data	Scoring of information	Agency
Ecological (intrinsic) values			
Naturalness			
Hydrologic stress	**DNR hydrology database**	Ratio of flow & volume of extraction (refer to Appendix 2). Scoring: 1 = high stress, 2 = medium stress, 3 = low stress.	**DWE**
Barriers[1]	**Stressed Rivers Reports**	Scoring: 1 = barrier on main stream, 2 = barrier on major tributary, 3 = barrier on minor tributary, unnamed watercourse, or absent.	**DWE**
Riparian vegetation[1]	**Various**	Percentage vegetation cover of river reaches. Scoring: 1 = low % cover, 2 = medium % cover, 3 = high % cover.	**DWE**
Estuary condition[2]	**Oz Estuaries**	Classification of overall estuary condition. Scoring: 1 = extensively modified, 2 = modified, 3 = near pristine or largely unmodified.	**DWE**
Diversity			
Fish community integrity	**Index provided by DPI**	Scoring: 1 = low fish community integrity, 2 = medium fish community integrity, 3 = high fish community integrity.	**DPI**
Aquatic macro-invertebrates	**NLWRA Aquatic Biota Index (AUSRIVAS)**	Index based on comparison to 'reference' condition. Scoring: 1 = poor condition, 2 = medium condition, 3 = good condition.	**DWE**
Wet fauna diversity[1]	**Scores provided by DEC (Wildlife Atlas)**	Scoring: 1 = 0% to 33% of all species found within zone are also found within that water source; 2 = 33% to 66% of all species found within zone are also found within that water source; 3 = 66% to 100% of all species found within zone are also found within that water source.	**DECC**
Seagrasses[2]	**Data taken from Roy et al. (2001)**	Percentage of water area covered by seagrasses. Scoring: 1 = low % cover, 2 = medium % cover, 3 = high % cover.	**DWE**
Rarity			
Threatened species, populations or communities	**Scores provided by DPI (fish) & DEC (other) (Wildlife Atlas & Threatened Species Profile Database)**	Scoring for fish: 0 = none present, 1 = present but not key location, 2 = present and key location. Scoring for others: 0 = species not known or modelled to be present, 1 = species modelled to be present, 2 = species known to be present. However, species predicted to be present were assigned the same value as those known to be present in the final value calculation. Scoring was weighted to factor in species sensitivity to extraction: 4 = highly sensitive to extraction (e.g. fish), 3 = strongly sensitive to extraction with a major part of life cycle dependent on flow (e.g. frogs), 2 = slightly sensitive to extraction (e.g. wading birds), 1 = secondary relationship to extraction (e.g. birds nesting in riparian vegetation). A second weighting was applied to the scoring to factor in the range of each species in the catchment: a factor of 1.0 was use if the species was present in only one water source, reducing exponentially to 0.3 if it was present in all catchments.	**DPI, DECC**

Indicator	Reference or source of data	Scoring of information	Agency
Special features			
Drought refuge [1]	**River Styles Framework Assessments**	Based on geomorphic condition. Scoring: 1 = poor condition (high stress), 2 = medium condition (medium stress), 3 = good condition (low stress).	**DWE**
Represent-ativeness[2]	**Data taken from Roy et al. (2001)**	Scoring: 1 = medium number of estuaries of type and condition is low, or numerous estuaries of type and condition is medium or low; 2 = medium number of estuaries of type and condition is high or medium, or numerous estuaries of type and condition is high; 3 = few estuaries of type.	**DWE**
Declared locations (including World Heritage Areas, Declared Wilderness Areas, Ramsar sites, SEPP 14 wetlands, nationally important wetlands and Marine Parks)	**Scores provided by DEC**	Marine Parks scoring: 0 = no Marine Park, or Marine Park not likely to be sensitive to flow extraction; 1 = area contains or is adjacent to a section of Marine Park that is not a 'sanctuary zone' and is likely to be sensitive to flow extraction; 2 = area contains or is adjacent to a 'sanctuary zone' of a Marine Park and is likely to be sensitive to flow extraction. Scoring for all other declared locations: 0 = location does not intersect or is not adjacent to a named water source, or not sensitive to extraction; 1 = only small proportion of location within water source, or significant amount of location within water source but likely to be only moderately sensitive to flow extraction; 2 = significant amount of location within water source and likely to be significantly sensitive to flow extraction.	**DECC**
Wild rivers	**Scores provided by DEC (*National Parks and Wildlife Act 1974*)**	Scoring: 1 = no wild river present; 2 = wild river present, but likely to be only moderately sensitive to flow extraction; 3 = wild river present and likely to be very sensitive to flow extraction. Note: The rivers used in the assessment were nominated for declaration, but had not been declared	**DECC**
Icon species (platypus) [1]	**Scores provided by DEC (Wildlife Atlas)**	Scoring: 1 = no iconic species recorded, 2 = species likely to be moderately sensitive to flow extraction, 3 = species likely to be very sensitive to flow extraction.	**DECC**
JAMBA or CAMBA	**Scores provided by DEC (Wildlife Atlas)**	Scoring: 1 = few or no JAMBA/CAMBA species sighted, 2 = moderate number of JAMBA /CAMBA species sighted, 3 = significant number of JAMBA/CAMBA species sighted.	**DECC**
Non extractive values			
Tourism	**Various information sources**	Scoring: 1 = low value, 2 = moderate value, 3 = high value.	**DWE**
Commercial fishing[2]	**Data taken from Roy et al. (2001)**	Amount of fish caught relative to area of estuary. Scoring: 1 = low catch per area, 2 = medium catch per area, 3 = high catch per area.	**DWE**

Indicator	Reference or source of data	Scoring of information	Agency
Recreational fishing	**Scores provided by DPI**	Estimates of relative importance of area as a recreational fishing area, considering fish stocking rates, subjective assessment of the importance of an area to recreational fishing, location of fishing havens, proximity of area to high angler numbers and assessors' knowledge of waterways. Scoring: 1 = low recreational fishing value, 2 = medium recreational fishing value, 3 = high recreational fishing value.	**DPI**
Other recreation	**Various information sources**	Scoring: 1 = low value, 2 = moderate value, 3 = high value.	**DWE**
Place values			
National Parks Estate	**DEC information**	Scoring: 1 = no estate within water source, or estate not sensitive to extraction; 2 = small proportion of estate located within water source, or significant amount of estate located within water source, but likely to be only moderately sensitive to flow extraction; 3 = significant amount of estate located within water source and likely to be significantly sensitive to flow extraction.	**DECC**

Table A3.1 is a summation of how instream information has been used to estimate in-stream values. Existing data sets were examined so that a relative score (to allow for comparison between water sources) could be assigned for each indicator.

Table A3.2 Justification and limitations of value criteria and attributes

Criteria	Attribute	Justification for use	Limitations
Naturalness	**Hydrologic stress**	The estimation of extraction is fundamental to this assessment and is used at several points in the assessment. It is used to indicate naturalness and to assess instream risk and extraction value.	Flow data is not available at all sites; flow data is measured at sites that are often downstream of significant extraction – this means flow is generally residual rather than natural (this is not considered a major problem, because the method assesses relative stress, not absolute stress); usage data is generally very approximate.
	Artificial barriers	Artificial instream barriers include dams, weirs, road crossings, culverts, causeways or similar structures that prevent the longitudinal movement of fish and can alter the natural flow of rivers, which in turn can modify water quality and fish habitat (NSW Fisheries 1999a, 1999b). Barriers to fish movement are also used as indicators in other States (Anderson 1993, Ladson and White 1999) and in national river assessment protocols (see Parsons et al. 2002). Changes to stream and river flow through water extraction may increase the impact of artificial instream barriers by further reducing longitudinal connectivity.	The locations of all artificial instream barriers may not be well known in each unregulated water source and may not all be included on existing geographical information system (GIS) or topographic maps.
	Riparian vegetation	Riparian vegetation is important for providing habitat and food items for instream (aquatic) biota, is a key provider of material to drive instream energy pathways and buffers the runoff of sediment and nutrients into Australian streams and rivers (Boulton and Brock 1999).	Data unlikely to provide details on exotic species and structure (vegetation layers).
	Estuary condition	Based on consistent existing assessment of all Australia's major estuaries (Oz-Estuaries database), which used the following parameters to describe condition: catchment cover, land use, catchment hydrology, tidal regime, floodplain, estuarine use, pests and weeds and estuarine ecology.	Incorporates some aspects (e.g. catchment hydrology) that are better addressed within other steps of the macro classification process.

Criteria	Attribute	Justification for use	Limitations
Diversity	**Fish community index**	The advantages of using fish as a bio-assessment tool (as listed in SRA 2004) were summarised by Harris (1995), with benefits including: fish being relatively long-lived and mobile and so providing good indicators of long-term responses; allowing the assessment of broader spatial-scale impacts; a range of trophic levels (omnivores, carnivores, herbivores), integrating various lower-level impacts; ease of interpretation of monitoring results, allowing direct assessment of economic resources; ease of collection and identification (taxonomy is generally well documented); identification in the field allowing live release, removing the need for destructive sampling and laboratory processing; ecology and habitat requirements being relatively well known (compared to invertebrates); typically present even in very small streams and polluted waters; and rapid evaluation of biological integrity.	Most fish respond to larger-scale and longer-term riverine disturbances.
	Macro - invertebrates	Macroinvertebrates are important biodiversity components of flowing streams. They are important food sources for many other aquatic species and are sensitive to stream flow (Boulton and Brock 1999). The National Heritage Trust (2002) assessment of Australian catchments, rivers and estuaries provided an aquatic biota index in which macroinvertebrates (using AUSRIVAS approach) were used as the key surrogate species. The AUSRIVAS sampling method and modelling is a standardised approach for measuring river health in all Australian States and Territories.	Modelled information was not available for all rivers and streams; macroinvertebrates may not be sensitive to all forms of river modification; and other biota may be better at showing effects at smaller or larger time and spatial scales.
Diversity	**Wet fauna diversity**	Diversity of wet fauna was regarded as sensitive to extraction and therefore a valid indicator for instream value. Only fauna likely to be sensitive to flow extraction, based on DEC ecologists' knowledge, was included in the assessment.	Incomplete spatial (distribution) information; species recorded through actual sightings; and did not consider likely or predicted species diversity in areas not studied.
	Seagrasses	Considered as an indicator of habitat in estuaries.	Did not consider the difference in value between common seagrass species versus rare species.

Criteria	Attribute	Justification for use	Limitations
Rarity	**Threatened species, populations and communities**	Wet flora and fauna (aquatic) threatened species have important requirements that must be considered as stated in individual threatened species recovery plans or mentioned otherwise within the *Threatened Species and Conservation Act 1995* or the *Fisheries Management Act 1994*. A list of species likely to be sensitive to extraction, based on DEC ecologists' knowledge, was used during the assessment.	Incomplete spatial (distribution) information; the databases used for this assessment are constantly reviewed and updated; species may only be found in specific habitat, not across whole water source; and not all threatened species that are sensitive to extraction were used, rather an 'indicator' approach was adopted.
Special features	**Drought refuge**	In periods of low river flow, aquatic biota may migrate to permanent pools that become essential in the maintenance of most aquatic populations (Humphries and Baldwin 2003). Drought refuge classifications are based on knowledge of river habitat and therefore require the input of data that provides information on the geomorphic structure and behaviour of the reaches to be assessed.	The location of important deep pools in river systems may not be known. Deep pools are important in the maintenance of aquatic biota populations.
	Represent - ativeness	Determines how well an estuary represents type within the marine bioregion. Scoring considered the number of like estuaries and the estuary condition.	The Tweed–Morton Bioregion extends into Queensland and Twofold Shelf Bioregion extends into Victoria; the analysis considered only the NSW estuaries within these bioregions.
	Declared locations	Declared locations in this assessment are critical habitats, marine parks or aquatic reserves as declared under the *Threatened Species and Conservation Act 1995, National Parks and Wildlife Act 1974* or the *Fisheries Management Act 1994*. SEPP 14 wetlands are those listed under this planning policy. Declared locations may also include wetlands listed under the Directory of Important Wetlands, Ramsar sites, World Heritage Areas and Declared Wilderness Areas. Sensitivity of location to extraction was based on DEC ecologists' expert knowledge.	Assumed that if location is adjacent to or intersected by a named watercourse, then it is sensitive to extraction; if less than 5% of location is within the water source area, then disregard; in some assessments, DIWA, SEPP 14 and Ramsar wetlands may have been double-counted, indicating highly valued wetlands; and assumed all wetlands are at least moderately sensitive to extraction.
	Iconic species (e.g platypus)	Some species not listed as threatened or listed under the JAMBA or CAMBA agreements have been included as iconic species. The iconic species likely to be sensitive to extraction were nominated based on DEC ecologists' knowledge.	Incomplete spatial (distribution) information; selection of iconic species was subjective; and a full list of iconic species was not prepared, rather a selection were used as indicators. Does not predict species occurrence, only those that have been sighted.

Criteria	Attribute	Justification for use	Limitations
Special features	**Wild rivers**	Significant river sections nominated for declaration as 'wild rivers' under the NSW National Parks and Wildlife Act and rivers identified as 'wild and scenic' in Wild and Scenic Rivers in New South Wales – Report No 1, Identification, Classification and Inventory, prepared by Cameron McNamara Consultants for the Dept Water Resources, November 1987, ISBN 07 240 3433 0. Sensitivity of rivers to extraction was based on DEC ecologists' expert knowledge.	Rivers are currently nominated for declaration and still undergoing further condition assessment; and other, as-yet unidentified rivers, may be considered for declaration in the future and have not been assessed at this stage.
	JAMBA and CAMBA	There are many migratory birds that make annual flights between the Southern and Northern Hemispheres. These birds rely on suitable habitats in a number of different countries and therefore the conservation of the birds and their habitats requires international cooperation. Birds that are threatened species were assessed in the 'Threatened Species, Populations and Communities' component. Species likely to be sensitive to extraction were nominated based on a quick and simple assessment.	Incomplete spatial (distribution) information; does not predict species occurrence, only those that have been sighted; and the species were selected to be indicators, not necessarily a comprehensive list.
Non-extractive values	**Tourism**	Some tourism, primarily in estuaries, is dependent on natural values, of which stream flow is one. For example, reduced flows because of extraction may lead to lower water quality in some coastal systems.	There is little available information on the relationship between water extraction and tourism and therefore it was difficult to estimate this value.
	Commercial fishing	Commercial fishing is important to many local economies and occurs almost exclusively in estuaries (or in the marine environment, which is not considered here).	Did not consider varying productivity based on estuary type.
	Recreational fishing	Recreational fishing has commercial and social values and is dependent on natural values, all of which may be affected by water extraction.	Most fish respond to larger-scale and longer-term riverine disturbances; and importance of an area to recreational fishing was subjective.
	Other recreation	Recreation covers a broad range of activities, both on the water and near water, which are very common in most estuary locations. Recreation is dependent on natural values, which may be affected by water extraction.	Synthesis of a broad range of activities into a single-value score was difficult and subjective; and incomplete information.

Criteria	Attribute	Justification for use	Limitations
Place value	**National Parks Estate**	National Park Estates that intersect or are adjacent to a named watercourse were identified in the assessment. In most regions, National Park Estates that are also World Heritage Areas or Wilderness Areas were considered in the 'Declared Locations' component.	Assumed that if location is adjacent to or intersected by a named watercourse, then it is sensitive to extraction; if less than 5% of location is within the water source area, then disregard; and in some assessments, National Park Estates, World Heritage Areas and Wilderness Areas were doubled-counted, indicating highly valued locations.

Table A3.2 provides an explanation of the reasons various attributes were used and their shortcomings.

Appendix 4: Determine estuary sensitivity to freshwater inflows

Inflow sensitivity is defined as the extent to which reduced freshwater inflows affect the salinity of an estuary. Variability of inflow sensitivity is driven by the physical attributes of the estuary.
A drowned river valley is open to the ocean, well flushed and generally characterised by marine features. Barrier estuaries are generally long and narrow, water exchange may be slow, and a salt wedge may migrate up or down the estuary depending on freshwater inflows.
Saline coastal lakes have intermittent openings and are generally the most sensitive estuaries to changes in freshwater inflow.

Reduced freshwater flow inflow may lead to:

- migration of the salt wedge further upstream in estuaries than is desirable, reducing the useability of surface waters and negatively affecting flora and fauna
- water quality problems such as algal blooms, stratification-induced deoxygenation and less dilution of pollutants
- hypersalinity, loss of water depth or complete drying of coastal lagoons.

A low flow and high flow inflow sensitivity spreadsheet was prepared for each marine bioregion (Environment Australia and IMCRA Technical Group 1998). Attributes from Roy et al. (2001) were used to derive sensitivities, as outlined in Table A4.2 and Muschal et al (2006).

The catchment spreadsheets were used to determine the cumulative hydrologic stress for the estuary (or parts of the estuary); just as the hydrologic stress was determined for freshwater reaches (refer to Appendix 2). The cumulative hydrologic stress and the low flow inflow sensitivity were then compared to determine hydrologic risk for the estuary (Table A4.1). The hydrologic risk was then used in the determining the indicative trading and access rules applicable to the entire catchment feeding into the estuary.

Table A4.1 Calculation of hydrologic risk to estuaries using low flow inflow sensitivity and cumulative hydrologic stress

	Low hydrologic stress	Medium hydrologic stress	High hydrologic stress
High sensitivity to inflow	Medium hydrologic risk	High hydrologic risk	High hydrologic risk
Medium sensitivity to inflow	Low hydrologic risk	Medium hydrologic risk	High hydrologic risk
Low sensitivity to inflow	Low hydrologic risk	Low hydrologic risk	Medium hydrologic risk

The sensitivity of estuaries to high flow inflows provided guidance in catchments where rules allowing conversion of low flow entitlements to high flow entitlements were considered. The sensitivities of estuaries during times of high flow inflows were the same as those determined for low-flow inflows except for:

- small creeks and rivers with catchment areas less than 100 km^2
- coastal lagoons with catchment area/estuary surface area ratio between 25 and 75.

Both types of estuaries are highly sensitive to the reduction of inflows during periods of low flow. However, during periods of high flow there is a greater likelihood of small creeks and rivers being flushed and lagoons being opened owing to their smaller catchment area/estuary surface area ratio. Their sensitivity to high flow inflows has therefore been reduced to medium.

Coastal lagoons with a catchment area/estuary surface area ratio of less than 25 were given an inflow sensitivity of high during both low and high inflows, because they open so infrequently that high flows generally remain in the system.

While freshwater inflows are critical for maintaining estuary health and protecting values, they will have varying impacts on different estuaries depending on, for example, the time water is retained in the estuary. Extraction during low river flows needs to consider the freshwater/saltwater interactions of each estuary and be carefully managed for local circumstances. Low flow sensitivity gives an indication of those interactions and was determined by examination of the estuary attributes.

Table A4.2 Low flow extraction sensitivity criteria

Attributes used to determine low flow sensitivity	Justification	Examples
High sensitivity to extraction at low river flow		
Freshwater/brackish barrier lakes.	Reduced inflows will increase salinities through evaporation and/or migration upstream of salt wedge.	Cudgen L, Broken Head Ck, Myall Lakes
Permanently open small creeks and rivers with a catchment area of less than 100 km^2.	Most sensitive to reductions in freshwater flows causing movement of salinity gradient into upper reaches.	Coffs Harbour Ck, Evans R, Crooked R, Bermagui R
Saline coastal lagoons with low catchment-to-estuary-surface-area ratio (<75), which therefore remain closed for long periods of time (>1 yr).	Reduced inflows will increase salinity through evaporation. May lead to hyper-salinity and drying of bed in shallow systems.	Tilba Tilba L, Coila L
Small coastal rivers and creeks with lagoons (area <0.5 km^2) prone to quick entrance closure and therefore closed most of the time (>75%).	Reduced inflows will increase salinity through evaporation. May lead to hypersalinity and drying of bed in shallow systems.	Meringo Ck, Merrica R
Medium sensitivity to extraction at low river flow		
Rivers with a catchment area between 100 and 500 km^2.	Moderate sensitivity to a reduction in freshwater inflows allowing movement of salinity gradient into upper reaches.	Sandon R, Brunswick R, Wooli Wooli R, Minnamurra R
Rivers with a very large catchment area greater than 500 km^2, with a very long river system with a tidal reach 50 km or greater inland.	Moderate sensitivity to a reduction in freshwater inflows due to salinity gradient or longer residence time and extent of tidal pool or tidal excursion.	Richmond R, Clarence R, Macleay R, Hunter R, Hawkesbury R, Shoalhaven R
Permanently open barrier estuaries or open >50% of the time, with large catchment-to-estuary-surface-area ratio (>25).	May experience a salinity gradient in upper reaches of feeder streams.	Murrah Lagoon, Pambula L
Small coastal rivers and creeks (area <0.5 km^2) open most of the time (>50%).	Open most of the time, so salinities generally approach oceanic concentrations.	Congo Ck

Attributes used to determine low flow sensitivity	Justification	Examples
Low sensitivity to extraction at low river flow		
Bays.	High tidal interchange.	Botany Bay, Jervis Bay, Twofold Bay
Drowned river valleys.	High tidal interchange.	Port Stephens, Port Jackson
Rivers with a very large catchment area greater than 500 km^2, with a tidal reach less than 50 km inland.	Large catchment area provides large volumes of freshwater. Extent of tidal pool excursion limited.	Tweed R, Bellinger R, Georges R, Clyde R
Permanently open barrier estuaries with small catchment-to-estuary-surface-area ratio (<25).	High dilution and tidal flushing capacity. Predominantly marine with minimal salinity gradient in feeder streams.	Wagonga Inlet, Merimbula L
Permanently open coastal creeks or tributaries with low catchment-to-estuary-surface-area ratio (<75).	Predominantly marine with minimal salinity gradient.	Cullendulla Ck

Appendix 5: Estimate extraction value and community dependence

Estimating the dependence of the local community on water extraction for irrigation was based on:

- the volume and economic value (which varies with usage) of water extracted
- the social impacts of water extraction. Essentially, whether there is anything in the social structure of an area (e.g. high unemployment or high dependence on irrigated agriculture) which affects the ability of the community to adapt to changes in rules for water access. This may be referred to as the community's resilience or vulnerability to changes in extractive values.

The extraction value calculation considered only irrigation and basic landholder rights (domestic and stock), because these form the bulk of the users. Town water supply was noted but not used in the computation, because this supply is managed as set out in the 'Other Considerations' section.

Information on irrigation value, calculated from volumetric conversion data and published information on gross margins for various irrigation usages, was compiled. The extraction volume and value of basic landholder rights (domestic and stock water) were needed only where they formed a significant proportion of low flow usage. The spreadsheet calculated the total irrigation and domestic and stock values and then divided the sum by the water source area to produce the value/catchment area score.

The Disadvantage Index and the Dependence on Agriculture information were entered into each catchment spreadsheet. The value/catchment area score was modified for the impact on the community (or social dependence) by dividing by the Disadvantage Index and multiplying by 1000 to give the initial dependence score.

The social impacts of water extraction for irrigation are considered to depend on many factors. The following were recognised in this method:

- The relative value of extraction, as estimated above
- The ABS Index of Social Advantage and Disadvantage can be used to indicate the vulnerability of the local community to changes in water availability
- The ABS information on employment in agriculture as a percentage of total employment indicates community dependence on irrigated agriculture
- NSW Department of Primary Industries' officers, in some circumstances, provided information (as high, medium and low scores entered as 1–2–3) on the level of investment in irrigation infrastructure and the vulnerability of the different irrigation industries in each water source to loss of access to water.

These items of information were entered into the spreadsheet, which computed the initial score for dependence on water extraction. It then computed a final dependence score of high, medium or low. The irrigated agriculture information in the last two points above is not used in the computation but was recorded in the spreadsheet for reference by the Interagency Regional Panel. The ABS information used in the points above was extrapolated from the original local government area basis to the water sources.

Appendix 6: Determine river types

The applicability and implication of access rules vary across river type. For the purposes of the macro water sharing approach, rivers have been divided into the following types:

1. **Gaining streams** are those where the flow generally increases through tributary or groundwater inflow as one moves downstream. During extreme droughts there may be reduced flow downstream, but there is either some flow at the end of the system or the stream stops flowing along the entire length at about the same time. In gaining streams, rules based on end-of-system flow are appropriate.
2. **Connected streams** are those with a strong surface and groundwater interaction, with spear points and wells as the common means of extracting water. In many of these systems the surface flow dries up, but users continue to extract, in some cases for years, from the groundwater. Rules in these types of rivers are designed primarily to protect refuge areas such as pools and groundwater-dependent ecosystems.
3. **Losing, terminal or effluent streams** are those where there is no flow at the end of the water source for a significant part of the time, making end-of-system rules inappropriate. There could, however, be flow at the top of the system and for some length of the river. The aim of the rules is to ensure that a sufficient length of stream is left flowing, or that flow reaches areas that are important environmental assets, or where there is no reasonable alternative for basic landholder rights requirements. Streams fed by mountain springs and anabranches of main rivers are examples of this river type.
4. **Tidal pools** are those sections of coastal rivers that are affected by both tidal and catchment processes. For the macro water sharing plans they were defined as the section between the tidal water fluctuation limit and the mangrove limit. In some of the larger river systems, a significant proportion of the water extracted comes from tidal pools. In some rivers, the tidal pool may be ephemeral or may diminish significantly during periods of low flow.
5. **Estuaries** as defined under the *Water Management Act 2000* mean the waters between the mouth of a river and the coastal waters of the State. For the purposes of defining water sources the macro approach extended that definition to include:
    - any part of a river whose level is affected (including intermittently) by coastal tides and
    - any partially enclosed body of water that is intermittently open to the sea.
6. **Ephemeral streams** flow intermittently.

A list of estuaries and parts thereof was compiled from Roy et al. (2001), the Healthy Rivers Commission (2002), the National Heritage Trust (2002) and DLWC (1998).

These river types represent the characteristics important for considering the appropriateness and effectiveness of flow rules. Some streams may exhibit part or all of these different characteristics in different locations and at different flow levels. In such cases, the Interagency Regional Panels used their discretion in determining the appropriate combination of the rules.

Appendix 7: Estimate risks to instream values

Instream values can be threatened from water extraction. In general terms, the more extraction taking place in a water source, the greater the risk to instream values.

Therefore in this context, risk to instream values is a direct function of the hydrologic stress from cumulative extraction (i.e. upstream of and within a water source).

Using the flow dependencies entered in step 1, a spreadsheet was used to automatically calculate the risk from cumulative extraction in each water source.

The spreadsheet takes the calculated values for instream risk which is then divided into three equal parts to indicate low, medium or high scores.

For estuaries, Table A7.1 was used to compare hydrologic risk with estuarine values in order to assign risk to the estuaries' instream values.

Table A7.1 Determination of risk to instream (estuary) values.

	Low hydrologic risk	**Medium hydrologic risk**	**High hydrologic risk**
High estuarine value	Medium risk to estuarine values	High risk to estuarine values	High risk to estuarine values
Medium estuarine value	Low risk to estuarine values	Medium risk to estuarine values	High risk to estuarine values
Low estuarine value	Low risk to estuarine values	Low risk to estuarine values	Medium risk to estuarine values

Appendix 8: River flow objectives and policy advice

River flow objectives

Following extensive community consultation, the NSW Government approved river flow objectives (RFOs) across most of NSW streams. These can be viewed at www.environment.nsw.gov.au and are provided in Table A8.1.

RFOs are high-level objectives that represent the key features of flow regimes that support (or affect) environmental values, including aquatic ecosystems, wetlands and water quality. The RFOs reflect best practice in the science and management of river flows by taking a holistic approach to managing flows for the needs of the whole aquatic ecosystem, rather than concentrating only on identified known species or sites.

The RFOs provide for management of a river system as a whole and 'check' that in general terms water sharing plan rules are meeting key ecological flow needs, even where specific needs are not known. This helps to contribute to the *Water Management Act 2000* requirement to maintain water sources and support their dependent ecosystems.

The RFOs formed the basis for the indicative rules.

Policy advice documents

During the first round of water sharing plans the following policy advice documents were provided to the Water Management Committees from the NSW Government.

Policy Advice 1: Managing to diversion limits in regulated rivers

Policy Advice 2: Supplementary water access

Policy Advice 3: Floodplain harvesting

Policy Advice 4: Regulated rivers (high security) access licences

Policy Advice 5: Managing to diversion limits in unregulated rivers

Policy Advice 6: Daily extraction management in unregulated rivers

Policy Advice 7: Diversion limits for coastal unregulated rivers

Policy Advice 8: Groundwater quantity management

Policy Advice 9: Groundwater dependent ecosystems

Policy Advice 10: Freshwater flows to estuaries and coastal waters

Policy Advice 11: Integrating the water quality and river flow objectives into water sharing plans

Policy Advice 12: Conservation of biodiversity and threatened species management

Policy Advice 13: Incorporating the results of the weir review into the water sharing plans

Policy Advice 14: Aboriginal issues and cultural heritage protection

The above policy advice documents were used to guide the development of the assessments which underpin the macro water sharing plans. For example, the estuarine assessment was based on the principles within Policy Advice 10. The policy advice documents were based on a typical gaining river and were therefore modified to develop rules for losing and connected rivers.

Table A8.1 Relationships between river flow characteristics (as summarised by the river flow objectives and ecological features for a typical unregulated stream)

Some river flow objectives will have little or no affect on some ecological features, but are critical for the sustainability of others. The table below summarises the affects on different river features such as wetlands and fish.

		Wetlands	Water plants	Floodplain connectivity & riparian / floodplain vegetation	Fish	Water birds	Macroinvertebrates	Other aquatic fauna	Instream habitats and channel structure	Water quality (including algal blooms)	Instream food production
River flow objectives	**Relevance to rules**	**Ecological features**									
1. Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flow	Commence & Cease to Pump – relationship to cease to flow	✓	✓		✓		✓	✓		✓	✓
2. Protect natural low flows	Commence & Cease to Pump – relationship to 95th percentile of days with flow		✓		✓	✓	✓	✓	✓	✓	✓
3. Protect or restore a proportion of moderate flows (freshes) and high flows	Commence & Cease to Pump – especially by having higher commence than cease to pump	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Maintain or restore natural inundation and distribution of floodwaters supporting natural wetland and floodplain ecosystems	Unlikely to be influenced by unregulated WSP unless very high extractions with instream or off stream storages	✓		✓		✓		✓			✓
5. Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways	Unlikely to be influenced by unregulated WSP. Not an issue in unregulated streams										
6. Maintain or mimic natural flow variability in all streams	Commence and cease to pump. Where applicable – Medium-high flow access rules and extraction limits. Not likely to be an issue in small unregulated stream.		✓	✓	✓	✓	✓	✓	✓	✓	

River flow objectives	Relevance to rules	Wetlands	Water plants	Floodplain connectivity & riparian / floodplain vegetation	Fish	Water birds	Macroinvertebrates	Other aquatic fauna	Instream habitats and channel structure	Water quality (including algal blooms)	Instream food production
		Ecological features									
7. Maintain rates of rise and fall of river heights within natural bounds	Commence and cease to pump. Where applicable – Medium- to high-flow access rules and extraction limits										
8. Maintain groundwater within natural levels and variability critical to surface flows and ecosystems	Relevant for connected and possibly losing streams. Rules may relate to groundwater level triggers. Important to maintain base flows						✓			✓	
9. Minimise the impact of instream structures	Cease to pump (or med- to high-flow access triggers) may relate to commence to flow over structures. Relevant to local water utility rules.				✓					✓	✓
10. Minimise downstream water quality impacts of storage releases	Relevant to local water utility rules. Not likely to be an issue in small unregulated streams										
11. Ensure river flow management provides for contingencies	Not relevant in unregulated systems, except where significant instream storage (e.g. utilities). Not possible in small unregulated stream										
12. Maintain or rehabilitate estuarine processes and habitats	Relevant where extraction is sufficiently high to influence estuarine processes downstream	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Appendix 9 Indicative trading rules (dealings)

This step specifically looks at dealings that move the right to access water between and within water sources and management zones. The following four principles apply to water dealings:

- Minister's Access Licence Dealing Principles must be adhered to.
- Trading should not cause an increase in hydrologic stress in water sources with high instream value or high hydrologic stress.
- Trading resulting in growth in use above the extraction limit of the plan will be subject to growth-in-use strategies at the EMU level.
- Trading covers transfer of access licence and assignment of water allocation between access licences, change of water sources and location for extraction. Interstate trade is also considered.

Trading arrangements need to result in environmental improvement rather than harm (Schofield 2003). The trading of water licences out of, into and within water sources will be a major mechanism for both environmental and economic improvements. This does not necessarily imply that there is absolute improvement in each water source. The water source receiving the licence must be able to accommodate any environmental harm and maintain healthy functioning ecosystems.

The management of licence trades aims to result in protection of high instream values, a lowering of hydrologic stress in highly stressed water sources and creating economic development opportunities.

The following indicative trading rules between water sources could apply for annual entitlements (shares):

- Trading is **allowed out of** all water sources.
- Trading is **allowed into** the water sources categorised as boxes **d**, **e**, **g** and **h** in Table A9.1.
- Trading is **not allowed into** or upstream of the water sources categorised as boxes **a**, **b** or **c** in Table A9.1, unless:
    - the transfer is from another water source upstream of that water source
    - the trading is in a direction that does not increase the hydrological stress (i.e. downstream for gaining rivers) and procedures are in place to prevent increased extraction in the water source from which trading occurred
    - the instream values have been spatially located so that it is possible to allow trading into that water source relative to those values (i.e. below those instream values).
- Trading is allowed into water sources categorised as boxes **f** and **i** in Table A9.1 where the equivalent volume or greater has been transferred out previously (**no net gain**) or from another upstream water source.
- Trading is generally allowed **within** water sources. Some water source have zones where trading is not allow into because of high instream values or high hydrologic stress.

For ephemeral inland streams, which are assumed to have high hydrologic stress (step 2), a simple set of trading rules have been developed:

- Regardless of stress or in-stream value, trades within a water source are permitted.
- No trading permitted into a high value water source.
- Trades in highly stressed water sources will only be permitted where there is no net increase in entitlement via trading.

- Trades into downstream water sources are permitted regardless of stress or in-stream value, as long as the water sources have a direct hydrological connection.
- Trades through the regulated reach are not permitted e.g. a licence cannot be traded from an unregulated water source upstream of the regulated reach to a water source downstream of the regulated reach.
- Trading is permitted into water sources with medium or low hydrological stress and in-stream value (trade volumes will be limited as per above method).

Table A9.1 Goals for dealings rules

	Low hydrologic stress or hydrologic risk	**Medium hydrologic stress or hydrologic risk**	**High hydrologic stress or hydrologic risk**
High instream values	**a** Reduce entitlement via trading out	**b** Reduce entitlement via trading out	**c** Reduce entitlement via trading out
Medium instream values	**d** Encourage development through trading of water entitlements and allocations into water sources up to defined limits	**e** Encourage development through trading of water entitlements and allocations into water sources up to defined limits	**f** Rule to prevent net increase in entitlement via trading
Low instream values	**g** Encourage development through trading of water entitlements and allocations into water sources up to defined limits	**h** Encourage development through trading of water entitlements and allocations into water sources up to defined limits	**i** Rule to prevent net increase in entitlement via trading

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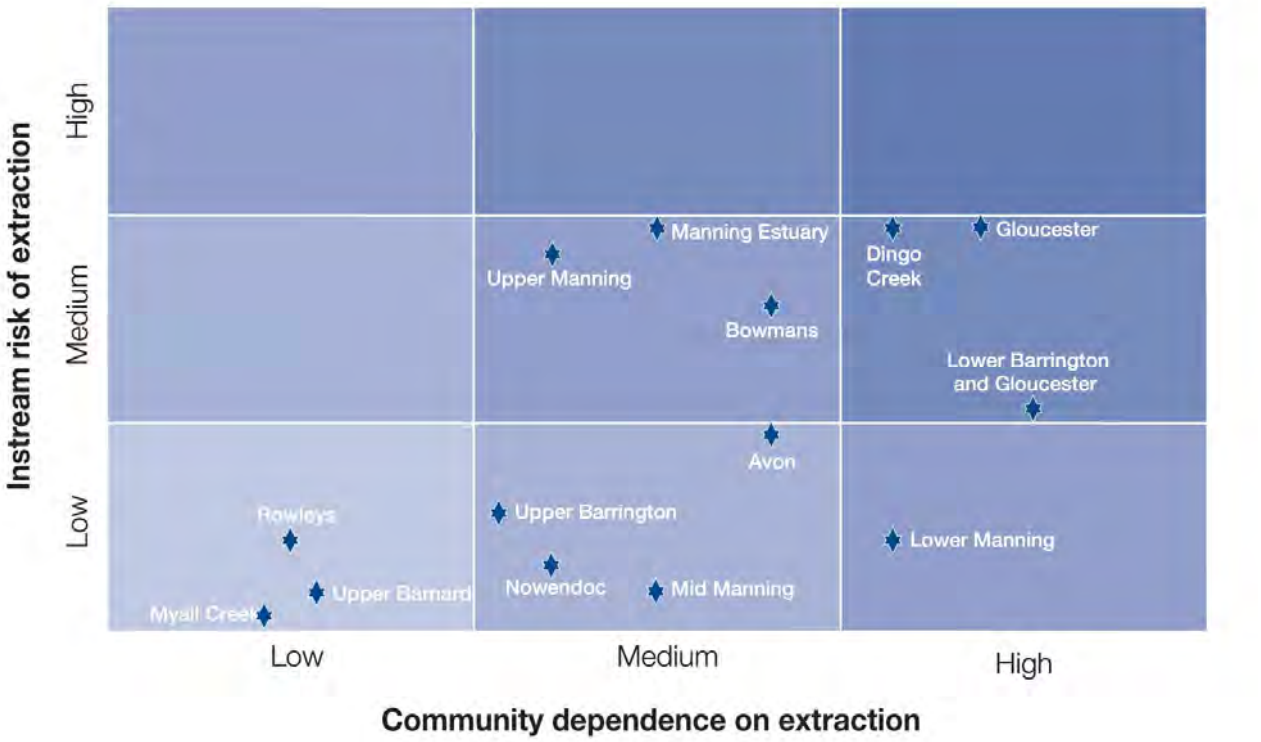
Appendix 10 Indicative access rules

The economic dependence (step 5) and instream risk (step 7) or instream value (step 3) were plotted on a risk table to determine the indicative access rules. Table A10.1 below shows an example from the Manning catchment. The maximum and minimum values on each axis are based on the catchment (spreadsheet) range, which was divided into three equal parts to indicate 'low', 'medium' and 'high' scores. Water sources plotting 'low' on the instream risk scale may nevertheless have high values, but these values were not considered to be at high risk from extraction.

Table A10.1 Pre–Interagency Regional Panel risk table from Manning catchment



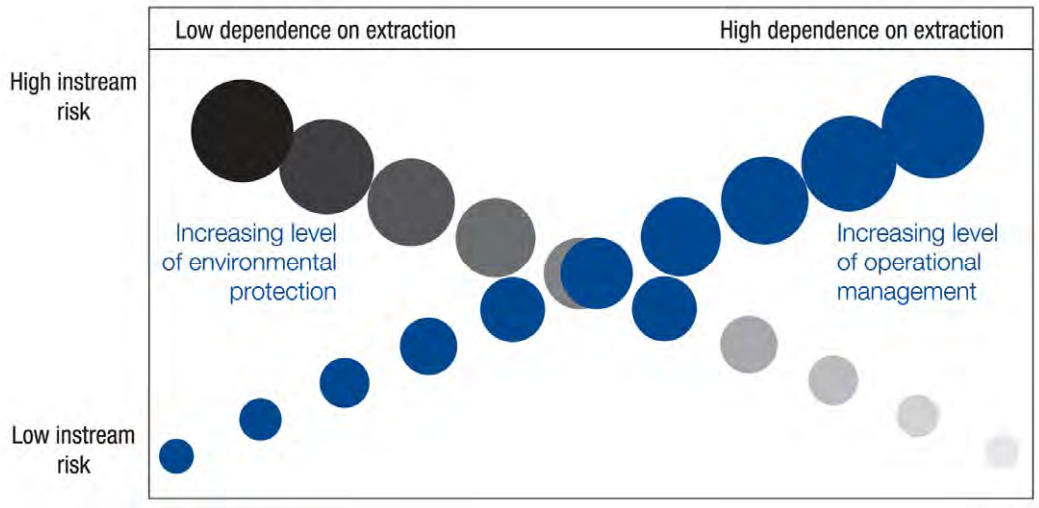
The indicative access rules aim to achieve a level of protection and management commensurate with:

- the risk to instream values from extraction
- the potential loss of economic value from reduced access
- the level of potential conflict between users.

The access rules start at the minimum environmental protection requirement, for low risk to instream value and high community dependence on extraction and progress through to higher requirements for high instream values and lower community dependence. The rules also reflect an increasing level of management, as shown in Figure A10.1. The rules give a higher level of operational management where both economic dependence and instream risk are high.

For each access rule the means of describing environmental water and protecting basic landholder rights are given in Table A10.2. Depending on climatic conditions and the amount of water extracted, the environment may receive a greater amount of water, however, this is the amount the plan identifies and establishes for the water source.

Table A10.2 Level of management and environmental protection



Tables A10.4 to A10.8 provide indicative rules for the different river types, based on the risk to instream values and community dependence on extraction. For estuaries (Table A10.8), the cumulative dependence on extraction to the estuary as a whole or part thereof was used. For ephemeral streams, where hydrologic stress is assumed to be high, instream value and community dependence on extraction were compared (Table A10.9 to A10.11).

The indicative access rules developed in Tables A10.4 to A10.11 were based on the following considerations:

- that the rules are simple and easy to implement
- the river flow objectives
- the goals as set out in step 10, Table 2.

The indicative rules tables allowed the Interagency Regional Panels to choose between hydrology-based rules (based on a flow occurring for a percentage of the time) and hydraulic-based rules (based on depth of flow at a reference point or within a particular habitat). The relative merits of these methods have been discussed in various reports, including Schofield et al. (2003).

The main benefit of the hydrology based rules is that they are inexpensive and rapid and have simple data requirements (Schofield et al. 2003). They also allow for the impact of access rules on water extractors to be readily identified. For example, a rule based on the 95th percentile would restrict access five per cent of the time. In catchments where upstream water sources are required to contribute to protecting downstream instream values, this method allows for an equitable distribution of contributions between the water sources.

The hydraulic-based rules are required in locations without stream flow records or where depth of flow can target specific species (such as fish passage) or habitat requirements. In the case of losing and connected rivers, the rules can address specific instream values (for example, a specific depth of water to allow inflows into a wetland). The impact on extractors is more difficult to determine without local knowledge or hydrology models.

‘Commence to pump’ rules achieve both environmental outcomes (such as allowing fish migration) and equity between users by allowing freshes (short term rises in river height) to reach downstream water sources.

Table A10.3 Access rules and how environmental water is defined

Rules	Environmental water			
	Gaining	**Connected**	**Losing**	**Estuarine**
Cease to pump at nominated percentile of flow at end of system.	The volume of water passing the gauging site below the specified percentile.	The volume of water passing the gauging site below the specified percentile and water in the aquifer below that water level.	The volume of water passing the gauging site below the specified percentile plus instream use to that point.	The volume of water passing the gauging site below the specified percentile less tidal pool use.
Cease to pump at nominated water depth at end of system.	The volume of water passing the gauging site below the specified height.	The volume of water passing the gauging site below the specified height and water in the aquifer below that height.	The volume of water passing the gauging site below the specified height plus instream use to that point.	The volume of water passing the gauging site below the specified height less tidal pool use.
Cease to pump at nominated pool level.	The volume of water in the pools less the volume of basic rights and exempt licence extractions (if any).	The volume of water in the pools and in the aquifer below that water level less the volume of basic rights and exempt licence extractions.	The volume of water in the pools to the specified location less the volume of basic rights and exempt licence extractions.	The volume of water in a coastal lagoon less the volume of basic right and exempted extractions.
Cease to pump at nominated groundwater level or rate of groundwater change.	Not applicable.	The volume of water in the aquifer at that depth less the volume of basic rights.	Not applicable.	Not applicable.
Commence to pump.	The volume of water passing the gauge prior to commencement of pumping.	The volume of water passing the gauge and recharging the aquifer prior to commencement of pumping.	The volume of water used to maintain ecosystems prior to reaching 'commence to pump' site.	The volume of water passing the gauge prior to commencement of pumping.
Cease to pump to maintain visible flow / prevent drawdown of natural pools	The volume of water in the pools less the volume of basic landholder rights and exempt licence extractions (if any).	The volume of water in pools and aquifer at that depth less the volume of basic landholder rights and exempt licence extractions.	The volume of water used to maintain ecosystem prior to reaching visible flow point.	No environmental water.
Basic landholder rights consideration.	If the rule reference point is at the end of the system, basic rights have been extracted before that point. If the rule point is not at end of the system, then additional basic rights should be deducted from volume of flow to give environmental water.	If the rule reference point is at the end of the system, basic landholder rights for both surface and groundwater have been extracted before that point. If the rule point is not at end of the system, then additional basic right should be deducted from volume of flow to give environmental water.	If the rule reference point is at the top of the system, then basic landholder rights, losses and extraction should be deducted from volume of flow to give environmental water.	If the rule is based on electrical conductivity, it should allow for stock and domestic purposes.

Note: Exempt licence extractions apply only to those licence holders who require very low flow access for the purposes of food safety, essential dairy care or to prevent cruelty to animals.

Table A10.4 Indicative low flow water access rules for gaining flow stream

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High risk to instream values	**LEVEL 1** • Cease to pump to maintain a specified depth of flow at end of water sources. • Specific flow rule for instream values. • Cease to pump to allow flows at or below the 80th percentile to pass end of water (specified by height or volume).	**LEVEL 2** • Cease to pump to maintain specified depth of flow at end of water sources. • Specific flow rule for instream values. and/or • Cease to pump to allow flows at or below the 90th percentile to pass end of water sources (specified by height or volume). • Environment to receive high proportion (i.e. 70% of daily flow).	**LEVEL 3** • Cease to pump to maintain specified depth of flow at end of water sources. • Specific flow rule for instream values. • Cease to pump to allow flows at or below the 95th percentile to pass end of water sources (specified by height or volume). • Environment to receive no less than 40% of daily flow share.
Medium risk to instream values	**LEVEL 2** • Cease to pump to maintain specified depth of flow at end of water sources. • Specific flow rule for instream values. • Cease to pump to allow flows at or below the 90th percentile to pass end of water source (specified by height or volume).	**LEVEL 3** • Cease to pump to maintain specified depth of flow at end of water source. • Specific flow rule for instream values. • Cease to pump to allow flows at or below the 95th percentile to pass end of water sources (specified by height or volume).	**LEVEL 4** • Cease to pump to maintain a visible flow at end of water source. • Consider specific flow rule for instream values.
Low risk to instream values	**LEVEL 3** • Cease to pump to maintain a specified depth of flow at end of water sources. • Consider specific flow rule for instream values. • Cease to pump to allow flows at or below the 95th percentile to pass end of water source (specified by height or volume). • Consideration of special cases.	**LEVEL 4** • Cease to pump to maintain a visible flow at end of water source. • Consider specific flow rule for instream values.	**LEVEL 4** • Cease to pump to maintain a visible flow at end of water source. • Consider specific flow rule for instream values.

Notes: Specific rules may be required to protect important instream values, such as the protection of habitat or passage for specific species or groups of species at particular times of the year. This may allow weir passage for spawning (e.g. cease to pump at 0.3 m for Eastern Cod to allow for fish passage in accordance with the recovery plan for this species NSW Fisheries 2002), wetland inundation or Aboriginal cultural heritage requirements.

- Rules based on percentile flow are used only where there is adequate gauging information to determine a value. If such information is required but unavailable, this fact was recorded.
- Alternate access rules may exist for extraction from pools (see step 11)
- Consideration of special cases refers to those circumstances where the introduction of flow rules may result in environmental degradation; for example, releasing water from saline storages.

Table A10.5 Indicative rules for low flow access to connected streams

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High risk to instream values	**LEVEL 1** • Cease to pump to maintain specified depth of flow at end of water source or • Cease to pump to allow flows at or below the 95th percentile to pass end of water source (specified by height or volume) and/or • Specific flow rule for instream values (e.g. no pumping from pools not protected by end of system cease-to-pump).	**LEVEL 2** • Cease to pump once the presence of water is not observed at the end of water source or • Specific flow rule relating to instream values.	**LEVEL 3** • Cease to pump for licences upstream of a strategic site once the presence of water is not observed at the site or • Cease to pump when water is not observed at pump site. • Specific flow rule for instream values.
Medium risk to instream values	**LEVEL 2** • Cease to pump once the presence of water is not observed at the end of the water source and/or • Specific flow rule relating to instream values.	**LEVEL 3** • Cease to pump for licences upstream of a strategic site once water disappears at the site or • Cease to pump when water is not observed at pump site and/or • Specific flow rule for instream values.	**LEVEL 4** • Cease to pump for licences upstream of a strategic site at a specific groundwater level at the site and • Commence to pump level at observation of visible surface water at the site or • Consider specific flow rule for instream values.
Low risk to instream values	**LEVEL 3** • Cease to pump for licences upstream of a strategic site once water disappears at the site. • Cease to pump when water is not observed at pump site or • Specific flow rule for instream values. • Consideration of special cases.	**LEVEL 4** • Cease to pump for licences upstream of a strategic site at a specific groundwater level at the site and • Commence to pump level at observation of visible surface water at the site. • Consider specific flow rule for instream values.	**LEVEL 4** • Cease to pump for licences upstream of a strategic site at a specific groundwater level at the site and • Commence to pump level at observation of visible surface water at the site or • Consider specific flow rule for instream values.

Notes:

- Connected streams refer to streams that predominantly have a sandy substrate or flow only occasionally after rain, with the bulk of extraction from wells or spear points.
- Alternate access rules may exist for extraction from pools (see step 11)
- Specific rules may be required to protect important instream values, such as Aboriginal cultural heritage or key habitat, e.g. deep pools.
- Rules based on percentile flow are used only where there is adequate gauging information to determine a value. If such information is required but unavailable, this fact was recorded.
- Consideration of special cases refers to those circumstances where the lack of extraction may result in environmental degradation; for example, saline aquifers feeding streams
- These access rules generally do not apply to town water supplies or licensed extraction for domestic and stock purposes

Table A10.6 Indicative low flow water access rules for losing flow, terminal or effluent streams

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High risk to instream values	**LEVEL 1** • Cease to pump to maintain specific depth of flow at end of water source and • Commence to pump once specified volume passes upstream control point or • Specific flow rule for instream values.	**LEVEL 2** • Cease to pump to maintain a visible flow at end of water source or • Specific flow rule for instream values.	**LEVEL 3** • Pumping is not permitted from natural pools when the water level in the pool is lower than it's full capacity, and • Cease to pump to maintain a visible flow at specific site and • Consider specific flow rule for instream values.
Medium risk to instream values	**LEVEL 2** • Cease to pump to maintain a visible flow at end of water source and • Consider specific flow rule for instream values.	**LEVEL 3** • Pumping is not permitted from natural pools when the water level in the pool is lower than it's full capacity, and • Consider a cease to pump to maintain a visible flow at specific site or • Consider specific flow rule for instream values.	**LEVEL 4** • Pumping is not permitted from natural pools when the water level in the pool is lower than it's full capacity and • Consider specific flow rule for instream values.
Low risk to instream values	**LEVEL 3** • Pumping is not permitted from natural pools when the water level in the pool is lower than it's full capacity and • Consider a cease to pump to maintain a visible flow at specific site or • Consider specific flow rule for instream values.	**LEVEL 4** • Pumping is not permitted from natural pools when the water level in the pool is lower than it's full capacity and • Consider specific flow rule for instream values.	**LEVEL 4** • Pumping is not permitted from natural pools when the water level in the pool is lower than it's full capacity and • Consider specific flow rule for instream values.

Notes: These types of streams predominantly do not flow at the end of the water source during low flows, as water is lost to either evaporation or groundwater.

- Alternate access rules may exist for extraction from pools (see step 11)
- Specific rules may be required to protect important instream values, such as key habitat, including pools or terminal wetlands.
- These access rules generally do not apply to town water supplies or licensed extraction for domestic and stock purposes.

Table A10.7 Indicative access rules for tidal pools

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High risk to estuarine values	**LEVEL 1** • Specific rule for conservation value or • Cease to pump when inflows to tidal pool are less than 80th percentile flow. • Cease to pump for tidal pool users when EC [1] reaches specified level at specified location. • Commence to pump for tidal pool users when EC reaches specified level at specified location.	**LEVEL 2** • Specific rule for conservation value or • Cease to pump for tidal pool users when EC reaches specified level at specified location. • Commence to pump for tidal pool users when EC reaches specified level at specified location.	**LEVEL 3** • Consider specific rule for conservation value or • Weekly/ monthly flow shares based on inflow and/or pool volume. • Cease to pump for tidal pool users when EC reaches specified level at specified location. • Commence to pump for tidal pool users when EC reaches specified level at specified location.
Medium risk to estuarine values	**LEVEL 2** • Specific rule for conservation value or • Cease to pump for tidal pool users when EC reaches specified level at specified location. • Commence to pump for tidal pool users when EC reaches specified level at specified location.	**LEVEL 3** • Consider specific rule for conservation value or • Cease to pump for tidal pool users when EC reaches specified level at specified location. • Commence to pump for tidal pool users when EC reaches specified level at specified location.	**LEVEL 4** • Consider whether tidal pool use requires 'cease to pump' rule based on upstream flow and/or EC levels. * See below
Low risk to estuarine values	**LEVEL 3** • Consider specific rule for conservation value.	**LEVEL 4** • Consider whether tidal pool use requires rule based on upstream flow and/or EC levels. * See below	**LEVEL 4** • Consider whether tidal pool use requires 'cease to pump' rule based on upstream flow and/or EC levels. * See below

1 EC = electrical conductivity

Notes:

- Specific rules for conservation value may include 'cease to pump to maintain EC level at specified location' or species specific flow requirement. (Note: The plans generally included a caveat provision for adaptive management to allow for incorporation of specific rules as flow requirements for conservation values are determined in the future. Any such changes are bounded.)
- EC can be measured in real time, daily, weekly or monthly depending on the rate of change of the interface and the risk to specific values.
- Variation between levels 2 and 3 is based on the location of EC readings. The lesser level is closer to the tidal limit.
- For the rule 'cease to pump when EC reaches specified level at specified location', the Interagency Regional Panels recommended possible monitoring sites.
- The panels ensured that the tidal pool rules complemented the estuary rules.

Table A10.8 Indicative flow rules for estuaries

	Low catchment dependence on extraction	Medium catchment dependence on extraction	High catchment dependence on extraction
High risk to estuarine values	**LEVEL 1** • Specific rule for conservation value. • Catchment-wide commence to pump to ensure freshes reach estuary. • Catchment-wide cease to pump when EC reaches specified level at specified location.	**LEVEL 2** • Catchment-wide commence to pump to ensure freshes reach estuary. • Specific rule for conservation value and fish passage. • Estuary to receive high proportion (i.e. 70% of daily flow at upstream gauge. • Catchment-wide cease to pump when EC reaches specified level at specified location.	**LEVEL 3** • 50% or more of medium to high flow protected. • Consider specific rule for conservation value. • Estuary to receive no less than 40% of daily flow share at upstream gauge.
Medium risk to estuarine values	**LEVEL 2** • Catchment-wide commence to pump to ensure freshes reach estuary, and/or • Specific rule for conservation value and fish passage. • Catchment-wide cease to pump when EC reaches specified level at specified location.	**LEVEL 3** • 50% or more of medium to high flow protected. • Consider specific rule for conservation value.	**LEVEL 4** • Consider whether upstream flow rules considered are sufficient for estuarine requirements.
Low risk to estuarine values	**LEVEL 3** • Consider specific rule for conservation value.	**LEVEL 4** • Consider whether upstream flow rules considered are sufficient for estuarine requirements.	**LEVEL 4** • Consider whether upstream flow rules considered are sufficient for estuarine requirements.

Notes:

- For the rule 'cease to pump when EC reaches specified level at specified location', the Interagency Regional Panels recommended possible monitoring sites.
- Rules based on percentage of flow required adequate gauging to determine a value. If such information is required but unavailable, this fact was recorded.
- Specific rules for conservation value require aspects of flow to be specifically considered; for example, adequacy and frequency of upstream freshes.
- Boxes with low risk to estuarine values are likely to be insensitive to EC changes; therefore, an EC rule was not appropriate.
- These access rules generally do not apply to town water supplies or licensed extraction for domestic and stock purposes

Table A10.9 Indicative low flow water access rules for ephemeral gaining flow stream

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High instream values	**LEVEL 1** • Consider commence to pump rule • No pumping below a specified flow level at EoS	**LEVEL 2** • Consider commence to pump rule • No pumping unless there is a visible flow at the reference point **LEVEL 3** • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 2** • Consider commence to pump rule • No pumping unless there is a visible flow at the reference point **LEVEL 3** • No drawing down of pools i.e. no pumping unless there is a visible flow into pools
Medium instream values	**LEVEL 2** • Consider commence to pump rule • No pumping unless there is a visible flow at the reference point **LEVEL 3** • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 2** • Consider commence to pump rule • No pumping unless there is a visible flow at the reference point **LEVEL 3** • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 4** • Consider allowing pools to be drawn down to a specified level.
Low instream values	**LEVEL 2** • Consider commence to pump rule • No pumping unless there is a visible flow at the reference point **LEVEL 3** • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 4** • Consider allowing pools to be drawn down to a specified level.	**LEVEL 4** • Consider allowing pools to be drawn down to a specified level.

Notes:

- Specific rules may be required to protect important instream values, such as the protection of habitat or passage for specific species or groups of species at particular times of the year. This may allow weir passage for spawning, wetland inundation or Aboriginal cultural heritage requirements.
- Between levels 2 and 3, the indicative rule will depend on whether there is an existing access rule and whether there is a stream gauge present
- Allowing pools to be drawn down is not generally permitted on the coast, but in some situations in the inland, this may be considered.
- Infrastructure limits, i.e. there are very few stream gauges in unregulated rivers which will limit rule options for ephemeral streams
- These access rules generally do not apply to town water supplies or licensed extraction for domestic and stock purposes.

Table A10.10 Indicative rules for low flow access to ephemeral connected streams

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High instream values	**LEVEL 1** • Consider commence to pump rule (other groundwater rules may also apply) • No pumping unless there is a visible flow at a specified location	**LEVEL 2** • Consider commence to pump rule • Consider specific rules to maintain long-term groundwater levels • No pumping from pools plus local impact rules **LEVEL 3** • No pumping when groundwater level[2] is below a specified level e.g. when draining aquifer has significant impacts on stream recovery	**LEVEL 2** • Consider commence to pump rule • Consider specific rules to maintain long-term groundwater levels • No pumping from pools plus local impact rules **LEVEL 3** • No pumping when groundwater level is below a specified level e.g. when draining aquifer has significant impacts on stream recovery
Medium instream values	**LEVEL 2** • Consider commence to pump rule • Consider specific rules to maintain long-term groundwater levels • No drawing down of pools plus local impact (groundwater) rules **LEVEL 3** • No pumping when groundwater level is below a specified level e.g. when draining aquifer has significant impacts on stream recovery	**LEVEL 2** • Consider commence to pump rule • Consider specific rules to maintain long-term groundwater levels • No drawing down of pools plus local impact (groundwater) rules **LEVEL 3** • No pumping when groundwater level is below a specified level e.g. when draining aquifer has significant impacts on stream recovery	**LEVEL 4** • Local impact rules only where aquifer naturally drains quickly and extraction has minimal impact on groundwater levels
Low instream values	**LEVEL 2** • Consider commence to pump rule • Consider specific rules to maintain long-term groundwater levels • No pumping from pools plus local impact rules **LEVEL 3** • No pumping when groundwater level is below a specified level e.g. when draining aquifer has significant impacts on stream recovery	**LEVEL 4** • Groundwater rules only where aquifer naturally drains quickly and extraction has minimal impact on groundwater levels	**LEVEL 4** • Groundwater rules only where aquifer naturally drains quickly and extraction has minimal impact on groundwater levels

[2]Telemetered monitoring bores may be established through the 'hydrometric network expansion' project

Notes:

- Connected streams refer to streams that predominantly have a sandy substrate or flow only occasionally after rain, with the bulk of extraction from wells or spear points.
- Specific rules may be required to protect important instream values, such as Aboriginal cultural heritage or key habitat, e.g. deep pools.
- Between levels 2 and 3, the indicative rule will depend on whether there is an existing access rule and whether there is a stream gauge present
- Practices such as allowing water users to draw down pools are generally forbidden on the coast, but in some parts of the inland this is permitted. The level 4 rules listed above acknowledge these phenomena.
- Infrastructure limits, i.e. very few stream gauges, will continue to drive access rules for ephemeral streams
- These access rules generally do not apply to town water supplies or licensed extraction for domestic and stock purposes.

Table A10.11 Indicative low flow water access rules for ephemeral losing flow, terminal or effluent streams

	Low dependence on extraction	Medium dependence on extraction	High dependence on extraction
High instream values	**LEVEL 1** • Consider commence to pump rule • EoS flow target	**LEVEL 2/3** • Consider mid-system commence to pump • Consider daily flow sharing • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 2/3** • Consider mid-system commence to pump • Consider daily flow sharing • No drawing down of pools i.e. no pumping unless there is a visible flow into pools
Medium instream values	**LEVEL 2/3** • Consider mid-system commence to pump • Consider daily flow sharing • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 2/3** • Consider mid-system commence to pump • Consider daily flow sharing • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 4** • Consider mid-system commence to pump • Consider allowing pools to be drawn down to a specified level.
Low instream values	**LEVEL 2/3** • Consider mid-system commence to pump. • Consider daily flow sharing • No drawing down of pools i.e. no pumping unless there is a visible flow into pools	**LEVEL 4** • Consider mid-system commence to pump • Consider allowing pools to be drawn down to a specified level.	**LEVEL 4** • Consider mid-system commence to pump • Consider allowing unrestricted access to pools

Notes:

- These types of streams predominantly do not flow at the end of the water source during low flows, as water is lost to either evaporation or groundwater.
- Specific rules may be required to protect important instream values, such as key habitat, including pools or terminal wetlands.
- Between levels 2 and 3, the indicative rule will depend on whether there is an existing access rule and whether there is a stream gauge present
- Between levels 2 and 3, the indicative rule will depend on whether there is an existing access rule and whether there is a stream gauge present
- Practices such as allowing pools to be drawn down are generally not permitted on the coast, but in some parts of the inland this may be considered.
- Infrastructure limits, i.e. there are very few stream gauges in unregulated rivers which will limit rule options for ephemeral streams
- These access rules generally do not apply to town water supplies or licensed extraction for domestic and stock purposes.

Appendix 11 Murray Darling Basin Ministerial Council cap units

The Murray-Darling Basin is divided into units for the administration of the cap.

The agreed MDBMC cap units for NSW are set out in Schedule F of the Murray–Darling Basin Agreement. These include:

- the NSW portion of the Border Rivers
- the NSW portion of the following river valleys: Moonie, Big Warrambool, the Culgoa–Birrie–Bokhara–Narran water supply system, Warrego, Paroo
- the Gwydir
- the Namoi
- the Macquarie–Castlereagh–Bogan water supply system
- the Barwon–Upper Darling water supply system and the Lower Darling from the furthest upstream reach of the Menindee Lakes to the furthest upstream reach of the Wentworth Weir Pool
- the Lachlan
- the Murrumbidgee
- the NSW portion of the Murray Valley, including the portion of the Lower Darling influenced by the Wentworth Weir Pool.

A cap unit may cover the same area as a macro water sharing plan (excluding regulated sections) (for example, the Gwydir), or cover several macro water sharing plan areas (for example the Castlereagh, Macquarie and Bogan macro water sharing plans).

The basis for the extraction limit for unregulated rivers is the usage information from the volumetric conversion process (DNR 2000). This is the only objective method for determining the likely usage in 1993–94 and assumes no growth in use between 1993 and 2000.

The extraction limit established by the macro water sharing plan will be managed at the extraction management unit (EMU) level. These EMUs were mostly determined in the first round of unregulated water sharing plans and include:

- Border Rivers unregulated rivers
- Gwydir unregulated rivers
- Namoi unregulated rivers
- Castlereagh valley
- Lachlan unregulated
- Murrumbidgee unregulated rivers
- Unregulated Billabong.

Glossary

Aquatic macroinvertebrates: Animals without backbones, including worms, insects, shrimp. Macroinvertebrates are large enough to be seen by the naked eye.

AUSRIVAS: The Australian River Assessment System (AusRivAS) is a nationally standardised approach to biological assessment of stream condition using macroinvertebrates that was developed under the auspices of the National River Health Program.

Barrier estuaries: Form when sand is deposited in the estuary to form a large delta and sand flats, often with long, winding channels (Underwood 2000).

Bioregion: An area defined by a combination of biological, social and geographic criteria.

CAMBA: As defined by the *Water Act 2007*.The China Australia Migratory Bird Agreement is a treaty between Australia and China to minimise harm to the major areas used by birds which migrate between the two countries.

Connectivity: Refers to the capacity of instream biota to move longitudinally in a river system and not be impeded by barriers (e.g. weirs, dams, culverts). Connectivity is important for instream aquatic processes and biota and the conservation of natural riverine systems.

Conversion factor: The adjustment factor that can be used when transferring between water sources to reflect different levels of reliability.

Critical habitat: Areas of habitat (land or water) that is crucial to the survival of particular threatened species, populations or communities.

Cumulative impact: The combined measure of all surface water extraction.

Domestic and stock rights: As defined by the *Water Management Act 2000*

Drowned river valley: Narrow estuaries with steep sides. They are common on the central NSW coast.

Ecological values: The intrinsic or core attributes associated with naturalness, diversity, rarity and special features, but excluding representativeness used to classify water sources for apportioning water management rules. The natural significance of ecosystem structure and functions is expressed in the terms written in italics.

Effluent stream: A stream that leaves a watercourse and does not return to it.

Electrical connectivity (EC): The ability of water (or any other solution) to conduct an electrical current on account of high levels of salts (dissolved ions) present. The most common measure of salinity used is expressed as microsiemens per cm (µS cm^{-1}).

Endangered ecological communities: Ecological communities listed in Schedule 1 of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.

Endemism: A term applied to species restricted to a particular geographic area or ecological unit. Usually occurs in areas that are isolated in some way.

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

Extraction limit: A limit on the amount of water that may be extracted from the extraction management unit. It is defined as a Long-Term Annual Extraction Limit (LTAEL).

Extraction management unit (EMU): A single water source or group of water sources; defined for the purpose of managing long-term annual average extraction.

Extraction of water: Removal of water from a river for off-stream or consumptive use.

Farm dam: A privately owned dam typically of earthen construction designed to collect and store water for use on a property. It does not include publicly owned dams or weirs.

Flow classes are categorised by the size and duration of flow levels in unregulated rivers, for example:

a) very low flows may be a class on their own
b) low flows may be categorised as 'A' class
c) moderate flows may be categorised as 'B' class
d) high flows may be categorised as 'C' class.

Flow gauging station: A device used to measure the height of a river, from which the flow in the river can be calculated.

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

Gross margin: The gross income from an enterprise less the variable costs incurred in production.

Harvestable rights: As defined by the *Water Management Act 2000*

Hyper-salinity: Having salinity greater than seawater, generally caused through evaporation.

Instream refuge habitat: Stream habitat containing pools that retain water for longer periods of time during drought and low flow. Instream biota will migrate to these more permanent habitats to survive.

Integrated Quantity and Quality Model: A hydrologic modelling tool developed by the then NSW Department of Natural Resources (now the NSW Office of Water), with collaborative assistance from the Queensland Department of Natural Resources, Mines and Water (NRMW). It is intended for use in investigating the impacts of water resource management policies or policy changes on stakeholders.

JAMBA: As defined by the *Water Act 2007*. The Japan Australia Migratory Bird Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment.

Land Board: Under the *Water Act 1912*, water licence appeals were referred to a Land Board, a community-based tribunal with an independent chairman and two local community members.

Management zone: An area within a water source used for defining the location of applicability of water sharing rules, but secondary to the water source. A management zone is more likely to be designated where local dealing restrictions are in place or where 'cease to pump' rules for works approvals apply.

Mandatory conditions: Those conditions as are from time to time required to be imposed on the access licence or approval by the relevant management plan or Minister's plan.

National Water Initiative: As defined by the Water Act 2007. The National Water Initiative (NWI) is Australia's blue print for national water reform. The Agreement has been signed by all governments.

Pools: Lentic water bodies (standing water), including anything falling within the definition of a "lake" found in the Dictionary of the *Water Management Act 2000,* except for tidal pools and estuaries.

Riparian: Relating to or living or located on the bank of a natural watercourse, such as a river or stream.

River Styles Framework: A regional-scale method for defining river types based on geomorphic characteristics.

Rule reference point: The location at which flow, water level height, salinity etc are read for the purpose of the access rules.

Saline coastal lagoons: Coastal lagoons cut of from the sea by a barrier of sand. They are non-tidal and contain brackish water or seawater (Underwood 2000).

Salinity: The total mass of dissolved salts per unit mass of water. Seawater has a salinity of about 35 g/kg or 35 parts per thousand.

Staff gauge: A simple device for reading river height against a graduated scale attached to a post or the side of a bridge.

Total daily extraction limit: The volume of water that may be extracted daily under access licences from an unregulated river in a particular flow class.

Tidal exchange: The amount of water moved between an estuary and the ocean over a tidal cycle.

Tidal limit: The most upstream location where a tidal rise and fall of water is discernible.

Visible flow: The continuous downstream movement of water that is perceptible to the eye.

Volumetric conversion: The process whereby area limits are replaced with volumetric conditions.

Water source: As defined by the *Water Management Act 2000*. The area primarily used for defining the location of applicability of water sharing rules. Water sources are generally used to designate where share entitlement limits may be applicable and where total daily extraction limits are defined. Water sources are likely to be made up of part of or one or more sub-catchments.

Yield: The amount of water that can be supplied in a specified interval of time.

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