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National Water Commission

Alignment of water planning and catchment planning

Mark Hamstead

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Waterlines

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Waterlines

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The maps in this report were prepared by Lucy Parsons of the NSW Office of Water, using data held by the NSW Office of Water, the Hunter–Central Rivers Catchment Management Authority and the NSW Department of Environment, Climate Change and Water.

Abbreviations and acronyms

CAP	Catchment action plan (NSW)
CMA	Catchment management authority (NSW)
COAG	Council of Australian Governments
CRG	Hunter–Central Rivers Community Reference Group
DECCW	NSW Department of Environment, Climate Change and Water
FARWH	Framework for the Assessment of River and Wetland Health
GCI	Geomorphic condition index
HCRCMA	Hunter–Central Rivers Catchment Management Authority
HSI	Hydrologic Stress Index
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
MER	Monitoring, evaluation and reporting
NRC	Natural Resources Commission
NRM	Natural resource management
NRVI	Native riparian vegetation index
NSW	New South Wales
NWC	National Water Commission
NWI	National Water Initiative
Office of Water	NSW Office of Water
Phase 1	Phase 1 of the Integration of Water Planning and Catchment Planning (NSW) project, being the development of a draft framework for integration.
Phase 2	Phase 2 of the Integration of Water Planning and Catchment Planning (NSW) project, being the trial of the framework developed in Phase 1 in the Hunter River catchment.
RBCI	River biodiversity condition index
RCI	River condition index
WSP	Water Sharing Plan (NSW)

Executive Summary

Introduction

All Australian jurisdictions (states and territories) have planning processes:

- to manage and share surface water and groundwater resources, predominantly through regulation, that result in plans that are variously called water sharing plans, water management plans, water allocation plans and other names. They may consist of one or multiple instruments. For the purpose of this report they are referred to as *water allocation plans*
- to maintain and improve the condition of land and water resources and ecosystems through investment, that result in plans that are referred to as catchment management plans, catchment action plans or natural resource management (NRM) plans. For the purpose of this report they are referred to as *catchment plans*.

While these two separate planning processes serve different purposes, there is an area of overlap, with both processes including provisions to maintain or improve the condition of freshwater aquatic ecosystems (rivers, aquifers, wetlands, etc.).

Achieving aquatic ecosystem outcomes is often dependent on many factors—for example, the condition of a river can be affected by a combination of such things as altered flow regime, channel modification, poor water quality, introduced exotic flora and fauna, loss of riparian vegetation, stock access, instream obstructions to fish passage, catchment disturbance and climate change. Often, addressing only one of them will not achieve the intended result and may in fact be ineffective because of inaction in addressing the others. Protecting low flows to preserve instream habitat may be ineffective if, for example, the habitats are destroyed by stock access or degraded water quality. Thus, there is a need to consider all the threats together and develop coordinated plans of action.

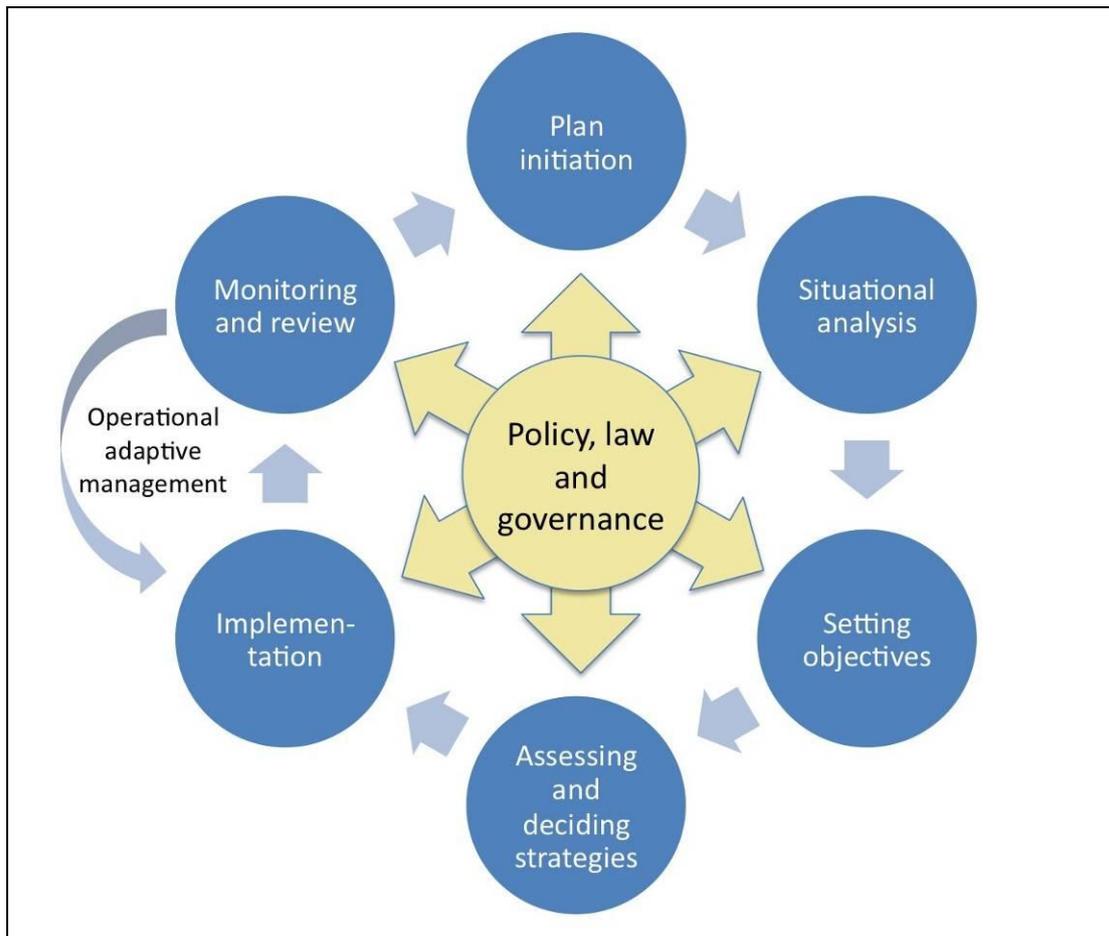
Although overlapping, these plans serve different purposes and large-scale institutional change would be required to combine them. This report therefore considers how to achieve a more integrated approach by improving the alignment of these existing processes, with minimal change to institutions and legislation.

Alignment in this report is taken to mean *the alignment of planning and coordination of action so as to deliver the maximum return for regulation and investment*. Within any planning area some ecosystems are more highly valued than others, some are more under threat than others, and some have greater potential for protection or recovery from damage. Alignment requires action to be planned and coordinated to take these factors into account so as to focus investment and maximise natural resource outcomes. As both types of planning processes require considerable resourcing, and as government and community resources are limited, improved alignment can increase the return on investment by minimising duplication and increasing synergy. This will improve community respect for and confidence in the plans and the regulatory and investment actions that derive from them, and the government agencies responsible.

The need to improve integration of water allocation and catchment planning within each jurisdiction was identified by the National Water Commission as a key issue for implementation under the National Water Initiative. This report is the final output of the Integration of Water Planning and Catchment Planning (NSW) project, developed in response to this issue. It sets out principles for aligning water allocation and catchment plans that can be applied, with some local variations, in any Australian jurisdiction. A case study is included to illustrate how this might be done.

Framework for alignment of water allocation and catchment plans

The framework was developed by identifying and assessing what could be done to achieve alignment during each of the generic planning steps outlined in Hamstead et al. (2008), as shown in the following figure.



Generic planning framework

The framework assumes that water allocation and catchment plans are developed separately but have a common element in that they seek to maintain or improve the condition of freshwater aquatic ecosystems. It assumes that the timing for making and reviewing these plans is not necessarily synchronised, and that responsibility for this may be with different agencies.

The framework does not mandate or require that all of the principles be adhered to, but proposes that the more that they are the greater the likelihood of better aquatic ecosystem outcomes, and of efficient and effective use of government and community resources. The cost and benefits of implementing each principle, however, should be considered in each case, as they will vary from jurisdiction to jurisdiction.

The framework consists of the following principles (in summary):

Policy, law and governance

1. Jurisdictional legislation and policy should allow, and preferably facilitate, alignment of water allocation and catchment planning.
2. There should be jurisdictional policies and objectives for managing freshwater aquatic ecosystems that apply to both types of plans.
3. There should be governance arrangements to support ongoing coordination between relevant agencies at a state and regional level in developing plans and implementing actions that contribute to shared objectives.

4. There should be common guidelines for methods and procedures for shared or linked aspects of planning and management.

Plan initiation and situational analysis

5. There should be an ongoing, coordinated approach to community engagement and input that respects the time and contribution of common stakeholders.
6. Spatial coverage of plans should be aligned.
7. Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process.
8. Spatial representation of assessments should be sufficiently detailed to inform within-region prioritisation decisions for both types of plans.

Resource and ecosystem objectives

9. A paired program logic mapping for both planning processes in each region should be developed and include shared freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined priorities to protect and restore freshwater aquatic ecosystem assets.

Identifying, assessing and deciding strategies

10. Strategies and management targets built into plans should reflect shared assessments of risks, built on shared priorities set out in aquatic ecosystem objectives.

Implementation

11. Plans should provide flexibility to adapt management actions when opportunities arise for coordinated action to improve the condition of aquatic ecosystems or to address previously unidentified risks to them.
12. Information needed to inform case-by-case consent and investment decisions affecting the achievement of shared objectives should be available to agencies in a readily usable form (e.g. detailed spatial mapping on accessible systems).

Monitoring and review

13. Aquatic ecosystem condition monitoring should be shared and occur in a coordinated manner, making the most efficient use of cross-agency skills and resources.
14. Reviews of the effectiveness of plans in achieving aquatic ecosystem objectives should include an assessment of cross-plan alignment and coordination in achieving optimal return on investment.

Application of the framework—a case study

Trialling of several mechanisms to implement the framework in the Hunter Valley, New South Wales, was done as part of the project and is presented as a case study. The key learnings from the trial are set out in the following table.

In New South Wales, catchment plans are called catchment action plans (CAPs) and are 10-year plans developed by catchment management authorities (CMAs) to ensure proper management of natural resources in the social, economic and environmental interests of the state through coordinating activity and investment. Each CMA prepares a single CAP for its area.

Water allocation plans are called water sharing plans (WSPs) and are developed by the NSW Office of Water. WSPs aim to provide for the sustainable management and use of water resources by regulating water extraction and constructing and using water infrastructure. They have a fixed, 10-year life and are prepared for any specified surface or groundwater resources. Typically, there are several WSPs within a CAP.

Table 1: Summary of key learnings from the trial of the framework

<i>Framework principles</i>	<i>Mechanisms trialled</i>	<i>Key learnings</i>
3	<p><i>Regional coordination.</i> Create a regional interagency aquatic theme team—based on existing CAP aquatic theme team and former regional agency macro-water sharing panel—to coordinate shared assessments and other matters.</p>	<p>Regional aquatic theme interagency coordinating groups are feasible to implement and can deliver real benefits in terms of improving natural resource outcomes and leveraging much greater return from existing agency skills and investments.</p> <p>Most will be gained if the full range of relevant agencies is represented, if there is continuity of members involved so as to establish networks and if the members have sufficient influence within their agencies to enable access to broader skills and resources—and by implementing shared products and processes.</p> <p>The success of such groups relies on the commitment of the agencies to staffing and supporting them. This is most likely to occur if meetings are limited and tightly managed to deliver outputs, and are sharply focussed on areas where benefits are to be gained for the accountabilities of all participants.</p>
7, 8, 12, 13	<p><i>River condition index.</i> Develop a spatially mapped river condition index (RCI), based on River Style condition assessment, combined with the hydrologic stress assessment from the macro-WSPs.</p>	<p>In New South Wales, it is feasible and relatively low cost to construct RCI maps for most of the state, using largely existing datasets and an approach consistent with the national Framework for Assessment of Riverland and Wetland Heath (FARWH) methodology. Some additional technical work and plugging of dataset gaps is required.</p> <p>Importantly, the datasets can be updated cost effectively to assess change in condition over time. This can be done incrementally, focusing on areas where activity and changes are occurring, and comprehensively on a periodic basis (five or 10-yearly, say).</p> <p>Preparing maps showing the RCI at a river-reach scale is preferred, as this is the scale of onground actions and is easily aggregated to larger units for reporting at regional and state level. It is also easily combined with other information at this scale for other purposes (as shown in subsequent sections).</p> <p>In the trial, the regional Interagency Aquatic Theme Team enabled cross-agency discovery and shared use of a large body of datasets being collected by different agencies for different purposes.</p> <p>However, if appropriate datasets are not already being captured for other purposes, gathering this information would make a similar RCI elsewhere more expensive.</p> <p>The RCI can be used to objectively measure progress in improving the condition of water ecosystems for CAPs, WSPs and state NRM objectives and targets.</p>

<i>Framework principles</i>	<i>Mechanisms trialled</i>	<i>Key learnings</i>
7, 8, 12	<p><i>Acquiring community values.</i> Test a methodology for assessing community values for aquatic ecosystems, using the Hunter–Central Rivers Community Reference Group (CRG) as a trial focus group.</p>	<p>Collecting meaningful information on community values for natural resources can be done and readily distilled into map form.</p> <p>The workshop method tested is workable, subject to a range of identified refinements to improve its efficiency and focus.</p> <p>Several types of values, e.g. those associated with biodiversity, are better done through technical processes, with the community perhaps having an opportunity to review them. The main focus should be on social, cultural and instream economic values.</p> <p>It is important to ensure that information collection covers the scope of the community, both geographically and in terms of different types of interests.</p> <p>Concrete engagement of the community in identifying values had the additional benefit of increasing its understanding of the complexity of natural resource management and its confidence that its values are being incorporated into the process.</p> <p>Collecting this information can be expensive. The trial tested only one approach, and did not compare it to other methods for efficiency and effectiveness. Further work is needed before recommending a preferred approach for broader adoption in New South Wales.</p>
7, 8, 12	<p><i>River value assessment.</i> Develop a spatially mapped river-value assessment, based on macro-WSP assessments, updated through CMA community consultation and any other information sources.</p>	<p>In New South Wales, the trial demonstrated that detailed maps of instream value for rivers can be assembled, using information from existing data collection programs. However, the method needs further development and there are gaps in data to be addressed.</p> <p>The method for collecting instream values needs to be a combination of scientific/technical assessment and community consultation. Generally speaking, ecological aspects of value may be best prepared through scientific analysis, whereas other values (recreation, cultural, etc.) may be better identified through community consultation. Additional input from government agencies on such things as important fishing areas may also be readily obtainable.</p> <p>It is important to separate value associated with extraction of water from instream value, as it is essentially the instream value that is needed to align CAPs and WSPs.</p> <p>Preparing value maps at a river-reach scale is preferred. The main, practical use of value maps is to contribute to risk maps that guide action, and the river reach is the scale of onground actions.</p> <p>As with the RCI, the regional Interagency Aquatic Theme Team enabled cross-agency discovery and shared use of datasets being collected by different agencies for different purposes.</p>

<i>Framework principles</i>	<i>Mechanisms trialled</i>	<i>Key learnings</i>
7, 8, 12	<p><i>River risk assessment.</i> Develop a spatially mapped river risk assessment, based on river-style recovery potential and geomorphic condition assessment, combined with the risk to instream value assessment from the macro-WSPs.</p>	<p>A risk assessment at a river-reach level was constructed and shown to be feasible for most of New South Wales for a relatively low cost, based largely on existing data collection programs. Further work to improve datasets and take account of land tenure is possible at relatively low cost.</p> <p>Risk assessments at a river-reach level provide a meaningful and supportable basis to prioritise and guide actions under WSPs and CAPs and other related activities—for example, to provide input into local government land-use planning and development approval decisions.</p> <p>The trialled risk assessment is built on two types of threats: the physical disturbance of the river and associated catchment, and water extraction. The assessment of the likelihood of damage from physical disturbance was based on scientific work that assesses stream fragility and recovery potential. This is generally applicable and can be derived from River Styles assessments that are expanding in New South Wales. It represents a ‘resilience’-based approach to risk assessment.</p> <p>The assessment of the likelihood of damage from water extraction in the unregulated rivers was based on likely change to low flows. This is appropriate in coastal and upland catchments, but would need to be added to in the drier inland to represent where extraction from moderate to higher flows is significant.</p> <p>The risk assessment is reliant also on the integrity of the value-assessment information discussed previously.</p>
9, 10	<p><i>Alignment of objectives and strategies.</i> Develop revised objectives and strategies in the CAP and WSPs that reflect shared, within-regional priorities, based on value and risk assessments.</p>	<p>Both WSPs and CAPs have objectives/outcomes/targets at different levels, strategies/actions and monitoring/reporting, all off which are explicitly or implicitly linked. By explicitly drawing out and documenting these in program logic charts, it is possible to identify how the plans can be aligned to better achieve shared objectives. The Commonwealth has a framework for program logic that is applied to NRM programs across Australia and can be used for this purpose.</p> <p>This alignment can be achieved by redesigning the existing objectives and strategies so as to refer to shared risk-assessment maps. It can be done without losing the original intent of the objectives, simply by refocusing them on shared priorities for action. Additionally, the shared-condition index provides a common basis for monitoring achievement of outcomes at this level.</p> <p>The result of applying this is regulation and investment that is focused on where it will result in the greatest gain in terms of natural resource outcomes, plus reduced duplication in plan development through use of shared condition, value and risk assessments, and a shared, more rigorous monitoring scheme.</p>

In summary, in relation to applying the framework in New South Wales, the trial determined:

- the feasibility of using a regional, interagency coordinating group, and its potential value in terms of improving natural resource outcomes and leveraging much greater return from existing investments by agencies
- that it is possible to develop detailed maps of river condition, value and risk using available information, and that these have a range of potential beneficial uses
- that aligning objectives and strategies between NSW CAPs and water sharing plans, using a combined aquatic health program logic and risk-based action priority maps, is achievable.

At a more general level, the trial showed that:

- developing a shared, spatially expressed approach to river ecosystem condition, value and risk assessment is the key underpinning for most of the alignment principles
- robust state and regional-level mechanisms for cross-agency coordination and cooperation are essential
- the presence of state-driven aquatic ecosystem objectives to which both types of plans and the responsible agencies were expected to contribute provided a focus under which alignment could be built
- the development of linked program logics for each type of plan is feasible and provides a coherent and logical framework for constructing plans that is defensible and demonstrates alignment
- the realisation by agency staff that the potential benefits of alignment for their own accountabilities are real and significant engendered enthusiasm to contribute time and resources, and to make accommodating adjustments.

Conclusion

Overall, the framework, if applied, has the potential to substantially improve water ecosystems and the return on government investment in catchment and water planning, and in related activities such as monitoring and assessment programs.

The trial demonstrated that, while all of the framework principles are relevant, the following are likely to make the biggest difference and drive the achievement of most of the other principles:

2. There should be jurisdictional policies and objectives to manage freshwater aquatic ecosystems that apply to both types of plans.
3. There should be governance arrangements supporting ongoing coordination between agencies at a state and regional level in developing plans and implementing actions that contribute to shared objectives.
7. Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process.
8. Spatial representation of assessments should be sufficiently detailed to inform within-region prioritisation decisions for both types of plans.
9. A paired program logic mapping for both planning processes in each region should be developed and include shared freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined priorities to protect and restore freshwater aquatic ecosystem assets.

Finally, the approach to developing the framework could be used to develop similar principles to align other plans with common outcomes.

1. Introduction

1.1. Water allocation planning and catchment planning in Australia

All Australian jurisdictions (states and territories) have planning processes:

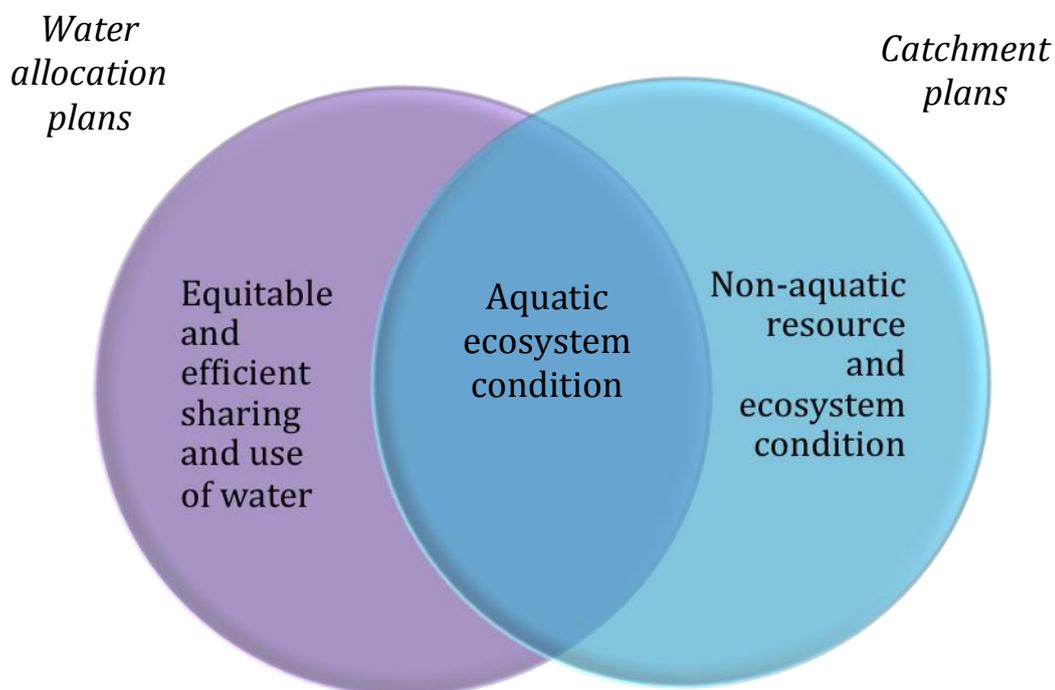
- to manage and share surface water and groundwater resources through regulation and investment
- to maintain and improve the condition of land and water resources and ecosystems through investment.

The first process results in plans that are variously called water sharing plans, water management plans, water allocation plans and other names. They may consist of one or multiple instruments. For the purpose of this report they are referred to as *water allocation plans*.

The second process results in plans that are referred to as catchment management plans, catchment action plans or natural resource management plans. For the purpose of this report they are referred to as *catchment plans*.

While these separate planning processes serve different purposes, there is an area of overlap. Both include provisions to maintain or improve the condition of freshwater aquatic ecosystems (rivers, aquifers, wetlands, etc.). The purposes of these two types of plans are broadly illustrated in Figure 1.

Figure 1: Overlap between water allocation plans and catchment plans



In Australia the two types of planning processes are mostly managed by different government agencies within each jurisdiction.

1.2. Integration through alignment

Achieving aquatic ecosystem outcomes is often dependent on many factors. For example, the condition of a river can be affected by a combination of such things as:

- altered flow regime
- channel modification
- poor water quality
- introduced exotic flora and fauna
- loss of riparian vegetation
- stock access
- instream obstructions to fish passage
- catchment disturbance
- climate change.

Often, addressing only one of them will not achieve the intended result and may in fact be ineffective because of inaction in addressing the others—for example, protecting low flows to preserve instream habitat may be ineffective if the habitats are destroyed by stock access or degraded water quality. Thus, there is a need to consider all the threats together and to develop coordinated plans of action.

Dictionary definitions of ‘integration’ indicate that it means a unifying or bringing together into a whole. However, integration can be achieved through a range of approaches, from simply establishing linkages between parallel processes to improve alignment, to combining processes into one.

Although overlapping, these plans serve different purposes and large-scale institutional change would be required to combine them. This report therefore considers how to achieve a more integrated approach by improving alignment of these existing processes, with minimal change to institutions and legislation.

The focus for alignment is on the overlapping area of managing freshwater aquatic ecosystems. Therefore the report does not consider aspects of catchment plans relating to other themes, such as vegetation and land use, unless they impact on the health of aquatic ecosystems. Nor does it consider aspects of water plans that relate to equitable and efficient sharing of water.

Alignment in this report is taken to mean *the alignment of planning and coordination of action so as to deliver the maximum return for regulation and investment*. Within any planning area some ecosystems are more highly valued than others, some are more under threat than others and some have greater potential for protection or recovery from damage. Alignment requires action to be planned and coordinated to take these factors into account to yield the maximum benefits.

As each type of plan has additional matters to address besides the common area of the condition of aquatic ecosystems, it is appropriate that alignment should guide action in the area of overlap, but still allow those planning processes flexibility to take account of other matters. For example, a water-allocation planning process has to weigh up the requirements and benefits of extracting water against those of leaving it in the ecosystem, and a catchment plan has to prioritise between investing in aquatic ecosystems and in other areas such as non-aquatic soil and vegetation management.

1.3. Benefits of good alignment

The condition of aquatic ecosystems is dependent not just on water management or land-use management, but on both. On the one hand, action in one area may be defeated by inaction

in another. On the other, action in one area can be greatly enhanced by coordinated action in another. Good alignment can address this.

Additionally, because of the overlap in planning processes, the potential for duplication can be eliminated and agency resources/processes/knowledge can be shared to produce a greater return on investment, particularly in regard to monitoring and reporting on aquatic ecosystem condition, value and risks, and on research and assessment.

Lastly, better alignment improves community respect for and confidence in the plans and the regulatory and investment actions that derive from them, and the government agencies responsible. It does this by demonstrating unity in approach and objectives; efficiency and effectiveness in use of community and government resources; and greater integrity in the decisions embodied in the plans.

1.4. Barriers of good alignment

Catchment plans and water allocation plans exist independently of each other. In other words, each type of plan would be prepared and implemented whether or not the other is prepared. They have separate origins, being put in place to address different issues:

1. catchment plans exist primarily to justify and guide investment of state/territory and Commonwealth funding in improved natural resource condition
2. water allocation plans exist to provide for sustainable management and use of water.

Flowing from this, barriers to alignment include:

3. plans being frequently prepared by different agencies where accountabilities drive production of the particular type of plan and alignment with plans by other agencies is a lesser priority
4. lack of understanding of the benefits of alignment and how to achieve it
5. geographic scales of plans being frequently different
6. unsynchronised timings for making and reviewing plans
7. statutory requirements that can make alignment difficult
8. limited funds to develop and implement tools to allow alignment.

This report assumes that institutional and legal changes will be minimal and that the actions needed for alignment must be within current agency resourcing levels to maximise the feasibility of implementation. Thus, there is a heavy reliance on interagency and interpersonal commitment and cooperation. There is a risk that short-term imperatives or differences of opinions between influential staff could lead to a reversion to plans being developed within institutional silos.

Overcoming these barriers needs a concerted effort to develop and implement tools and protocols for alignment. The returns for each agency in improved performance in their areas of accountability, and for the jurisdiction as a whole, must be worth the effort and investment required. However, as is shown in the case study, the benefits are there and the barriers are surmountable.

1.5. Integration of water allocation and catchment planning project

The need to improve the integration of water allocation and catchment planning within each jurisdiction was identified by a review (Hamstead et al. 2008) commissioned by the National Water Commission (NWC) as a key issue for implementing the National Water Initiative (NWI). The review noted that the jurisdictions are working to integrate water allocation, catchment and urban water-supply planning, but much improvement is possible. The 2009

Biennial Assessment of National Water Initiative implementation (NWC 2009) found progress to be slow in all jurisdictions.

This report is the final output of the Integration of Water Planning and Catchment Planning (NSW) project, developed in response to this issue. The project consisted of:

Phase 1: Developing a draft framework for integration to inform new and revised catchment and water allocation plans. Recommending how it might be implemented in New South Wales.

Phase 2: Trialling the framework in the Hunter Region to assess feasibility, costs and benefits.

Phase 3: Preparing a final report (this report) for a national audience.

The project was initiated by the former Land & Water Australia following discussions with NSW agencies and jointly funded by the NWC and the following NSW state agencies: the Department of Environment, Climate Change and Water (DECCW), the Office of Water, the Department of Planning, the Natural Resources Commission and the Hunter–Central Rivers Catchment Management Authority (HCRCMA). The project was directed by a joint agency steering committee and staff from the NSW agencies provided direct input, particularly during Phase 2. Hamstead Consulting prepared the draft framework, contributed to Phase 2 and prepared the final report under the direction of the steering committee.

While the focus of the project was on aligning water allocation and catchment plans, consideration was given as to how local government land-use, floodplain and environmental water planning might also be better aligned to deliver improved aquatic ecosystem outcomes.

1.6. Purpose of this report

This report sets out principles for aligning water allocation and catchment plans that can be applied, with some local variations, in any Australian jurisdiction. A case study of applying the principles to water allocation and catchment planning in New South Wales is included to illustrate how this might be done.

While the framework is tailored to water allocation and catchment plans, it is envisaged that it could be readily adapted to align other NRM planning processes where there are areas of overlap.

2. Framework for alignment of water allocation and catchment planning

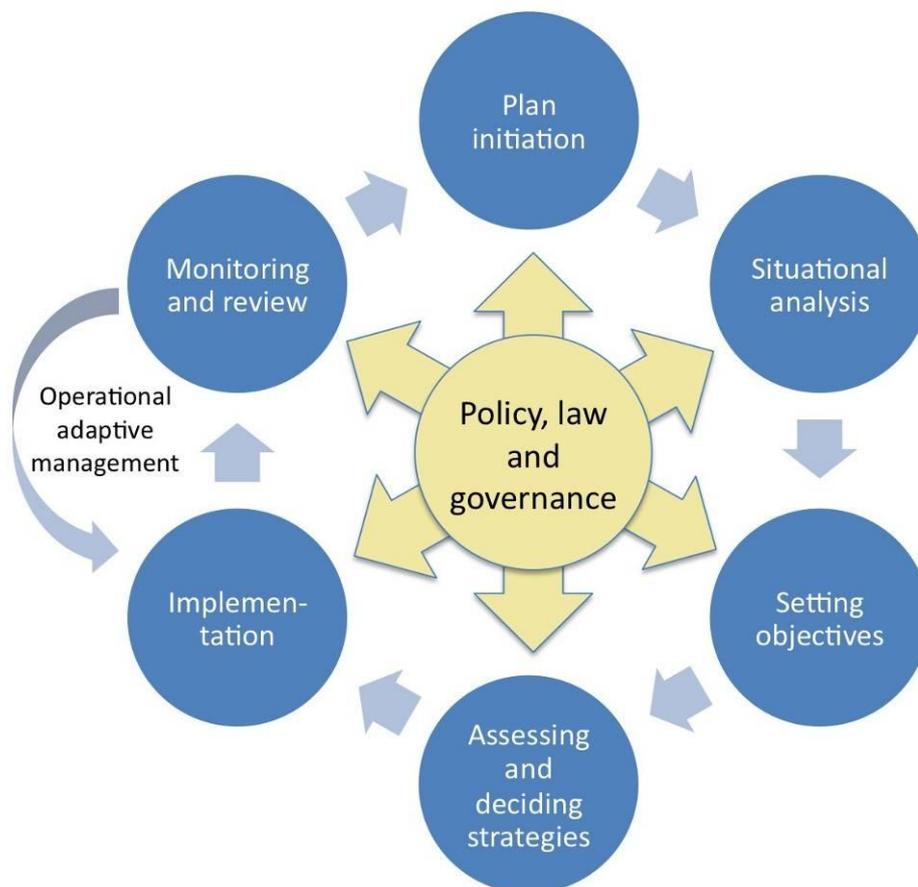
2.1. Basis for the framework

The framework was developed by identifying and assessing what could be done to achieve alignment during each of the generic planning steps outlined in Hamstead et al. (2008). With some adaptation, these steps are:

1. plan initiation
2. situational analysis
3. setting objectives
4. assessing and deciding strategies
5. implementation
6. monitoring and review.

These are underpinned by policy, law and governance arrangements.

Figure 2: Generic planning framework



The framework assumes that water allocation and catchment plans are developed separately, but have a common element in that they seek to maintain or improve the condition of freshwater aquatic ecosystems. It assumes that the timing of making and reviewing these plans is not necessarily synchronised, and that the responsibility for this may be with different agencies.

The framework does not mandate or require that all of the principles be adhered to but proposes that the more that are, the greater the likelihood of better aquatic ecosystem outcomes and of efficient and effective use of government and community resources. However, the cost and benefits of implementing each principle should be considered in each case, as they will vary from jurisdiction to jurisdiction.

2.2. Framework principles

2.2.1. Policy, law and governance

Each jurisdiction currently has legislation, policies and governance/institutional arrangements that together enable water management. To support alignment of plans, the following should apply:

1. Jurisdictional legislation and policy should allow, and preferably facilitate, alignment of water allocation and catchment planning.
2. There should be jurisdictional policies and objectives to manage freshwater aquatic ecosystems that apply to both types of plans.
3. There should be governance arrangements to support ongoing coordination between agencies at a state and regional level in developing plans and implementing actions that contribute to shared objectives.
4. There should be common guidelines for methods and procedures for shared or linked aspects of planning and management that would apply to implementing many principles that follow—for example, shared aquatic ecosystem condition, value and risk assessment; information collection and management; setting objectives; community engagement; spatial mapping; and conducting reviews of effectiveness in achieving common freshwater aquatic ecosystem objectives.

2.2.2. Plan initiation and situation analysis

Plan initiation involves determining the scale and scope of the proposed plan; the planning horizon; identifying stakeholders, their issues and concerns; developing an engagement plan for stakeholders; assessing the current state of knowledge and knowledge gaps; lining up resources needed; and the formal start of the plan-development process.

During any natural resource planning process, there is normally an initial situational assessment phase, when information on the current state of the resource, issues, threats, pressures, opportunities, risks, etc. is gathered and considered. While data collection is ongoing, it needs to be pulled together in a way that can be used for planning.

To support alignment of plans, the following should apply:

5. There should be an ongoing, coordinated approach to community engagement and input that respects the time and contribution of common stakeholders.
6. Spatial coverage of plans should be aligned. This does not necessarily mean the same boundaries—for example, there might be multiple water allocation plans within one catchment plan area. What should be avoided are boundaries that cross—for example, a water allocation plan that is partly in one catchment plan area and partly in another. For some types of aquifers this may, however, be unavoidable.

7. Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process that makes best use of combined agency skills and resources, uses best practice, is standardised and uses repeatable methods with clear spatial definition of aquatic ecosystem assets.
8. Spatial representation of assessments should be sufficiently detailed to inform within-region prioritisation decisions for both types of plans.

2.2.3. Resource and ecosystem objectives

Each type of plan has objectives or aims that are typically expressed in terms of preserving resources or providing for beneficial use of the resources. 'Objectives' is used here as a generic term for results that are intended to be achieved through implementing the plans being considered. The terminology used from plan type to plan type varies considerably. Terms like 'outcomes', 'targets' and 'objectives' are used in different ways and on different levels, with more concrete lower level objectives contributing to more aspirational higher level objectives.

Program logic theory provides an approach for a disciplined structuring of objectives, strategies and monitoring processes that links them together coherently and demonstrates the logic of the plan. For overlapping plans, shared objectives, strategies and monitoring can be expressed so as to promote greater alignment of activity and management.

To support alignment of plans, the following should apply:

9. A paired program logic mapping for both planning processes in each region should be developed and include freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined, priorities to protect and restore the assets of freshwater aquatic ecosystems.

2.2.4. Identifying, assessing and deciding strategies

Given intended objectives, plans define what will be done (strategies) to achieve those objectives. Typically, plans will have a range of possible strategies to be deployed to achieve objectives. Catchment plans guide investment in capacity building, onground works and information gathering. Water allocation plans put in place rules for sharing water and operating water infrastructure, and can provide for water that can be adaptively managed for environmental purposes.

In the process of making a plan, the strategies to be used and the extent of their use need to be determined. Management targets are often included that quantitatively define the application of strategies (e.g. funds to be invested in defined ways, quantities of water inflows to be set aside for the environment, etc.) consistent with the objectives. Commonly these strategies come at a cost, have both positive and negative impacts and vary in their effectiveness, so there has to be a process for weighing and deciding on the type and nature of strategies, and their prioritisation (spatial or otherwise) in the final plan.

At a regional level, there will be some areas where action will contribute more to objectives than others. Risk assessment is an approach to assessing this objectively. For example, one area may be highly valued, but be at low risk, and therefore not necessarily be a high priority for action.

To support alignment of plans, the following should apply:

10. Strategies and management targets should reflect shared assessments of risks, built on shared priorities set out in aquatic ecosystem objectives.

2.2.5. Implementation

Once plans are made agencies are responsible for implementing them. While some strategies are fixed and inflexible (e.g. many rules in water allocation plans), many include operational flexibility (e.g. use of adaptive environmental water entitlements, investment in riparian re-vegetation). These provide responsible agencies with the capacity to adapt to changing

knowledge and circumstances, and to opportunities that might arise. For these there is considerable potential benefit in coordinated operations. When there are high levels of uncertainty, flexibility is a good thing. When there are multiple agencies making periodic decisions about investment, the exercise of regulatory powers, etc. towards common objectives, coordination becomes essential to maximise outcomes and return on investment.

To support alignment of plan implementation, the following should apply:

11. Plans should provide flexibility to adapt management actions when opportunities arise for coordinated action to improve the condition of aquatic ecosystems or to address previously unidentified risks to them.
12. Information needed to inform case-by-case consent and investment decisions affecting the achievement of shared objectives should be available to agencies in a readily usable form (e.g. detailed spatial mapping on accessible systems).

2.2.6. Monitoring and review

When there are objectives, there must be measurement and evaluation to determine whether they are being achieved and whether the plans are effective. When there are common objectives, there are obvious benefits in having a common framework for monitoring, reporting and review, and for coordinating the work of the agencies involved.

To support the alignment of plan monitoring and review, the following should apply:

13. Aquatic ecosystem condition monitoring should be shared and coordinated, making the most efficient use of cross-agency skills and resources.
14. Reviews of the effectiveness of plans in achieving aquatic ecosystem objectives should include an assessment of the cross-plan alignment and coordination in achieving optimal return on investment.

3. Application of the framework – a case study

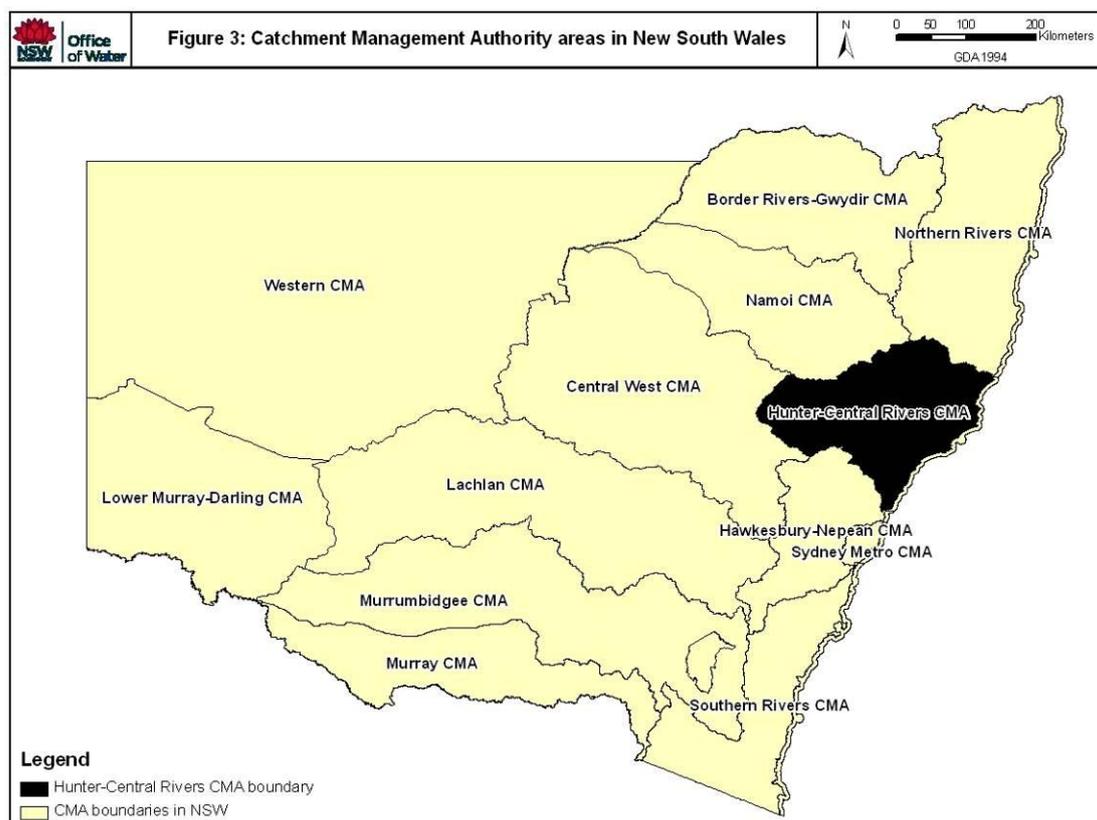
In Phase 2 of the Integration of Water Planning and Catchment Planning (NSW) project, the implementation of several alignment framework principles was trialled in the Hunter region in early 2010. The outcomes are described below as a case study for applying the framework

3.1. Water allocation and catchment plans in NSW

In New South Wales, catchment plans are called catchment action plans (CAPs) and are 10-year plans developed by catchment management authorities (CMAs) under the *Catchment Management Authorities Act 2003*. The role of CMAs is to ensure 'proper management of natural resources in the social, economic and environmental interests of the State' (s. 3 of the Act) through coordinating activity and investment.

Each CMA is required to prepare a CAP for its area. CAPs guide investment in natural resources at the catchment level to promote the state-wide NRM targets. As a matter of policy, CAPs are reviewed approximately every five years.

Figure 3: Catchment Management Authority areas in New South Wales

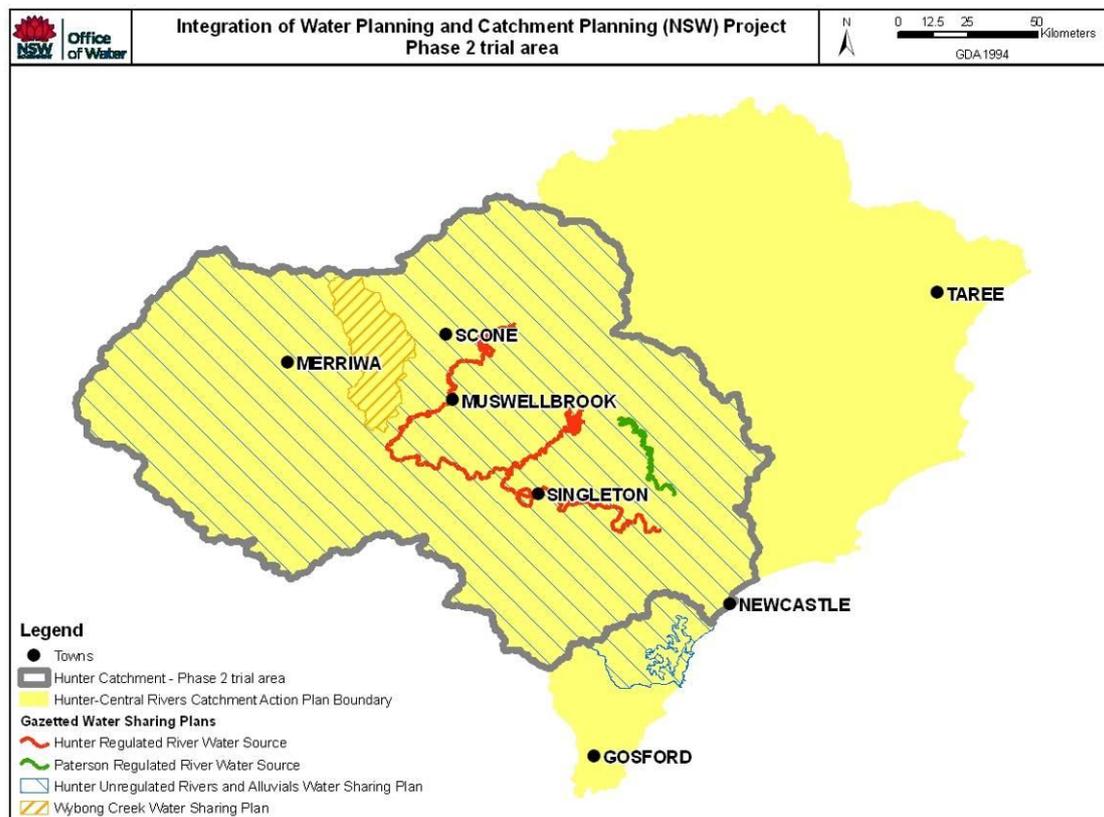


In New South Wales, water allocation plans are called water sharing plans (WSPs) and are developed by the NSW Office of Water under the *Water Management Act 2000*. WSPs aim to provide for the sustainable management and use of water resources by regulating the extraction of water and the construction and use of water infrastructure. They have a fixed 10-year life, after which they must be re-made or extended.

WSPs apply to any specified water resources: rivers and catchments, aquifers or a combination. They are being developed in a phased manner across the state and will eventually cover all NSW water resources where there is licensed water use. In 2004 separate WSPs were gazetted for the major regulated river systems, covering the regulated rivers from the headworks to the end point of regulation of flow. Separate WSPs were made for each of the most heavily used aquifer systems and several unregulated river subcatchments. More recently, WSPs covering all the surface water, plus water in closely connected aquifers, on a catchment scale have been developed (called 'macro'-WSPs). In early 2010 the first catchment-scale plan covering all the surface water (including both regulated and unregulated rivers) and all the aquifers in the area was gazetted for the Peel Valley. This appears to be the scope and scale to which WSPs are evolving.

In the Phase 2 trial area, WSPs were made for the regulated Hunter River system and Wybong Creek in 2004. In 2007 the Paterson Regulated River WSP was gazetted and in 2008 the Hunter Unregulated Rivers and Alluvial Water Sources WSP was gazetted, covering the remaining rivers in the Hunter River catchment. As can be seen in Figure 4, these all sit within the area of the Hunter–Central Rivers CAP. WSPs have also been gazetted for most of the remaining water in the CAP area.

Figure 4: Phase 2 trial area in the Hunter Valley



3.2. Current status of alignment in NSW

To set the context, an analysis of the current state of alignment of CAPs and WSPs in New South Wales, based on the framework, is presented in the following table.

Table 2: Current status of CAP and WSP alignment in NSW

Framework principle	Current status in NSW
<p>Policy, law and governance</p> <ol style="list-style-type: none"> <li data-bbox="240 566 715 678">1. Jurisdictional legislation and policy should allow and preferably facilitate alignment of water allocation and catchment planning. <li data-bbox="240 734 715 846">2. There should be jurisdictional policies and objectives to manage freshwater aquatic ecosystems that apply to both types of plans. <li data-bbox="240 1485 715 1686">3. There should be governance arrangements to support ongoing coordination between relevant agencies at a state and regional level in both plan development and in implementing actions that contribute to shared objectives. 	<p>Legislation requires CMAs to ‘have regard to’ WSPs when preparing CAPs (<i>Catchment Management Authorities Act 2003</i> s. 20), and the minister to have ‘due regard’ to the relevant CAP when preparing a WSP (<i>Water Management Act 2000</i> s. 18).</p> <p>The Natural Resources Commission prepares state-wide standards and targets for NRM for adoption by the government. These have been included in the State Plan. State NRM targets particularly relevant to both WSPs and CAPs include the following:</p> <ul style="list-style-type: none"> <li data-bbox="730 891 1345 947">• by 2015 there is an improvement in the condition of riverine ecosystems <li data-bbox="730 969 1345 1070">• by 2015 there is an improvement in the ability of groundwater systems to support groundwater dependent ecosystems and designated beneficial uses <li data-bbox="730 1093 1345 1171">• by 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained. <p>CAPs are required to be consistent with these standards and targets to be approved, and are audited against their effectiveness in achieving them (<i>Natural Resources Commission Act 2003</i> s. 13).</p> <p>Before remaking a WSP, the minister is to consider a review of the extent that the plan has contributed, or failed to contribute, to achieving the state-wide NRM standards and targets in the CMA (<i>Water Management Act 2000</i> s. 43A).</p> <p>New South Wales has established state-level interagency coordinating groups (Natural Resources and Environment Chief Executive Officers cluster group, NRM Senior Officers group) to coordinate across agencies.</p> <p>At a regional level, CMAs typically consult with other agencies in developing CAPs, and the Office of Water involves other agencies in the expert panel for developing WSPs.</p> <p>Operational coordination of actions, such as investment, regulatory decisions and use of environmental water by CMAs, the Office of Water and DECCW (which manages environmental water), varies from region to region but is generally limited.</p>

<i>Framework principle</i>	<i>Current status in NSW</i>
<p>4. There should be common guidelines for methods and procedures for shared or linked aspects of planning and management.</p>	<p>No common guidelines apply either to the Office of Water or CMAs for such things as aquatic ecosystem condition, value and risk assessment, setting objectives, community engagement, spatial mapping, etc. Each has developed its own approach, though some ad hoc coordination has occurred.</p>
<p>Plan initiation and situational analysis</p>	
<p>5. There should be an ongoing, coordinated, approach to community engagement and input that respects the time and contribution of common stakeholders.</p>	<p>Each agency has developed and implemented its own approach to community engagement independently.</p>
<p>6. Spatial coverage of plans should be aligned. This does not necessarily mean the same boundaries—e.g. there might be multiple water allocation plans within one catchment plan area. What should be avoided are boundaries that cross—e.g. a water allocation plan that is partly in one catchment plan area and partly in another.</p>	<p>Generally, spatial alignment is good. Across New South Wales, WSPs sit within CAP boundaries with the only exceptions being some aquifer plans, where the aquifers span multiple catchments (e.g. the Great Artesian Basin).</p>
<p>7. Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process that makes best use of combined agency skills and resources, uses best practice, is standardised and uses repeatable methods with clear spatial definition of aquatic ecosystem assets.</p>	<p>Approaches to these assessments are still evolving and changing. At a catchment level, interagency coordination of monitoring of conditions is occurring for the state Monitoring, Evaluation and Reporting (MER) Strategy, and <i>State of the Catchment</i> reports are close to being published. However, these do not resolve the variation in condition within catchments. At a finer scale, monitoring has been done independently by each agency. There is no coordinated approach to value and risk assessments for aquatic ecosystems.</p>
<p>8. Spatial representation of assessments should be sufficiently detailed to inform, within regional planning prioritisation, decisions for both types of plans.</p>	<p>Some assessments (e.g. River Styles) available at a detailed spatial scale.</p>
<p>Resource and ecosystem objectives</p>	
<p>9. A paired program logic mapping for both planning processes in each region should be developed and include freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined priorities to protect and restore freshwater aquatic ecosystem assets.</p>	<p>CAPs are generally underpinned by a formally developed program logic, based on national guidelines. WSPs have not yet done this.</p> <p>While both types of plans typically have objectives relating to the condition of aquatic ecosystems condition that are not inconsistent, they are not specific or spatially defined enough to provide alignment.</p>
<p>Identifying, assessing and deciding strategies</p>	
<p>10. Strategies and management targets built into plans should reflect shared assessments of risks, built on shared priorities set out in aquatic ecosystem objectives.</p>	<p>Strategies in WSPs and CAPs are not inconsistent, but do not provide for any sense of within-catchment, shared prioritisation of activity based on risk.</p>

Framework principle	Current status in NSW
<p>Implementation</p> <p>11. Plans should provide flexibility to adapt management actions when opportunities arise for coordinated action to improve the condition of aquatic ecosystems or to address previously unidentified risks to them.</p> <p>12. Information needed to inform case-by-case consent and investment decisions affecting the achievement of shared objectives should be available to agencies in a readily usable form (e.g. detailed spatial mapping, on accessible systems).</p> <p>Monitoring and review</p> <p>13. Aquatic ecosystem condition monitoring should be shared and occur in a coordinated manner, making the most efficient use of cross-agency skills and resources.</p> <p>14. Reviews of the effectiveness of plans in achieving aquatic ecosystem objectives should include assessment of cross-plan alignment and coordination in achieving optimal return on investment.</p>	<p>CAPs allow considerable flexibility in investment. While the investment is consistent with objectives, CMAs are able to adapt where investment occurs to take account of opportunities to work with landholders, etc. as they arise.</p> <p>WSPs generally have fixed regulatory rules that apply for the term of the plan. Some flexibility is available in regulated rivers through environmental water contingency volumes and/or environmental water access licences. Other than this, some plans have defined opportunities to adjust rules (within bounds) at mid-term.</p> <p>NSW Government agencies have developed spatial data management systems to facilitate access to and storage of data, e.g. Enterprise Data Base and the Land Management Database. However, much of the information is not in a readily useful form without significant manipulation, nor is all the information readily accessible to those who need it.</p> <p>Information at a whole-of-catchment scale has been shared and its collection is being coordinated through interagency working groups accountable for state natural resource monitoring and reporting against the State Plan.</p> <p>The Natural Resources Commission assesses both types of plans for their effectiveness in contributing to state NRM targets. The commission audits the effectiveness of CAPs in achieving the targets at least every five years (<i>Natural Resources Commission Act 2003</i> s. 13 and <i>Catchment Management Authorities Act 2003</i> s. 26).</p> <p>For WSPs, s. 43a of the <i>Water Management Act 2000</i> requires the Commission to assess the extent that the plan has contributed to these targets in the relevant catchment.</p> <p>Including such assessments of how effective cross-plan alignment has been has not been considered.</p>

3.3. Scope of the trial

The trial was designed to test recommendations developed in Phase 1. As can be seen in Figure 4, it was limited to the actual Hunter River catchment, within the Hunter–Central Rivers CAP area. It applied to the alignment of the CAP within the catchment with the Hunter Unregulated Rivers and Alluvials WSP, the Paterson Regulated River WSP and the Hunter Regulated River WSP. It focused on the condition of river ecosystems, and did not go into other aquatic ecosystems, such as wetlands or estuaries or groundwater-dependent ecosystems, leaving these for future consideration.

There was not time to pilot all the mechanisms identified in Phase 1. The following were tested, being selected by the project team and steering committee as the most important.

Table 3: Alignment mechanisms trialled in the Hunter River catchment

<i>Framework principles</i>	<i>Mechanisms trialled</i>
<p>3. There should be governance arrangements to support ongoing coordination between relevant agencies at a state and regional level in developing plans and implementing actions that contribute to shared objectives.</p>	<p><i>Regional coordination.</i> Create a regional interagency aquatic theme team, based on the existing CAP aquatic theme team and the former regional agency macro-water sharing panel, to coordinate shared assessments and other matters.</p>
<p>7. Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process that makes best use of combined agency skills and resources, uses best practice, is standardised and uses repeatable methods with clear spatial definition of aquatic ecosystem assets.</p> <p>8. Spatial representation of assessments should be sufficiently detailed to inform, within regional planning prioritisation, decisions for both types of plans.</p> <p>12. Information needed to inform case-by-case consent and investment decisions affecting the achievement of shared objectives should be available to relevant agencies in a readily usable form (e.g. detailed spatial mapping, on accessible systems).</p> <p>13. Aquatic ecosystem condition monitoring should be shared and coordinated, making the most efficient use of cross-agency skills and resources.</p>	<p><i>River condition index.</i> Develop a spatially mapped RCI, based on river-style condition assessment, combined with the hydrologic stress assessment from the macro-WSPs.</p> <p><i>Acquiring community values.</i> Test a methodology for assessing community values for aquatic ecosystems, using the Hunter–Central Rivers CRG as a trial focus group.</p> <p><i>River value assessment.</i> Develop a spatially mapped river value assessment, based on macro-WSP assessments, updated through CMA community consultation and any other information sources.</p> <p><i>River risk assessment.</i> Develop a spatially mapped river risk assessment, based on River Styles recovery potential and geomorphic condition assessment, combined with the risk to instream value assessment from the macro-WSPs.</p>
<p>9. A paired program logic mapping for both planning processes in each region should be developed and include shared freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined, priorities to protect and restore freshwater aquatic ecosystem assets.</p> <p>10. Strategies and management targets built into plans should reflect shared assessments of risks, built on shared priorities set out in aquatic ecosystem objectives.</p>	<p><i>Alignment of objectives and strategies.</i> Develop revised objectives and strategies in the CAP and WSPs that reflect shared, within-regional priorities, based on value and risk assessments.</p>

3.4. Regional coordination

3.4.1. Purpose

To enable alignment and coordination, Phase 1 recommended creating a formalised, regional aquatic ecosystem coordination group in each CMA area. A range of regional interagency groups are already in place, e.g. interagency panels for WSP development, CMA theme coordination groups for CAP development and environmental water advisory committees.

The proposal was to have one formalised group that meets regularly and addresses matters that are common to the separate planning processes. The group would provide a cross-agency governance arrangement for ongoing coordination of shared activities such as aquatic asset condition, value and risk assessment, community engagement, operational activity and monitoring and reporting.

Based on this, the project team recommended trialling a regional interagency aquatic theme team in the Hunter to coordinate the trial of the other mechanisms.

3.4.2. Method

The Interagency Aquatic Theme Team was based on the CMA Aquatic Theme Team members and WSP regional panel, with members drawn from the Office of Water, the Hunter–Central Rivers Catchment Management Authority and the state government departments of Planning, of Environment, Climate Change and Water, and of Industry and Investment. The team consisted of regionally based staff, with several other technical expert staff based in the Hunter region.

The team was established:

- to trial specific mechanisms of the work plan to improve alignment and coordination of water and catchment plans in the Hunter catchment
- to improve collaboration between agencies on water planning and management in the Hunter catchment
- to evaluate the merits of this approach for other catchments in New South Wales.

The members were selected to represent their agencies and/or to bring in particular expertise. The team met four times and covered the following matters:

- its terms of reference and operational protocols
- the development of condition, value and risk assessment maps, including the methodology behind their development
- the development of the shared program logic for the objectives and strategies in the CAP and WSPs.

3.4.3. What was achieved

The team proved to be a practical way of bringing together the resources of the different agencies to increase effectiveness and efficiency for natural resource management in the Hunter. The trial demonstrated a willingness to participate, as different agencies could see mutual and multiple benefits related to their own accountabilities. In particular:

- agencies became more aware of other agency data and research that could be used for this and other processes, resulting in greater return on investment from current data collection and research. Agency datasets such as the Office of Water's WSP assessments, the CMA's vegetation information and DECCW's biodiversity forecaster were made known and available for use by the other agencies, and put to specific use in the condition, value and risk assessments
- agency staff involved in developing plans were also involved in shaping the shared assessments so that the assessments would be useful for all their purposes

- an approach to incorporating shared aquatic health priorities (based on a shared risk assessment) into objectives and strategies for CAPs and WSPs was developed in a way that was effective for both types of plans, without unnecessarily impeding flexibility to achieve the different statutory purposes
- the approaches developed were documented and reviewed from a technical perspective by the theme team, bringing to bear a range of technical expertise and experience
- there was support gained from the agency staff involved for using the products developed in their own planning and operational processes, because they could see advantages for them and for the natural resource in doing so
- the team operation resulted in increased cross-agency networking of staff working in related projects, creating increased likelihood of ongoing collaboration
- the team pulled together parallel work being done by different agencies into a shared process, allowing for reduced duplication of effort (e.g. in condition, value and risk assessments), improved technical rigour (because of the greater level of technical expertise and experience that is able to be shared) and improved natural resource outcomes. It built on existing approaches, such as the WSP macro-plan interagency panel and CMA cross-agency consultation, in developing CAPs and, if used on an ongoing basis, would replace them with a more robust and effective arrangement.

It is difficult to see how a shared condition, value and risk assessment mechanism could have been trialled without the theme team to coordinate the work.

The trial concluded that the draft terms of reference and operating arrangements need to be refined as a template for ongoing operation. The creation of further theme teams on a trial basis for input into CAP and WSPs in other regions could be done readily, replacing or enhancing existing arrangements. Inclusion of other agency staff responsible for crown lands and fish was recommended.

3.4.4. Key learnings

- Regional aquatic theme interagency coordinating groups are feasible to implement and can deliver real benefits in terms of improving natural resource outcomes and leveraging much greater return from existing agency skills and investments.
- Most will be gained if the full range of relevant agencies is represented, if there is continuity of members involved so as to establish networks and if the members have sufficient influence within their agencies to enable access to broader skills and resources—and by implementing shared products and processes.
- The success of such groups relies on the commitment of the agencies to staffing and supporting them. This is most likely to occur if meetings are limited and tightly managed to deliver outputs, and are sharply focussed on areas where there are benefits to be gained for the accountabilities of all participants.

3.5. River condition index

3.5.1 Purpose

For CAPs and WSPs there is a common need to assess aquatic asset (rivers, wetlands, aquifers, estuaries) condition, value and the threats and risks to them. In the past this has been done independently for each plan, with varying approaches and levels of rigour. The Phase 1 report concluded that there is potentially much to be gained by having a shared process, using the best practice methodology possible with the combined resources available.

It was noted that the state MER strategy currently does not address what is needed to assess conditions within regions and for response monitoring. Resource condition assessment is at the catchment level. However, a large amount of information has been collected that is detailed enough to provide the kind of subregional assessment desired, including River Styles

assessments, riparian vegetation and hydrologic stress (disturbance). It was concluded that, in combination, all this information had the essential elements of a RCI that is comparable to the Victorian Index of Stream Condition and along the lines of the national Framework for Assessment of River and Wetland Health (FARWH). Such an index could not only contribute to the alignment of CAPs and WSPs, but could also enhance the state MER strategy. This trial was used to test the feasibility of generating the index as proposed.

The method used to develop the RCI for the Phase 2 trial was based on the NWC's Framework for the Assessment of River and Wetland Health (FARWH) (see Norris et al. 2007a). The framework is being developed as a national standard by the Commission.

3.5.2 Method

Four input datasets formed the basis for the development of a trial index. They were:

- River Styles condition assessment—input under FARWH 'physical form' category to generate the geomorphic condition index
- Riparian vegetation cover assessment (native woody vegetation)—input under FARWH 'fringing zone' category to create the native riparian vegetation index (NRVI)
- Water planning: hydrologic stress rating—input under FARWH 'hydrological change' category to create the hydrologic stress index (HSI)
- River biodiversity condition from the biodiversity forecaster—input under FARWH 'aquatic biota' category to create the river biodiversity condition index (RBCI).

The Hunter River catchment was divided into 174 subcatchment planning units. For each of these, four input indices and the RCI were calculated. While having the RCI at the more detailed river-reach level would have been preferred, this scale was used because the HSI was not available at the time at a river-reach level. The 174 planning units are existing Office of Water water-source planning subcatchments.

Use of the River Styles condition assessment is justified by the work of Chessman et al. (2006) and Brierley and Fryirs (2005). Their assumption is that native aquatic taxa favour stream locations in good geomorphic condition, as river reaches in poor geomorphic condition lack the complexity of geomorphic units relative to the reference condition required to support higher ecosystem services and functions.

Use of the riparian vegetation information is justified on the assumption that a greater cover of native woody riparian vegetation provides greater benefits to base food web requirements, increases shade and shelter for instream organisms, increases geomorphic complexity, reduces significant bank and bed erosion and increases channel roughness (Lovett & Price 2007). For the trial, this was selected as the most appropriate measure of impact on the 'fringing zone'.

The river biodiversity condition index is based on the extrapolation of site assessments of the biological health of short river reaches to entire drainage network in the region (Turak et al. 2010). The key assumptions underlying the method and its application here are: integrity of river macro-invertebrate assemblages provides a useful measure of the biological condition of river reaches; spatial patterns in biological condition of river reaches in the region are determined by spatial patterns in the extent of human-induced disturbance, together with location of the river reach within the catchment and the landscape; and, by aggregating the assessments made for 9140 small subcatchments into 174 larger subcatchments, critical information on spatial patterns in the river health in the region is not lost.

Geomorphic Condition Index (GCI)

The Geomorphic Condition Index input scores (range 0–1) for each of the 174 subcatchment planning units were determined from the percentage stream length in each of the ‘good’, ‘moderate’, and ‘poor’ categories from the River Styles condition assessment dataset, as follows:

$$GCI = \frac{(\%Good * 1) + (\%Moderate * 0.5) + (\%Poor * 0)}{100}$$

The formula is based on Equation 45 in Norris et al. (2007b).

Native Riparian Vegetation Index (NRVI)

Mapping of the extent of riparian vegetation by the NSW Office of Water was used as the basis for determining NRVI. Percentage bandwidths for benchmark riparian vegetation cover were then assigned, based on expert opinion.

NRVI input index scores (range 0–1) for each of the 174 planning units were determined from the percentage stream length in ‘poor’ (significantly different to benchmark), ‘moderate’ (outside benchmark) and ‘good’ (within benchmark) as follows:

$$NRVI = \frac{(\%Good * 1) + (\%Moderate * 0.5) + (\%Poor * 0)}{100}$$

The formula is based on Equation 45 in Norris et al. (2007b).

Hydrologic Stress Index (HSI)

The Hunter Unregulated Rivers and Alluvials WSP assigned a hydrologic stress rating (range 0–1) to each of the 33 WSP water-source planning units (see NSW Department of Water and Energy 2008). These hydrologic stress scores were applied evenly to all subcatchment planning units within each water source planning unit. As ‘high stress’ for the WSP (a score of 1) was equivalent to a ‘low’ condition rating (a value of 0), the raw hydrological stress score needed to be reversed for input into the RCI.

Since the WSP stress ratings were determined at a larger scale (33 water sharing, water source planning units) no differentiation between the subcatchment planning units within each water-source planning unit could be made. The result was that far more subcatchments were rated as ‘highly stressed’ than is thought to be reasonable.

Accordingly, the overall weighting of this index was modified to half that of the GCI, NRVI and RBCI scores. This was done by recalculating the input scores from a range of 0 to 1 to a range of 0.5 to 1. Additionally, in cases where a subcatchment planning unit had no active water licences, the unit was assigned a ‘very low’ stress score of 1. In cases where more than 50 per cent of the planning unit was a regulated river, the planning unit received a score of 0.5, indicating very high stress.

River Biodiversity Condition Index (RBCI)

River biodiversity condition index scores (range 0–1) from the biodiversity forecaster tool developed by DECCW (see Turak et al. 2010) were assigned to 9140 small subcatchments. These scores were aggregated into the 174 much larger planning units, based on average scores.

River Condition Index (RCI)

The RCI uses a standardised Euclidean distance formula to integrate input indices. The standardised Euclidean distance formula was chosen in accordance with the recommended FARWH approach (Norris et al. 2007a section 2.7.2). The formula used is:

$$RCI = 1 - \frac{\sqrt{(1-GCI)^2 + (1-NRVI)^2 + (1-HSI)^2 + (1-RBCI)^2}}{\sqrt{4}}$$

Application of the method results in a score (range 0–1) for all 174 planning units with a higher score applying to planning units in better condition.

The range of scores was split into five classes:

0.8–1	= Very good (equivalent to FARWH 'largely unmodified')
0.6–0.8	= Good (equivalent to FARWH 'slightly modified')
0.4–0.6	= Moderate (equivalent to FARWH 'moderately modified')
0.2–0.4	= Poor (equivalent to FARWH 'substantially modified')
0–0.2	= Very poor (equivalent to FARWH 'severely modified')

In the Hunter trial the RCI scores ranged from 0.17 to 0.95.

All of the subindices, as well as the RCI, were calculated using Microsoft Excel, Microsoft Access and ArcGIS. All layers are able to be displayed as map layers.

3.5.3. What was achieved

It was proved that there are sufficient datasets between agencies in New South Wales to create a detailed RCI that aligns with the national FARWH methodology. Further technical work is needed on the calculation of the subindices and the method used to integrate data. Refinement to allow the RCI to be prepared at the finer river-reach scale is desirable and feasible with further work on the hydrologic stress dataset.

It is possible to generate the index for a substantial proportion of New South Wales for minimal additional costs. The limitation is availability of datasets. River Styles and riparian vegetation mapping are being extended under current programs. Hydrologic stress data is being generated as WSPs are developed. Biodiversity condition is capable of being expanded to state coverage for a low cost. Inclusion of additional datasets (e.g. fish) requires further investigation.

Further evaluation of the RCI is presented in the Appendix.

Maps were prepared for the RCI and input indices, as shown on the following pages.

Cost of developing and producing the RCI map, including staff wages and on-costs, are estimated at \$15 000. There was no additional cost for data collection, as existing information could be used. Once finalised, the method of index and map assembly is capable of being modelled in GIS software to automate the process. After this, the cost of periodic updating would be that of updating each of the data input layers.

The spatially defined RCI is suitable for use as an objectively assessable measure of progress in improving water ecosystem condition and useful to CMAs for CAPs, the Office of Water for WSPs, the DECCW for floodplain management plans and environmental water management plans, and for reporting on aquatic theme targets in the State Plan.

3.5.4. Key learnings

- In New South Wales, it is feasible and relatively low cost to construct RCI maps for most of the state, using largely existing datasets and an approach consistent with the national FARWH methodology. Some additional technical work and plugging of dataset gaps are required.
- Importantly, the datasets are capable of being updated cost effectively to enable assessment of change in condition over time. This can be done incrementally, focusing on areas where activity and changes are occurring, and comprehensively on a periodic basis (five or 10-yearly, say).
- Preparing maps showing the RCI at a river-reach scale is preferred, as this is the scale of onground actions and is easily aggregated to larger units for reporting at regional and state level. It is also easily combined with other information at this scale for other purposes (as is shown in subsequent sections).
- In the trial, the regional Interagency Aquatic Theme Team enabled cross-agency discovery and shared use of a large body of datasets being collected by different agencies for different purposes.
- However, if appropriate datasets are not already being captured for other purposes, the gathering of this information would make a similar RCI elsewhere more expensive to undertake.
- The RCI can be used as an objectively assessable measure of progress in improving the condition of water ecosystems for CAPs, WSPs and state NRM objectives and targets.

Figure 5: Native Riparian vegetation index

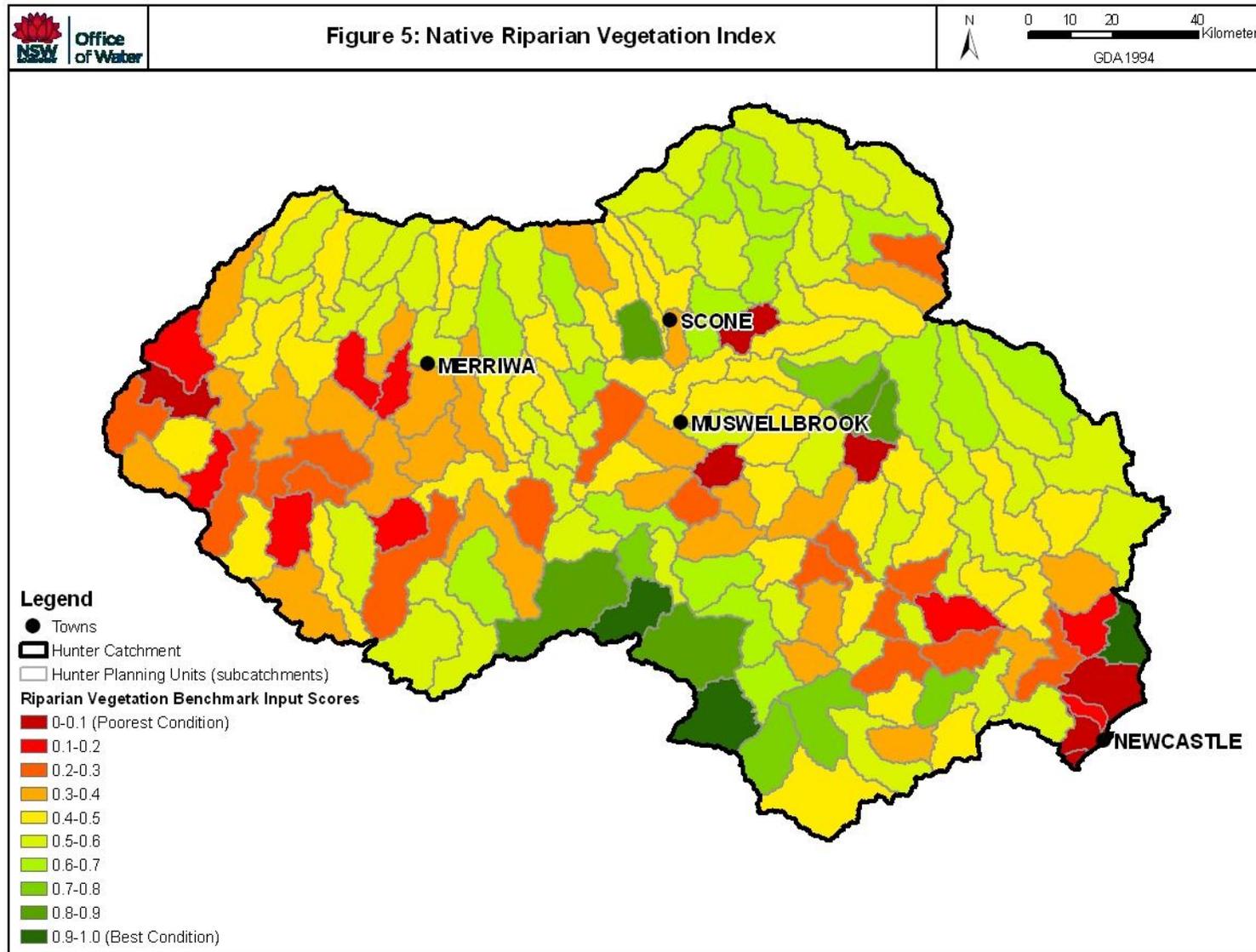


Figure 6: Geomorphic condition index

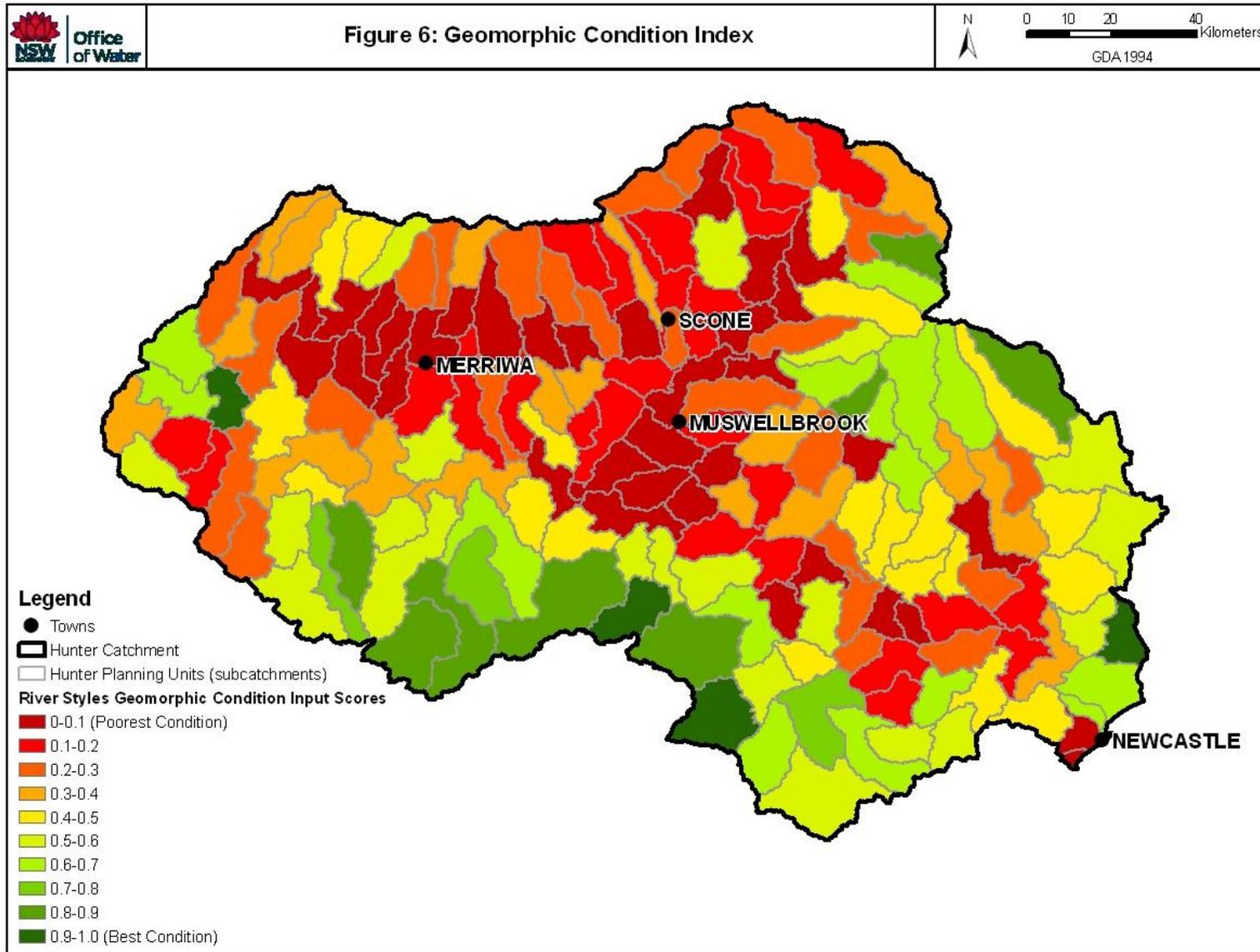


Figure 7: River biodiversity condition index

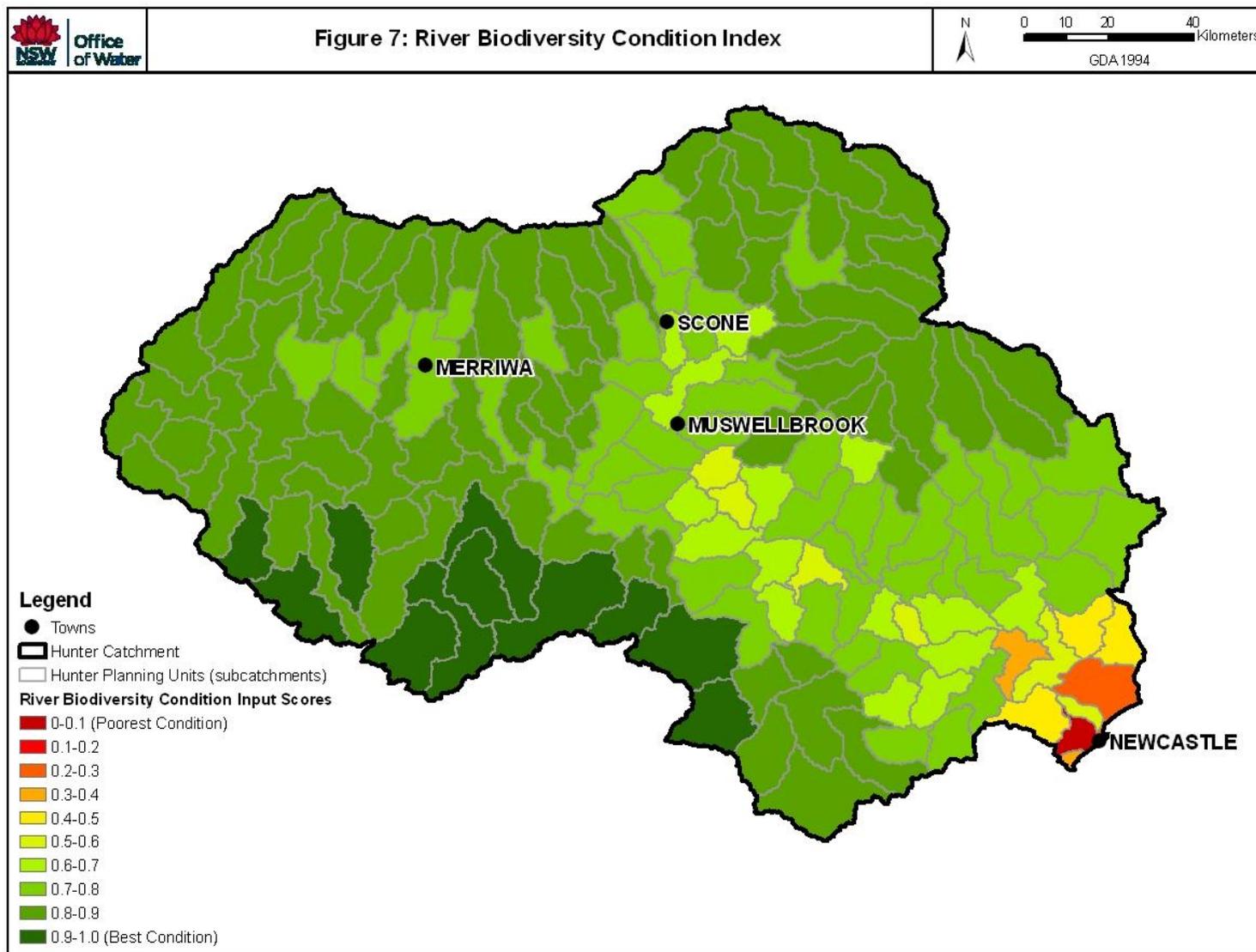


Figure 8: Hydrological stress index

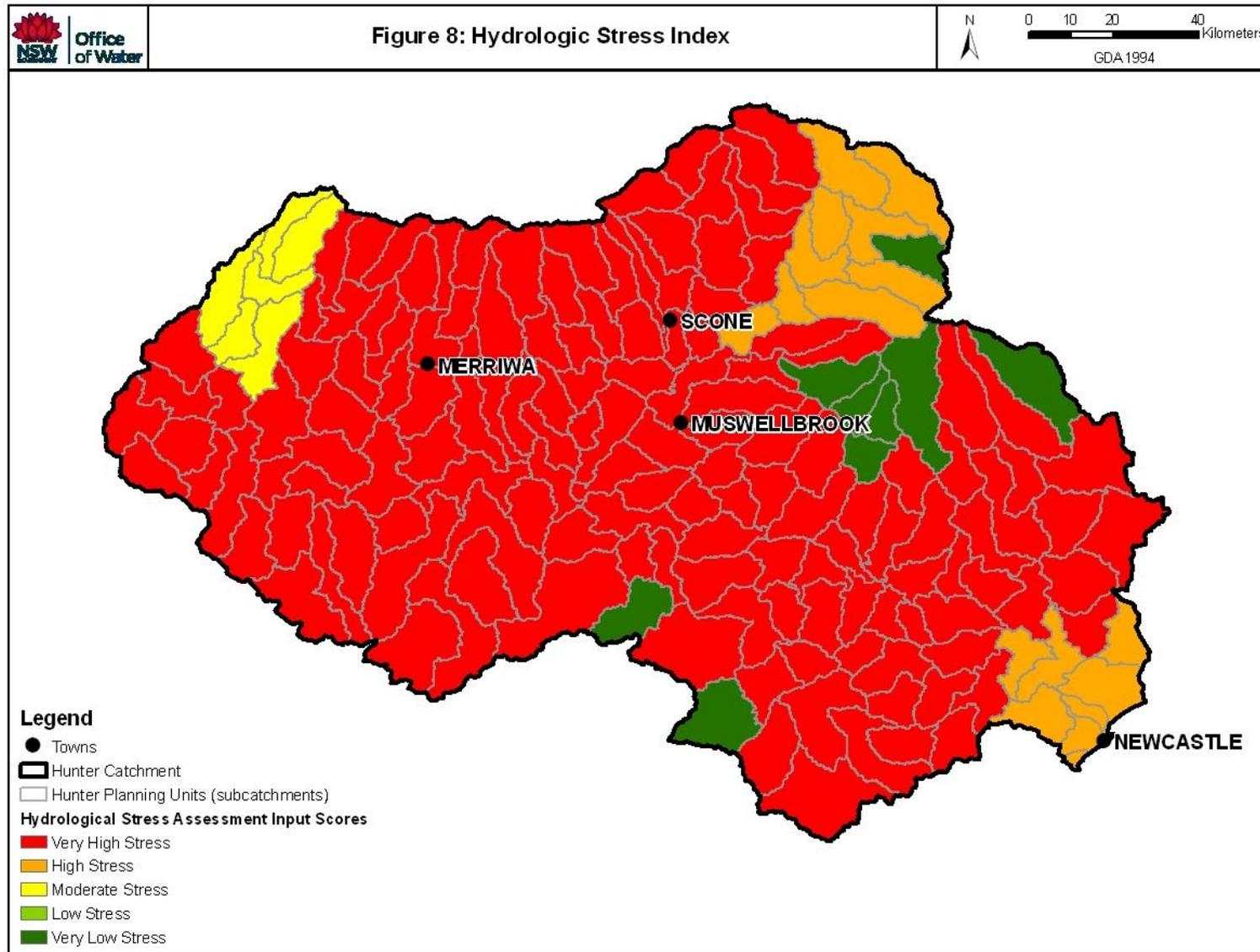
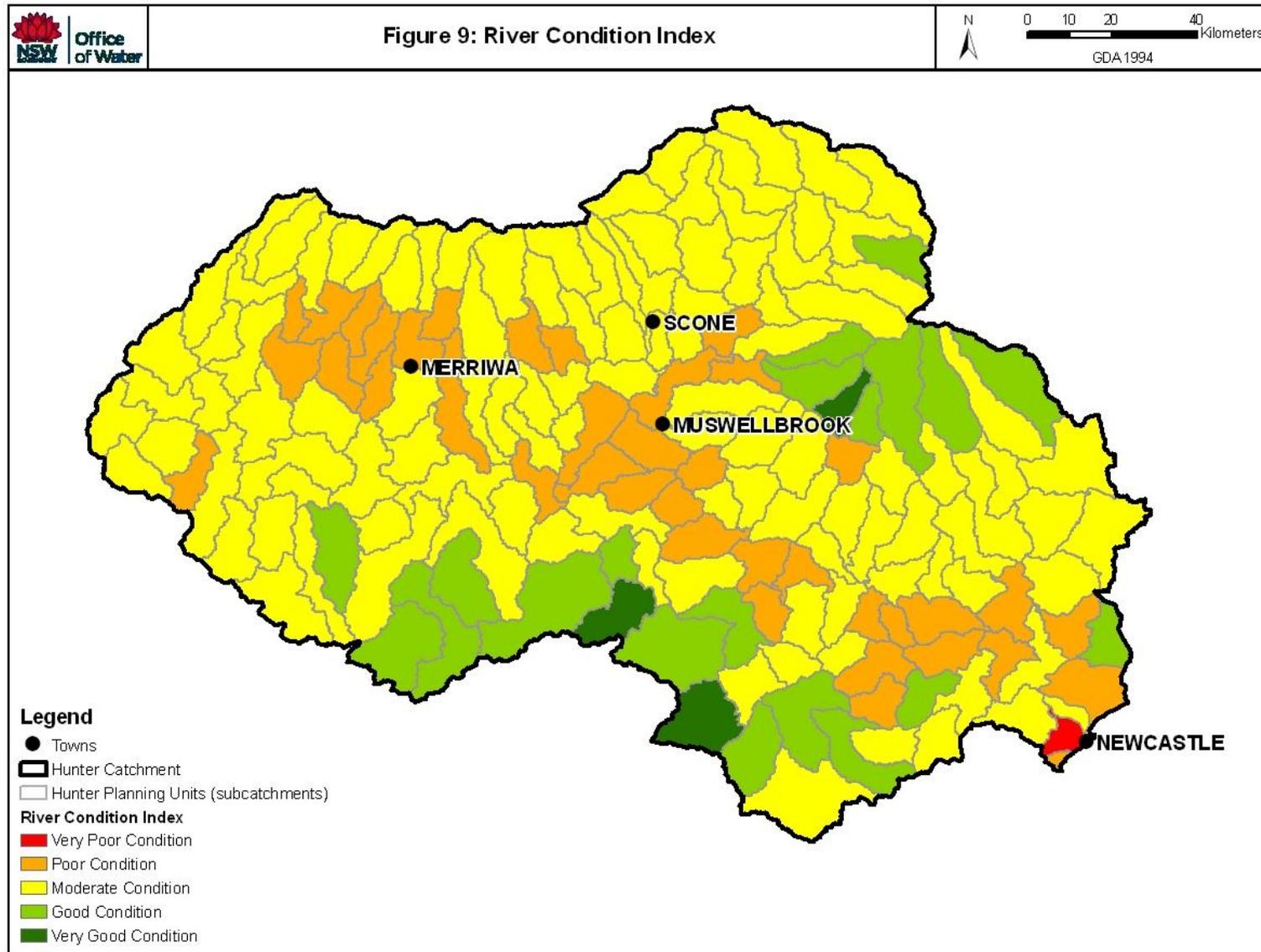


Figure 9: River condition index



3.6 Acquiring community values

3.6.1. Purpose

A key part of the process of alignment and coordination is establishing spatial layers that identify valued aquatic assets. Rivers and wetlands are valued for the range of services they provide, including biodiversity, recreation, social and cultural values and water supply for towns and agriculture. Understanding which rivers are most valued is important to prioritise where investment and regulatory effort should be focused.

Scientific assessments can provide a solid basis for identifying priority areas for such things as biodiversity. However, social, cultural, recreational and other such values are often not identified in agency data (e.g. historic sites, popular swimming holes, or commercial interests).

A community value assessment trial was undertaken to fill this data gap and to test how this information might be efficiently gathered and mapped. The asset identification process was adapted from a process being used by the Central West CMA (the Investment Framework For Environmental Resources, INFFER—see Pannel et al. 2009). The project team decided to use the Hunter–Central Rivers CRG as a sample focus group for this purpose.

In doing this it is noted there was no intention to suggest that a standing reference group, such as the CRG, should be used as the best or only way to obtain community values. The method tested required a focus group representing a cross-section of the catchment, and the CRG was a convenient group to use in this instance. In general, one or multiple focus groups could be assembled as needed once the method is developed.

3.6.2. Method

A one-day workshop with the CRG was held at Tocal on 29 January 2010 to identify community assets associated with water within the Hunter Valley and to trial a method of spatially capturing water-based asset information.

Participants were provided with three regional maps—of the Upper Hunter catchment (1:170,000), of the Mid and Lower Hunter catchment (1:170,000) and of the Goulburn River catchment (1:130,000). Rivers, creeks, major roads, national parks and towns were marked on the maps. Natural resource information, such as geomorphology, vegetation mapping and threatened species, was deliberately excluded, as mapping of these natural features for the workshop was judged potentially prejudicial.

The CRG was given a background description of the project and a short session on asset identification, and then an extended period to ask questions.

The room was organised so that three large tables contained the three maps. CRG members were asked to move to the table that was most relevant to them and told there would be three rotations through the day. The CRG members were given the opportunity to stay on at a table if they so desired. Agencies representatives (two at each table) were nominated as scribes for mapping and data sheets. Formal and informal direction and clarification was provided as issues were raised.

Prioritisation of the identified assets was planned following the rotations. However, the group unanimously agreed that the list presented represented its priorities. The time was used to gain feedback from the CRG on the process, including its strengths, limitations and potential applications.

3.6.3. What was achieved

The trial confirmed that gathering values of water assets from the community through a focus group is feasible and advantageous to agencies, and that these values can be recorded in a spatial map form that can be readily integrated with other information.

The consultation identified 53 water assets across the three geographic areas. Mapped locations of these assets are shown in the following figures. Participants declined to rank or prioritise assets, preferring to recommend the whole list. The values so obtained are suitable for use in developing shared value and risk maps, and can fill an important information gap.

The process delivered a meaningful information layer, but adjustments are recommended to make it more effective and applicable for cross-agency use. These include:

- a need to separate the different types of values, in particular those associated with extracting water from values associated with leaving water instream, as these compete with one another and combining them is not useful
- a less open-ended process—a more efficient result would be achieved if particular types of values were targeted—e.g. recreational, aesthetic, social—that cannot be gathered more effectively using other processes
- ensuring that the representation covers the needs of multiple planning needs (WSPs, CAPs, floodplain plans, land-use plans) in regard to water values, so that it is acceptable for the respective agencies
- pre-priming the process, with maps showing such things as known recreational sites
- presenting maps of other values—e.g. biodiversity, water extraction value—which can be developed from technical and expert assessment and could be presented for confirmation or addition by the community
- using a subcatchment scale (between 1:25,000 and 1:100,000) for workshops to get a finer scale delineation of assets identified, since this data goes into the value and risk maps, which are at a river reach scale
- providing pre-workshop information and training to assist workshop effectiveness
- extending the consultation base to a wider demography, including using similar exercises undertaken by local government in developing strategic plans
- investigating the use of browser-based Google Earth technology to enhance the process and possibly enable broader input.

There is also a strong need to invest in managing expectations of what the information is for and how it will be used. In particular, those involved need to understand that identifying valued assets does not guarantee their protection or improvement, but that this information enables more informed prioritisation in investment and trade-offs determined through the respective planning processes.

The workshop, including catering, CRG mileage, consultant facilitation, agency attendance and preparation, cost an estimated \$14 500.

A similar process is now being trialled in the Central West CMA, where there were 12 community meetings, using 51 x 1:50,000 scale maps, and additional consultation with the CMA reference group, local and state government. The cost of meaningful consultation of this type on a broader scale is very high. However, if it is already being done as a part of normal process by CMAs, then the additional cost of minor adjustments to cater for use by multiple agencies is low and would likely be more than offset by removing the need for similar value collection being done as part of WSP or other plan development. If a different approach to collecting and recording community value information is finally adopted, then the capacity for it to be used or adapted by multiple agencies will need to be assessed.

The approach of incremental updating of layers could be a highly efficient way of maintaining the information on value. If the spatial layer is shared then any information on values gathered by any of the agencies from time to time as part of ongoing programs or particular projects could be added and the layer redistributed to the agencies. The layer could be maintained as a corporate data layer within the Enterprise Database maintained by NSW ServiceFirst and updated by the Spatial Services and Information group within the Office of Water. This would allow the CMAs and DECCW access to the data through the common GIS software.

Updating the data could also be focused on areas of land-use change, population growth, recreational activity growth, etc. where values are most likely to change, enabling the dataset to be kept up to date, and a comprehensive update would not be needed for 10–20 years.

3.6.4 Key learnings

- Collecting meaningful information on community values for natural resources can be done and readily distilled into map form.
- The workshop method tested is workable, subject to a range of identified refinements to improve its efficiency and focus.
- Several types of values—e.g. those associated with biodiversity—are better done through technical processes, with the community perhaps having an opportunity to review. The main focus for community value collection of this kind should be social, cultural and instream economic values.
- It is important to ensure information collection covers the scope of the community, geographically and in terms of different types of interests.
- Concrete engagement of the community in identifying values had the additional benefit of increasing the community's understanding of the complexity of natural resource management and its confidence that its values are being incorporated into the process.
- Collecting this information can be expensive. The trial tested only one approach, without comparing it to other methods for efficiency and effectiveness. Further work is needed before recommending a preferred approach for broader adoption in New South Wales.

Figure 10: Goulburn River community valued water assets

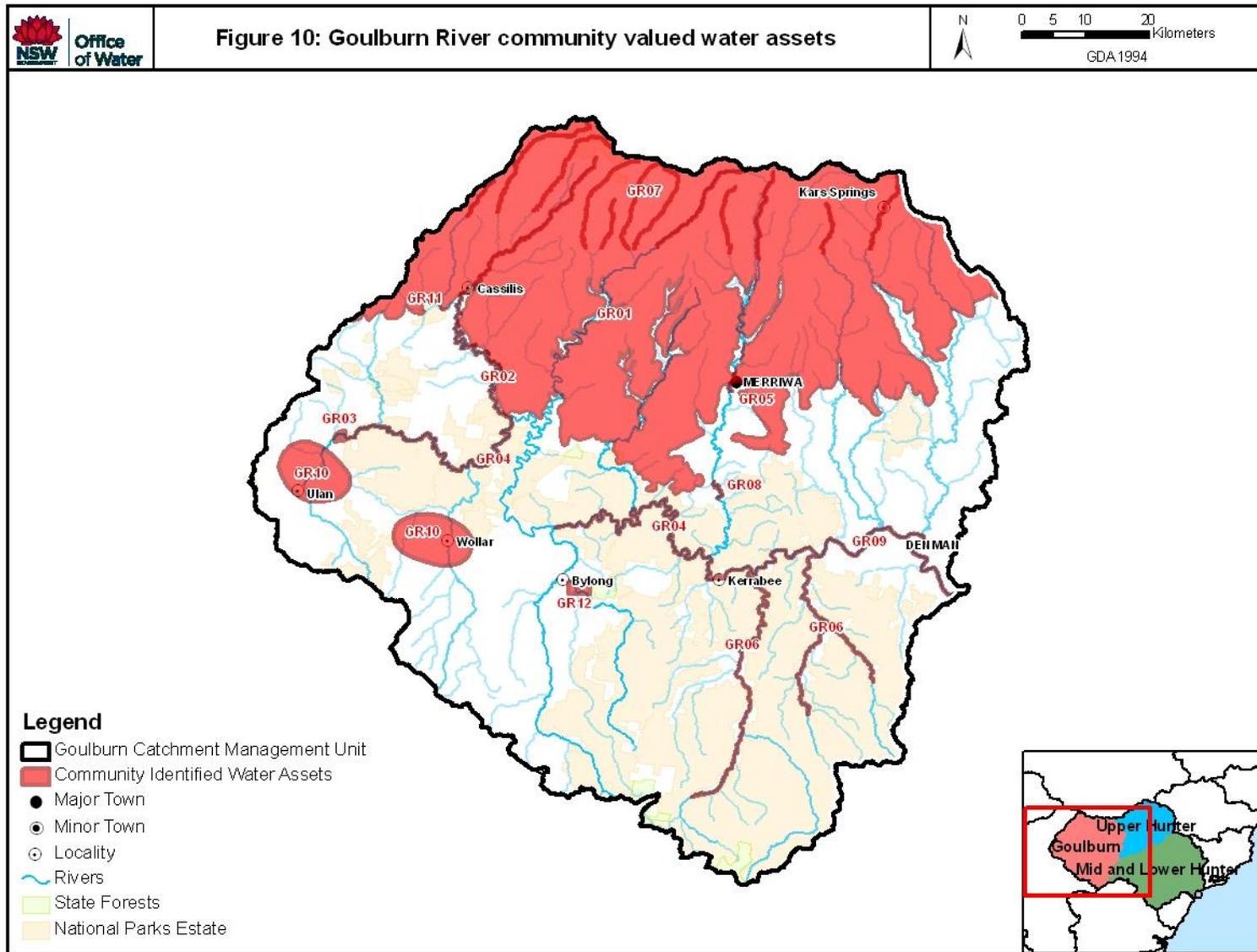


Figure 11: Mid and Lower Hunter community valued water assets

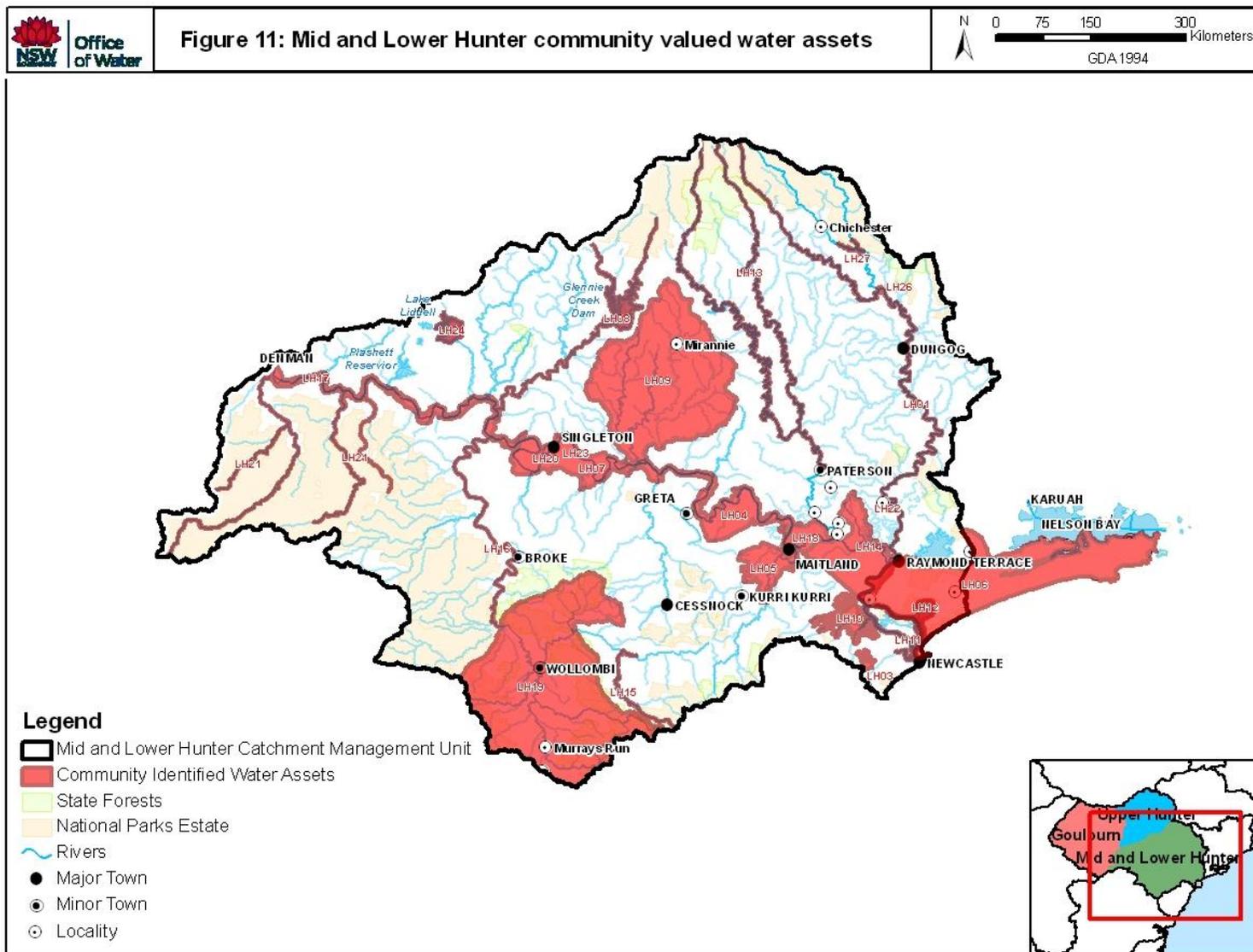
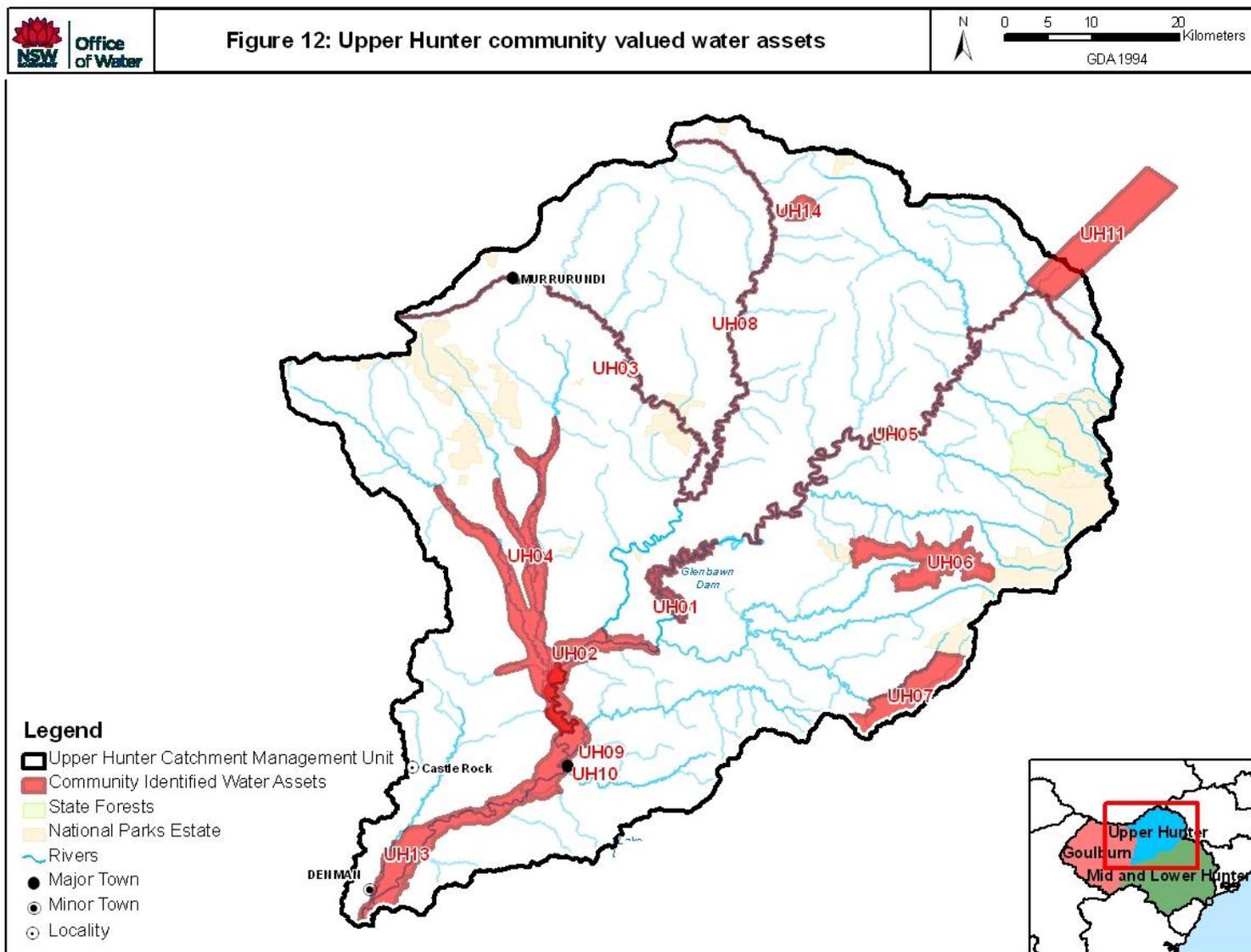


Figure 12: Upper Hunter community valued water assets



3.7. River value assessment

3.7.1. Purpose

For CAPs and WSPs there is a common need to assess aquatic asset (rivers, wetlands, aquifers, estuaries) value as an essential building block of risk assessments. Value provides a measure of the importance of the asset to the local, national and global community, now and in the future. It embodies the ecosystem services that the asset does or can provide. These services include biodiversity, recreation and cultural values, and water supply for agriculture and towns.

In the past this has been done independently for each type of plan, with varying approaches and levels of rigour, or not at all. The Phase 1 report concluded that potentially much is to be gained by having a shared process, using the best practice methodology possible with the combined resources available.

It was noted that a large amount of information had already been collected or was being collected through WSP and CAP processes related to river value. The first mechanism tested in the trial (described in the previous section) was a method of collecting information on community values for rivers.

The trial was intended to test whether a value assessment at a subcatchment level could be assembled, based on WSP value assessments, with the addition of CMA community consultation and any other information sources.

3.7.2. Method

The river value assessment was completed in two parts:

1. *Instream value*: the value of a river section, excluding the value of extraction, i.e. the value of biodiversity, recreation, tourism, heritage, cultural and other such services.
2. *Water extraction value*: the value of a river section associated with extracting the water, i.e. for irrigation, water supply, power generation.

The *instream value* assessment was prepared by combining the following assessments:

- CRG identified assets valued for purposes other than water for extraction (as described in the previous section)
- biodiversity forecaster conservation priority (see Turak et al. 2010)
- Hunter Unregulated Rivers and Alluvials WSP—*instream value* (see NSW Office of Water 2010).

The *water extraction value* assessment was prepared by combining the following assessments:

- CRG identified assets valued for water for extraction (as described in the previous section)
- Hunter Unregulated Rivers and Alluvials WSP—community dependence on extraction.

It was evident that the use of a river-reach level was more appropriate than a subcatchment level, as this is the scale at which management actions are undertaken. Each river reach identified in River Styles mapping was assigned input scores from input datasets. The input scores were then combined to get an overall *Instream Value* score and *Extraction Value* score for each river reach.

Extraction Value Index

Data describing the dependence of local communities on water extraction from the WSP was combined with the assets having water extraction identified by the CRG.

Since the level of dependence of the local communities on water extraction from the WSP was based on the volume and economic value of water extracted, as well as the social benefit of water extraction, it was assumed that this dataset is a good representation of water extraction values within the catchment (see NSW Department of Water and Energy 2008, NSW Office of Water 2010). By consulting the CRG about assets with extraction values, further assessment was added.

River reaches throughout the catchment were assigned a CRG score of 1 if they were part of an asset or were contained by an asset that had value relating to extraction, as identified by the CRG data. All other river reaches received a CRG score of 0.

River reaches also received a WSP score for the level of dependence on water extraction developed for the WSP, ranging from 0 to 1, with 1 representing high dependence. Raw scores were assigned to 33 unregulated river WSP water sources. The river reaches that fell inside these water source subcatchments were given the corresponding score. As the regulated rivers are a major source of water extraction, they were assigned a score of 1.

The scores for CRG data and WSP data were then averaged to get an overall score assessing the level of extraction value for each river reach. However, since the process used for collecting data from the CRG was difficult to filter, the weighting of the WSP data was doubled.

$$\text{Extraction Value Index} = \frac{(\text{CRG score} + (\text{WSP score} * 2))}{3}$$

The calculations resulted in river reaches being assessed as having 'very high', 'high', 'medium', 'low' or 'very low' extraction value, based on increments of 0.2.

Instream Value Index

Instream value data from the WSP was combined with instream value data from the CRG and conservation priority scores from DECCW's biodiversity forecaster tool.

The WSP process used three different types of values contributing to instream value—ecological (intrinsic), economic (non-extractive use) and cultural (place). Identified special areas (e.g. critical habitat, wetlands), and threatened or endangered species, ecological communities and populations were also assessed in the WSP (see NSW Department of Water and Energy 2008, NSW Office of Water 2010). Because of these inputs, the WSP instream values assessment is recognised as being representative of numerous environmental and instream values within the catchment.

Since WSPs influence management relating to water extraction, the WSP assessed only values considered vulnerable to water extraction. Therefore, by consulting the CRG about assets relating to biodiversity, recreation, tourism, heritage and culture, it is thought that a greater range of assets could be identified as having instream value.

The conservation priority represents the biodiversity components of instream values. These were derived by ranking the 9140 river sections (reaches) in the Hunter catchment in terms of their quantitative contribution to catchment biodiversity, using the integrity of macro-invertebrate assemblages as a surrogate for biodiversity condition (see Turak et al. 2010). The contribution of each river reach to river biodiversity was computed as a function of both the current condition of the reach and the river type it belongs to. Using this method, a river reach in relatively poor biological condition but belonging to an uncommon river type may be given a higher conservation priority than a river type in very good condition but belonging to a common river type. This is because the loss of its remaining biodiversity would have greater regional significance than the loss of value of more common river reaches.

River reaches throughout the catchment were assigned a CRG score of 1 if they were part of an asset or contained by an asset with instream value identified by the CRG data. All other river reaches received a CRG score of 0.

River reaches were assigned a WSP score for the level of instream value developed for the WSP, ranging from 0 to 1, with 1 representing high instream value (see NSW Department of

Water and Energy 2008). Raw scores were assigned to 33 unregulated river WSP water sources. The river reaches that fell inside these water source subcatchments were given the corresponding score.

Conservation priority scores (ranging from 0 to 1, with 1 representing high conservation priority) had been calculated for 9140 subcatchments by the biodiversity forecaster tool for the Hunter catchment in line with the method described in Turak et al. (2010). River reaches were assigned the score of the subcatchment that they intersected.

The scores for CRG and WSP data and for conservation priority were then averaged to get an overall score assessing the level of instream value for each river reach. However, since the process used for data collection from the CRG was difficult to filter, the weighting of the WSP data and the conservation priority data was doubled.

$$\text{Instream Value Index} = \frac{(\text{CRG score} + (\text{WSP score} * 2) + (\text{conservation priority} * 2))}{5}$$

The calculations resulted in river reaches being assessed as having 'very high', 'high', 'medium', 'low', or 'very low', instream value, based on increments of 0.2.

3.7.3. What was achieved

The trial showed that an integrated instream value assessment is feasible and likely to be achievable in a relatively short period. The available information was able to be combined to give a measured value assessment considered sufficient for the trial. Maps were prepared as shown on the following pages.

The trial demonstrated a willingness to share datasets and information for this project, as different agencies could see a mutual benefit. The datasets were developed in a common platform between agencies, which allowed for data compatibility. Ongoing development relies on this cross-agency cooperation being maintained.

The trial showed that it is important to separate value associated with extraction of water from instream value, as it is essentially the instream value that is needed to align CAPs and WSPs. The water extraction value is essentially in competition with the instream value, and is used solely by the WSP process.

The maps produced represent an amalgamation of the data layers available. However, limitations to the data have been recognised, such as the method of community value-data collection described in the previous section, resolution of WSP data and overlaps within the datasets.

An investment in further analysis and method development is needed to prepare a robust method that can be used state-wide. Generally speaking, ecological aspects of value may be best prepared through scientific analysis (e.g. as done in the biodiversity forecaster or through the WSP expert panel process), whereas other values (recreation, cultural, etc.) may be better identified through community consultation. Additional input from government agencies on such things as important fishing areas may also be readily obtainable.

The cost of developing and producing the value maps, including staff wages and on-costs but not data collecting costs, is estimated at \$15 000. Once finalised, the method of assembling indices and maps is capable of being modelled in GIS software to automate the process. After this, the cost of periodic updating would be that of updating each data input layer. The cost of obtaining community values was discussed in the previous section. WSP assessments continue to be done as WSPs are prepared. The conservation priority assessment from the biodiversity forecaster requires developing new models for other NSW regions. This is possible for around \$150 000.

3.7.4. Key learnings

- In New South Wales, the trial demonstrated that detailed maps of instream value for rivers can be assembled using information from existing data collection programs. However, the method needs further development and for gaps in data to be addressed.
- The method for collecting instream values needs to be a combination of scientific/technical assessment and community consultation. Generally speaking, ecological aspects of value may be best prepared through scientific analysis, whereas other values (recreation, cultural, etc.) may be better identified through community consultation. Additional input from government agencies on such things as important fishing areas may also be readily obtainable.
- It is important to separate value associated with water extraction from instream value, as it is essentially the instream value that is needed to align CAPs and WSPs.
- Preparing value maps at a river-reach scale is preferred. The main practical use of value maps is to contribute to risk maps that guide action, and the river reach is the scale of on-ground actions.
- As with the RCI, the regional Interagency Aquatic Theme Team enabled cross-agency discovery and shared use of datasets being collected by different agencies for different purposes.

Figure 13: Instream value index

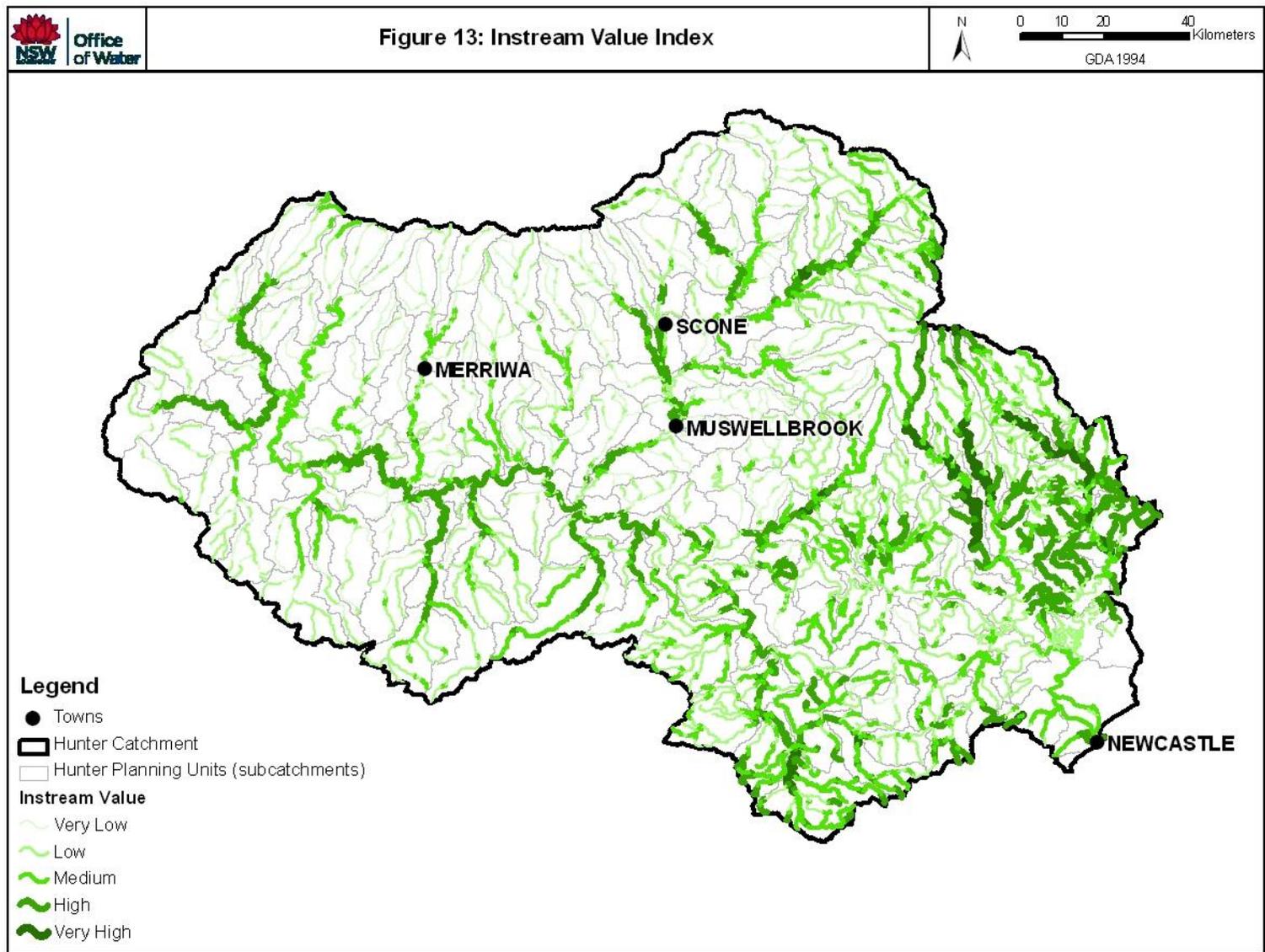
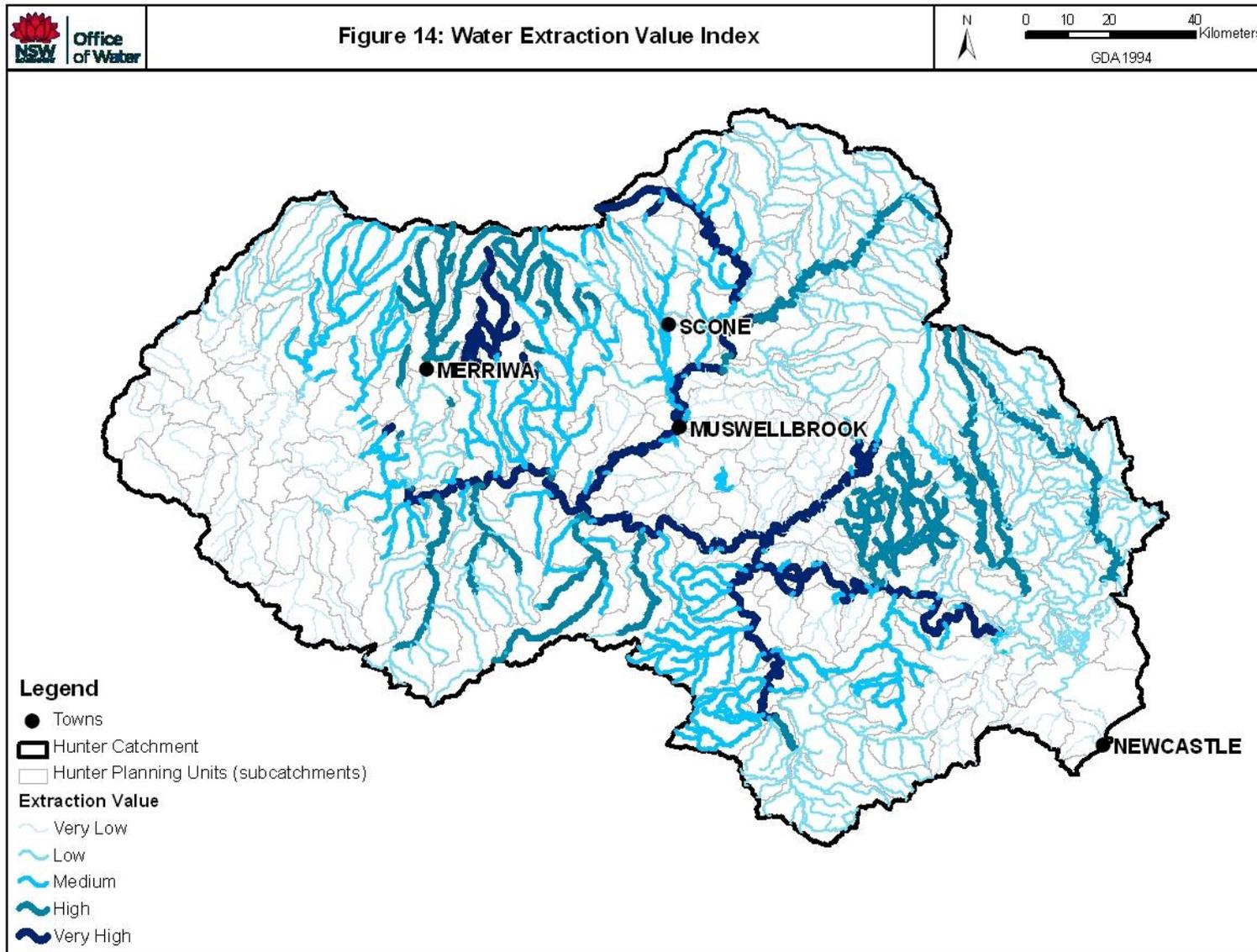


Figure 14: Water extraction value index



3.8. River risk assessment

3.8.1. Purpose

The Phase 1 report noted an opportunity to reduce probability of waste of investment and increase the probability of success in achieving natural resource objectives by aligning management targets and strategies in plans to focus on shared intra-regional, priority river reaches. Priority for action is best determined by risk assessment, as risk embodies the value or importance of the river reach and the potential to prevent damage or improve it through action. It results in identifying areas where most is to be gained by regulation or investment.

The trial was to develop a river risk assessment at a river-reach level, based on combining the River Styles recovery potential and geomorphic condition assessment with the risk to instream value assessment from the WSPs.

3.8.2. Method

The river risk assessment was completed in three parts:

1. Risk of physical disturbance to instream value.
2. Risk of water extraction to instream value.
3. Combined risk to instream value.

The *risk of physical disturbance to instream value* assessment was prepared by combining the following subindices:

- River Styles—recovery potential and fragility assessments
- instream value assessment (described in the previous section).

The *risk of water extraction to instream value* assessment was prepared by combining the following sub indices:

- Hunter Unregulated Rivers and Alluvials WSP—hydrologic stress (see NSW Office of Water 2010)
- instream value assessment (described in the previous section).

The *combined risk to instream value* assessment was prepared by combining the subindices.

A river risk assessment at a river-reach level was developed. It was evident that a river-reach level was an appropriate scale to use, as this is the scale in which management actions are undertaken. Risk is generally defined as:

$$\text{Risk} = \text{likelihood} \times \text{consequence}$$

Thus, likelihood and consequence values needed to be assessed for river reaches in the Hunter catchment.

Risk of physical disturbance to instream value

Likelihood

The River Styles information was used to develop a measure of likelihood by combining the recovery potential assessments and the stream fragility classifications. Fragility is a measure of how susceptible to change in character and behaviour a particular river type is, and recovery potential is the direction in which change is heading, based on the limiting factors of geomorphic recovery.

The rationale for using recovery potential is based on the fact that recovery potential inherently reflects geomorphic condition (as it is an input for determining recovery potential). The definition of recovery potential is that it is a measure of the capacity of a reach to return

to good condition or to a realistic rehabilitated condition, given the limiting controls of the reach. These controls are based on the physics of hydraulics and the ability of vegetation and sediment to facilitate geomorphic evolution. These principles are well documented within the current literature. For example, Petts & Gurnell (2005) states that fluvial geomorphology is responsible for maintaining the structural features essential for a healthy riverine ecosystem.

Recovery potential is an indicator of physical disturbance-related threats and pressures. It is assessed on observable features such as the condition, ecological processes (e.g. weed succession), land use (e.g. livestock grazing and trampling impacts), presence of infrastructure (e.g. dams) and the rate/degree of physical pressures acting on the reach over time and space.

The fragility classification was developed as part of the *Hunter River Styles* report (Cook and Schneider 2006) and based on the adjustment potential of three main characteristics of each river style—channel attributes (geometry, size and connection to floodplain), stream planform (lateral stability, number of channels and sinuosity) and bed character (bedform and bed materials). Stream fragility was defined as the susceptibility/sensitivity of certain geomorphic categories to physically adjust/change when subjected to degradation or certain threatening activities. Significant change is more often seen in stream types that have higher levels of fragility i.e. streams that are not robust or have lower resilience). This significant adjustment can also result in certain geomorphic categories changing to another one when a certain threshold (level of disturbance) of a damaging impact is exceeded.

Three categories were then derived based on this definition:

- Low fragility: resilient ('unbreakable'). Minimal or no adjustment potential. Only minor changes occur, such as bedform alteration, and the category or subcategory never changes to another one, regardless of the level of damaging impact.
- Medium fragility: local adjustment potential. It may adjust over short sections within the vicinity of the threatening process. Major character changes can occur or the category or subcategory can change to another—but only when a high threshold of damaging impact is exceeded, e.g. it may require a catastrophic flood, sediment slug or clearing of all vegetation from bed, banks and floodplain.
- High fragility: significant adjustment potential. Sensitive. It may alter/degrade dramatically and over long reaches. Major character changes can occur or the category or subcategory can change to another one when a low threshold of damaging impact is exceeded, e.g. clearing of bank toe vegetation alone).

In this assessment, the likelihood (or resilience) is indicated by the vulnerability or susceptibility (stream fragility) to physical disturbance threats (recovery potential). Thus, the method calculates the likelihood as:

$$\textit{Likelihood} = \textit{fragility} \times \textit{recovery potential}$$

The following table shows how the likelihood was calculated for different levels of recovery potential and fragility.

			<i>THREAT</i>					
			<i>River Styles Recovery Potential – based on Condition</i>					
			<i>Conservation</i>	<i>Strategic</i>	<i>Rapid</i>	<i>High</i>	<i>Moderate</i>	<i>Low</i>
			6	5	4	3	2	1
<i>VULNERABILITY</i> <i>River Styles Fragility</i>	<i>High</i>	3	18	15	12	9	6	3
	<i>Medium</i>	2	12	10	8	6	4	2
	<i>Low</i>	1	6	5	4	3	2	1

The assessments of likelihood shown above were combined spatially so that each river reach was assigned likelihood value to identify the areas that are most vulnerable to threats. Five likelihood categories were determined. From these five categories, each river reach was assigned a value ranging from 0 to 1, as shown below.

<i>Likelihood Score</i>	<i>Category</i>	<i>Risk Input Score</i>
18–15	Very high likelihood	1
12–10	High likelihood	0.8
9–6	Moderate likelihood	0.6
5–4	Low likelihood	0.4
3–1	Very low likelihood	0.2

Consequence

Consequence refers to the loss or damage to something of value. Therefore, the instream value assessment described in the previous section was used. The instream value assessment gave each river reach in the catchment a score ranging from 0 to 1.

Risk

The method calculates the *risk of physical disturbance to instream value* for each river reach as:

$$Risk = likelihood \times consequence$$

In this case:

$$Risk \text{ of physical disturbance to instream value} \\ = (fragility \times recovery \text{ potential}) \times instream \text{ value index}$$

Risk of water extraction to instream value

Likelihood

For the assessment of *risk of water extraction to instream value*, likelihood is indicated by the Hydrological Stress Index from the WSPs used in the RCI. Hydrological stress is taken as an indicator of the likelihood of water extraction leading to damage to instream ecosystems. River reaches therefore received a likelihood score, being the Hydrological Stress Index developed as part of the RCI discussed previously.

Consequence

Consequence refers to the loss or damage to something of value. Therefore, the instream value assessment described in the previous section was used. The instream value assessment gave each river reach in the catchment a score ranging from 0 to 1.

Risk

Thus, the method calculates the *risk of water extraction to instream value* for each river reach as:

$$\text{Risk} = \text{likelihood} \times \text{consequence}$$

In this case:

$$\begin{aligned} \text{Risk of water extraction to instream value} \\ = \text{Hydrologic Stress Index} \times \text{Instream Value Index} \end{aligned}$$

Combined risk to instream value

To evaluate the combined risk to instream value, the final scores from risk of physical disturbance to instream value and risk of water extraction to instream value were combined. By averaging these scores, a value between 0 and 1 was calculated to represent the overall level of risk.

When calculated from the raw information as described above, the actual distribution of risk values were heavily lumped into a small range. The main reason for this was that the hydrologic stress data used could not be broken down to river-reach level in the time of the trial (as discussed earlier, the Office of Water is addressing this now). A greater differentiation of risk values was needed to prioritise within the region. This was achieved by converting the raw risk values to the number of standard deviations from the mean. Such converted values are, however, not comparable across different CMA regions.

Four risk categories were used:

<i>Variance from the mean</i>	<i>Risk category</i>
<-0.5 standard deviations	Low risk
-0.5–0.5 standard deviations	Moderate risk
0.5–1.5 standard deviations	High risk
>1.5 standard deviations	Very high risk

3.8.3. What was achieved

It was proved that it is possible to use currently available information to construct a useful risk assessment. Maps were prepared as shown on the following pages. In addition to being used for WSPs and CAPs, the maps also have the potential to be used by local government as part of its constraints mapping when developing land-use plans.

Limitations to the level of detail provided by the WSP data were an issue for the trial. Since the mapping of the WSP data was based on 33 water sources, rather than river reaches, differentiation between river reaches is not possible for this data, even though variation would certainly exist. Improvements to the hydrologic stress assessment to link it directly to river reaches (as discussed in the RCI) would improve the risk assessment and probably remove the need to convert the data to allow differentiation.

There is also a reliance on the validity of the value assessment, which, as was shown in the previous section, is in need of further refinement.

Land tenure or use was not taken into account—i.e. for the trial it was assumed that physical disturbance is equally likely, regardless of land tenure. For example, consideration of land-use zonings (via local environment plans), national parks and state forests, which are spatial, could be a refinement to the risk assessment.

These maps are capable of being prepared for other parts of the state for small additional cost, assuming that the value and condition assessment information as described previously is available. However, the community value, River Styles, biodiversity forecaster and hydrologic stress information for many areas may not be available for some time.

3.8.4. Key learnings

- A risk assessment at a river-reach level was constructed and shown to be feasible for most of New South Wales for a relatively low cost, based largely on existing data collection programs. Further work to improve datasets and take account of land tenure is possible for relatively low cost.
- Risk assessments at a river-reach level provide a meaningful and supportable basis for prioritising and guiding actions under WSPs and CAPs and a range of other related activities, e.g. to input to local government land-use planning and development-approval decisions.
- The trialled risk assessment is built on two types of threats: the physical disturbance of the river and associated catchment, and water extraction. The assessment of likelihood of damage from physical disturbance was based on scientific work using assessments of stream fragility and recovery potential. This is generally applicable and can be derived from River Styles assessments that are expanding in coverage in New South Wales. It represents a 'resilience'-based approach to risk assessment.
- The assessment of likelihood of damage from water extraction in the unregulated rivers was based on likely change to low flows. This is appropriate in coastal and upland catchments, but would need to be added to in the drier inland to represent where extraction from moderate to higher flows is significant.
- The risk assessment is reliant also on the integrity of the value assessment information discussed previously.

Figure 15: Risk of physical disturbance to instream value

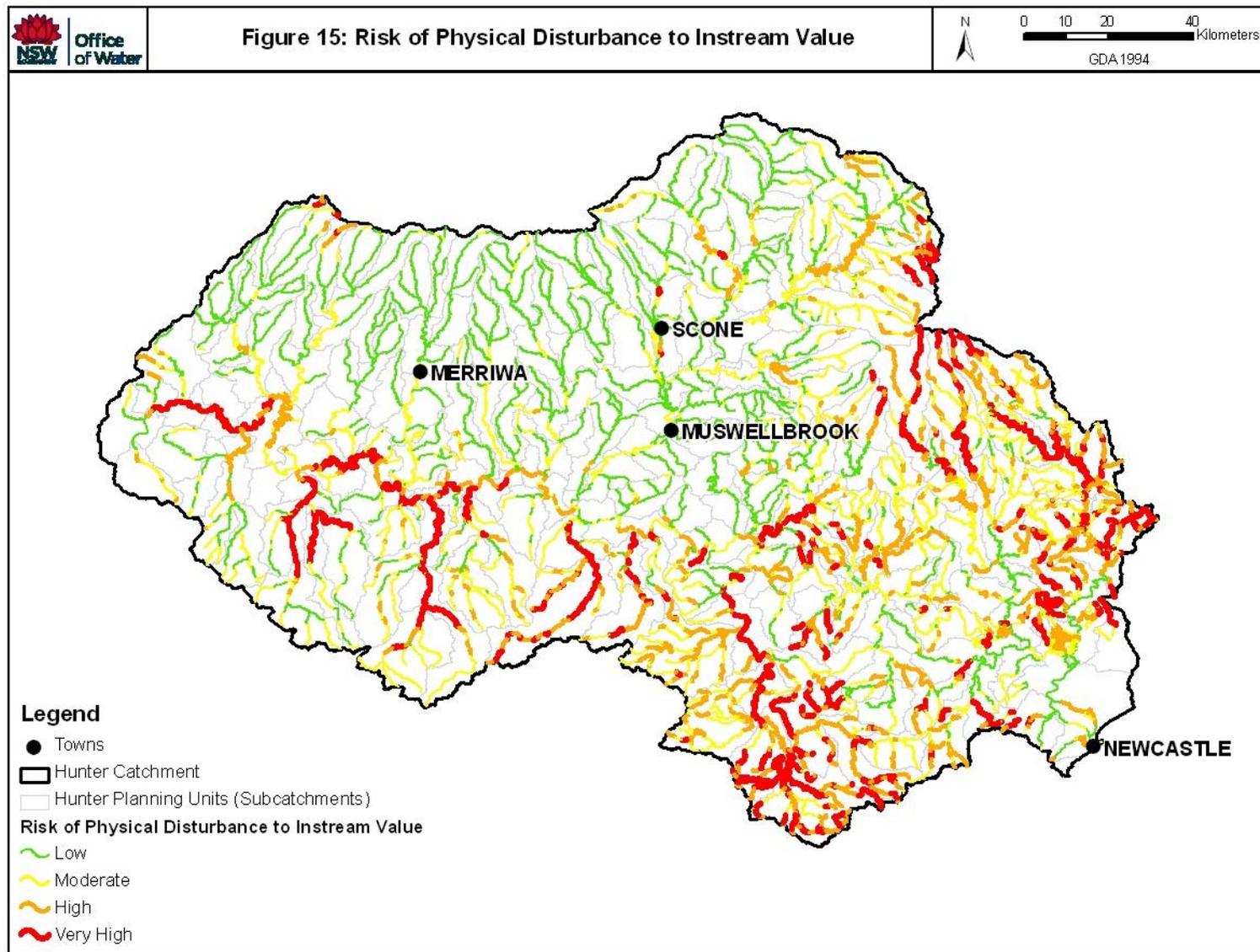


Figure 16: Risk of extraction to instream value

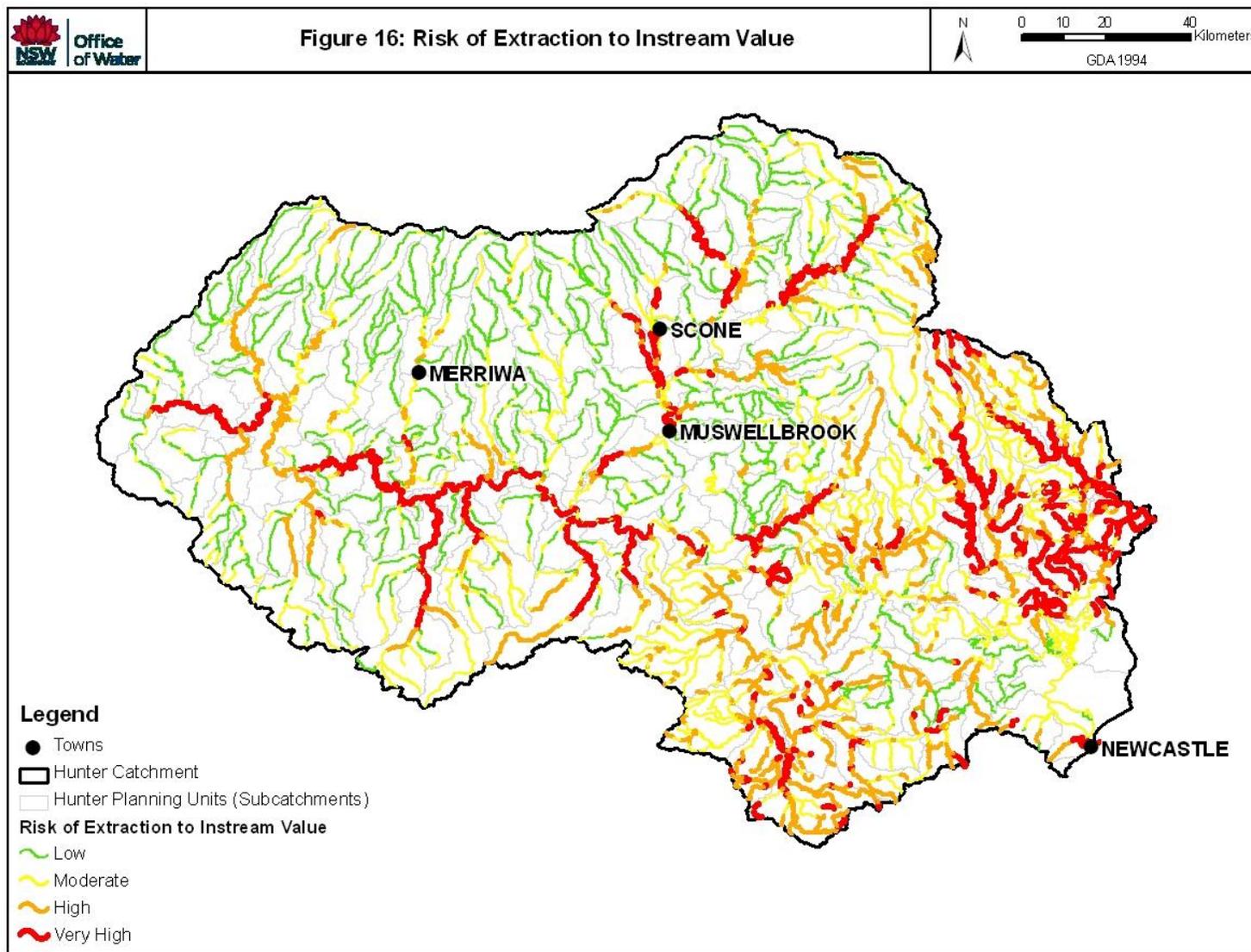
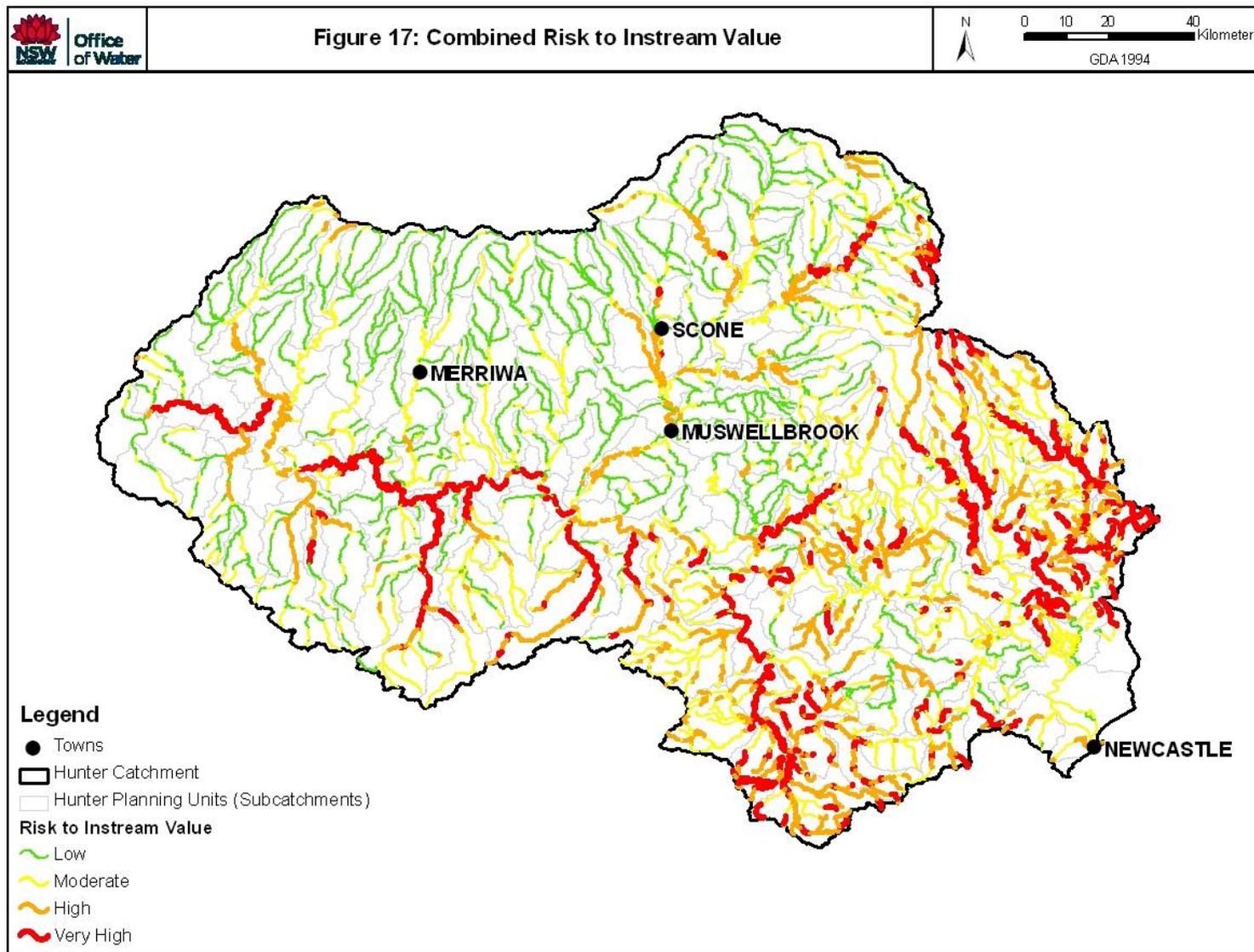


Figure 17: Combined risk to instream value



3.9. Alignment of objectives and strategies

3.9.1. Purpose

As explained earlier, the term ‘objectives’ is used generically in this report for results that are intended to be achieved by implementing the plans being considered. There is considerable variation in the actual terminology used, with terms like ‘outcomes’, ‘targets’ and ‘objectives’ being used in different ways from plan type to plan type and jurisdiction to jurisdiction. ‘Objectives’ is used here to represent any and all of them.

The Phase 1 report noted that both CAPs and WSPs have objectives relating to aquatic ecosystems. If objectives in plans can be aligned, then it is likely that more effective and efficient management action will follow. Well-structured plans have SMART (specific, measurable, achievable, relevant, time-bound) objectives, with strategies and monitoring and review mechanisms tightly aligned to them. Objectives thus define what plans are intended to achieve and where regulation and investment is to be focused. Alignment of aquatic ecosystem objectives in CAPs and WSPs is therefore fundamental to integration.

To achieve this, these objectives must not only be similar but also sufficiently specific, and clearly indicate where priorities are within the CMA region. General objectives such as ‘water sources and dependent ecosystems should be protected and restored’ do not achieve this. Within the CMA region, for defined rivers, wetland, aquifers, estuaries, the objectives need to specify the targeted resource condition and the priority to achieve that target. This may be based on having a common, prioritised set of resource/ecosystem assets with accompanying condition targets that reflect the value and importance of the ecosystem services provided. There are likely to be a hierarchy of objectives, clearly linked at the top, to achieving state and national objectives when they are present.

Providing information that can be readily used for decisions by government agencies, supports better alignment of planning and operational activities. Examples are:

- prioritising grant funding and other NRM investment
- granting approvals for constructing water supply works (pumps, dams, etc.)
- local government making land-use development control plans
- issuing controlled activity permits and determining riparian buffer widths for development assessment
- granting new water access licences or change of location of licences.

Detailed spatial mapping of areas where protection or rehabilitation of land and vegetation (e.g. priority riparian zones, wetlands) can assist greatly in considering such applications and ensuring that catchment priorities and objectives are not undermined. Likewise for mapping areas where there is a priority for additional management of water extraction, e.g. for protecting or restoring low flows in rivers, maintaining groundwater levels near wetlands, etc.

It was determined to use the trial to evaluate how this might be achieved.

3.9.2. Method

The program logic model used in the Commonwealth Natural Resource Management Monitoring, Evaluation, Reporting and Improvement Framework (see Commonwealth of Australia 2009) was used to align objectives and strategies in WSPs and CAPs.

Program logic is intended to capture the rationale behind a program, outlining the expected cause-and-effect relationships between program activities, outputs, intermediate outcomes and longer-term desired outcomes. Program logic is usually represented as a diagram or matrix showing a series of expected consequences, not just a sequence of events. The Commonwealth program logic model is commonly used by CMAs for CAPs and the underlying logic can equally be applied to WSPs. Broadly, it has the following components:

- foundational activities that underpin the program or plan
- immediate activities and outcomes—easily identifiable activities and related immediate goods, services and infrastructure
- intermediate outcomes—a combination of biophysical and non-biophysical results that lead to change by way of maintaining and/or improving NRM asset condition
- longer-term outcomes—tangible and measurable changes resulting from maintaining and/or improving NRM assets.

A program logic diagram shows the causal relationships between the components.

The Commonwealth framework also provides guidance on good practice in specifying outcomes and linking them to monitoring and evaluation.

Because CAPs and WSPs share desired longer-term outcomes, it is possible to construct a combined program logic diagram in relation to those shared outcomes, maintaining the intent of the current plan objectives. Both plans share a link to common state-wide NRM targets, and both are reviewed in relation to their contribution to the targets.

To incorporate intra-regional priorities into the objectives and strategies, the approach required adding references to maps of action priority, based on the risk assessment discussed in the previous section.

Preparation of action priority maps

Priority maps were produced, based on the combined risk assessment and input datasets for the RCI.

A priority map was developed for riparian vegetation action using the combined risk assessment, but differentiating where riparian vegetation needs to be protected and where it needs to be restored, using the NRVI.

Similarly, a priority map was prepared for river geomorphology action (e.g. instream stabilisation works), using the combined risk assessment and the Geomorphic Condition Index to guide where protection or restoration are needed.

A priority map for WSP stream-flow protection and restoration was envisaged but not able to be prepared within the timeframe of the project because hydrological stress is currently only mapped at a subcatchment level rather than by river reach. However, it is feasible to do so after a review of the hydrological stress dataset, as was mentioned earlier in the discussion of the River Condition Index.

Specification of shared priorities in plan objectives

A combined CAP/WSP program logic was developed for river health. It aimed to:

- spell out of the linkage to state NRM targets at the top level, overarching both types of plans
- refine objectives to be more SMART and less vague and general
- use the RCI as a common method to assess progress in river condition
- reference action priority maps, reflecting the shared risk assessment in the objectives of CAPs and WSPs.

It was assumed that current strategies would then be evaluated and retuned to these shared priorities when they are next revised.

3.9.3. What was achieved

It was proved that a more aligned set of objectives for WSPs and CAPs could be achieved, based on a shared, risk-based action priority assessment, and that the practice in specifying objectives could be improved without losing the original intent of the respective plans. It was also shown that river reach-scale, action prioritisation maps could be prepared readily from the RCI and risk assessment maps.

A paired program logic using the established Commonwealth framework that links WSP and CAP objectives to common state NRM objectives was prepared. Alignment of strategies was enabled through reference in the program logic to priority action maps for different types of management actions, linked to a shared risk assessment. This provides a strong direction for coordinated activity to better achieve state NRM targets without unduly constraining or dictating how the plans achieve the result. It can also lead to more effective monitoring and evaluation of achievement of natural resource outcomes.

The combined program logic and the two priority maps developed are shown on the following pages.

The program logic developed is suitable for a starting point for a paired WSP–CAP program logic template to be used across New South Wales. It would be beneficial to refine the template and to document the logic (assumptions and linkages), and also to develop a manual for how to use it and apply best practices in the development of plans.

The HCRCMA is developing data that ranks the community's 'willingness to participate'. Further development of this data is suggested so that it could be incorporated into the priority for action assessment.

Implementation relies on cross-agency agreement to incorporate these outputs into NRM planning process. However, at officer level in the Hunter there was a strong level of support because of the benefits. It was noted that there is a need for increased staff education in program logic concepts and framework and good practice in defining objectives, strategies, monitoring, evaluation and review into plans and programs.

3.9.4. Key learnings

- Both WSPs and CAPs have objectives/outcomes/targets at different levels, strategies/actions and monitoring/reporting, all of which are explicitly or implicitly linked. By explicitly drawing out and documenting these in program logic charts, it is possible to identify how the plans can be aligned to better achieve shared objectives. The Commonwealth has a framework for program logic that is applied to NRM programs across Australia that can be used for doing this.
- This alignment can be achieved by redesigning the existing objectives and strategies so as to refer to shared risk-assessment maps. It can be done without losing the original intent of the objectives, simply by refocusing them on shared priorities for action. Additionally, the shared condition index provides a common basis for monitoring achievement of outcomes at this level.
- The result of applying this is regulation and investment that are focused on where they will result in the greatest gain in terms of natural resource outcomes, plus reduced duplication in plan development through the use of shared condition, value and risk assessments, and a shared, more rigorous monitoring scheme.

Figure 18: Linked WSP and CAP program logic

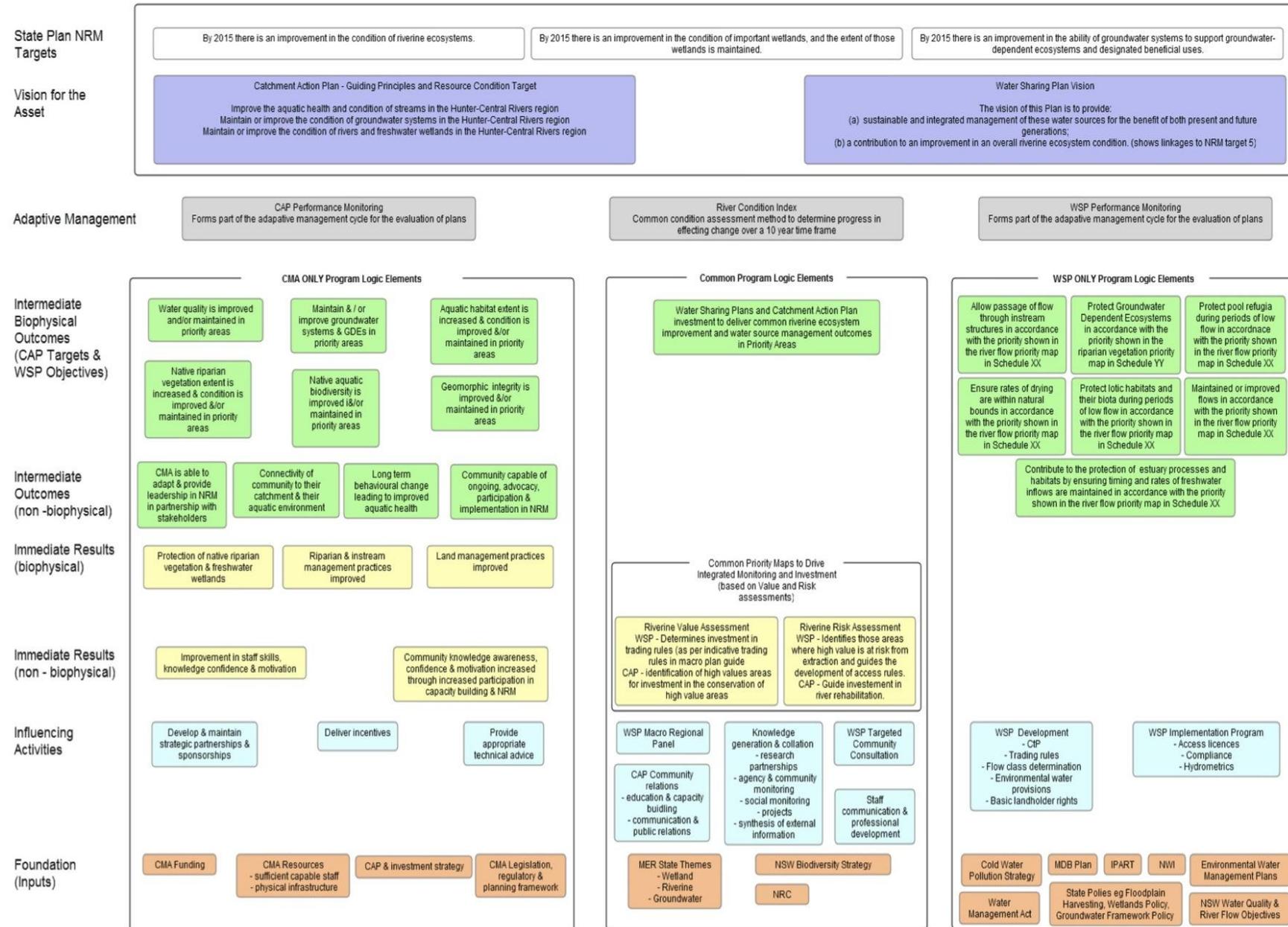


Figure 19: River geomorphology action priority

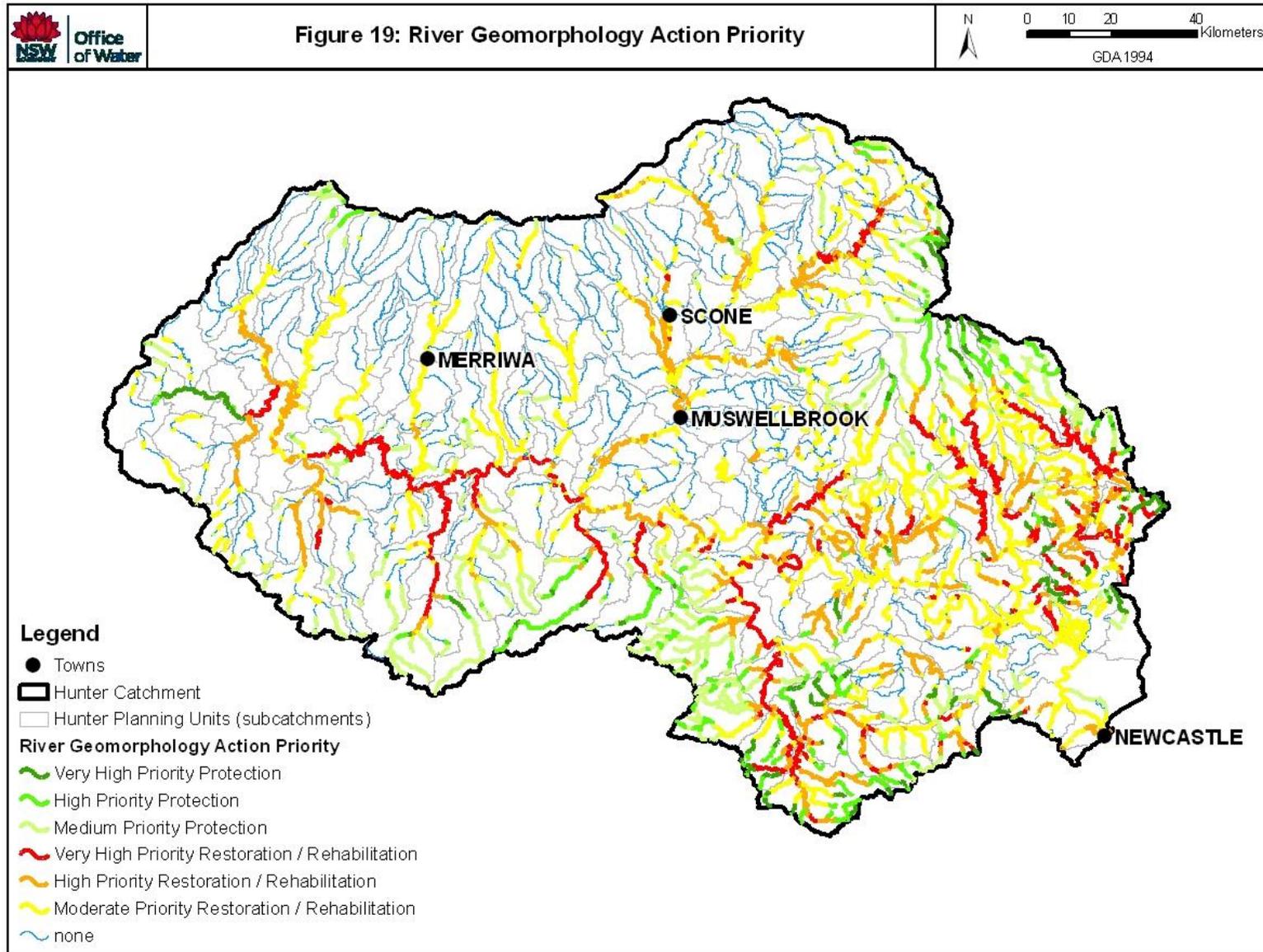
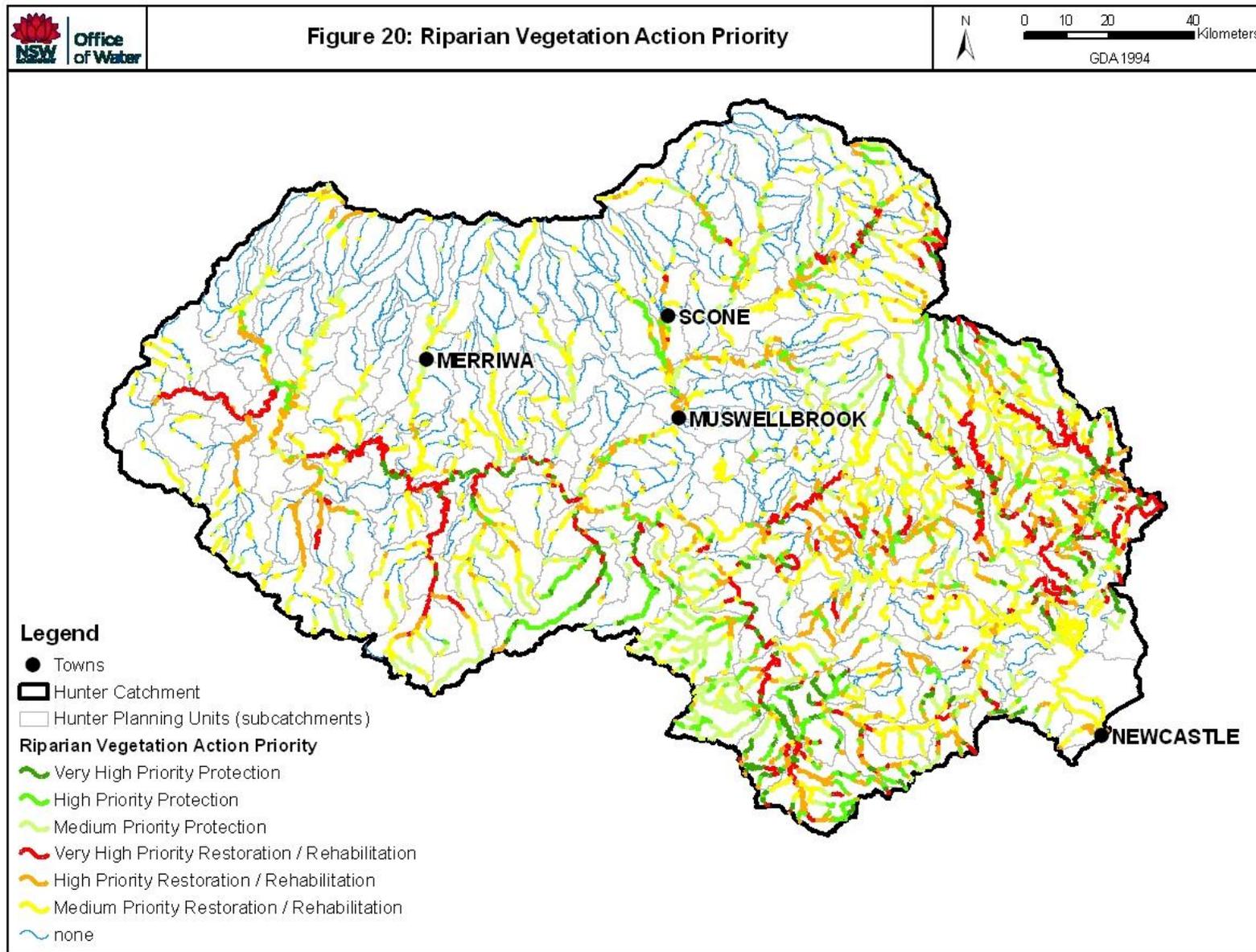


Figure 20: Riparian vegetation action priority



3.10. Impact of trialled mechanisms on alignment

The analysis below shows how the state of alignment of CAPs and WSPs in New South Wales would change if the trialled mechanisms are implemented. The current status is shown in summary form—fuller detail was provided earlier.

Table 4: Effect of implementing trialled mechanisms on alignment of CAPs and WSPs

<i>Framework principle</i>	<i>Current status in NSW (summary)</i>	<i>Effect of implementing trialled mechanisms</i>
Policy, law and governance		
1. Jurisdictional legislation and policy should allow, and preferably facilitate, alignment of water allocation and catchment planning.	Preparation of either type of plan to 'have regard to' the other.	Shared, spatially defined priorities and linked program logics provide a means by which the plans can have regard to each other.
2. There should be jurisdictional policies and objectives to manage freshwater aquatic ecosystems that apply to both types of plans.	Both types of plans assessed for effectiveness in contributing to common state NRM targets relating to aquatic ecosystem condition.	No change
3. There should be governance arrangements to support ongoing coordination between relevant agencies at a state and regional level in developing plans and implementing actions that contribute to shared objectives.	Interagency coordinating groups in place at a state level. Consultation between agencies at a regional level occurs when plans are being developed.	Ongoing regional interagency aquatic theme teams provide a means to enhance existing focus and for stronger coordination at a regional level.
4. There should be common guidelines for methods and procedures for shared or linked aspects of planning and management.	There are no common guidelines.	Trialled mechanisms provide a basis for establishing shared guidelines for assessments and program logic.
Plan initiation and situational analysis		
5. There should be an ongoing, coordinated approach to community engagement and input that respects the time and contribution of common stakeholders.	Each agency has developed and implemented its own approach to community engagement independently.	Only able to be partially touched on in the trial—subject to further development.
6. Spatial coverage of plans should be aligned.	Generally spatial alignment is good.	No change.

<i>Framework principle</i>	<i>Current status in NSW (summary)</i>	<i>Effect of implementing trialled mechanisms</i>
7. Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process that makes best use of combined agency skills and resources, uses best practice, is standardised and uses repeatable methods with clear spatial definition of aquatic ecosystem assets.	Condition monitoring at a whole-of-catchment scale coordinated across agencies. Otherwise each agency acting independently.	The shared process for river condition, value and risk assessments, proven to be feasible in the trial would provide compliance with this principle as far as river ecosystems are concerned.
8. Spatial representation of assessments should be sufficiently detailed to inform, within-region prioritisation decisions for both types of plans.	Some assessments (e.g. River Styles) available at a detailed spatial scale.	Spatially mapped risk assessments developed in the trial are sufficiently detailed to inform prioritisation for both types of plans.
Resource and ecosystem objectives		
9. A paired program logic mapping for both planning processes in each region should be developed to include shared freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined priorities for protecting and restoring freshwater aquatic ecosystem assets.	CAPs generally are underpinned by a formally developed program logic based on national guidelines. WSPs have not done this. While both types of plans typically have objectives relating to aquatic ecosystem condition that are not inconsistent, they are not specific or spatially defined enough to provide alignment.	The program logic developed provides a model for linking WSP and CAP aquatic ecosystem objectives, based on shared, spatially defined, within-regional priorities.
Identifying, assessing and deciding strategies		
10. Strategies and management targets built into plans should reflect shared assessments of risks, built on shared priorities set out in aquatic ecosystem objectives.	Strategies in WSPs and CAPs are not inconsistent, but do not provide for any sense of within-catchment shared prioritisation of activity based on risk.	The program logic developed uses shared risk assessments to align CAP and WSP strategies to shared, spatially defined, within-regional objectives and priorities for action.
Implementation		
11. Plans should provide flexibility to adapt management actions where opportunities arise for coordinated action to improve aquatic ecosystem condition or to address previously unidentified risks to aquatic ecosystems.	CAPs allow considerable flexibility in investment. WSPs generally have fixed regulatory rules that apply for the term of the plan. Some flexibility is available through adaptively manageable environmental water and, in some cases, defined opportunities to adjust rules (within bounds) at plan mid-term.	No change.

<i>Framework principle</i>	<i>Current status in NSW (summary)</i>	<i>Effect of implementing trialled mechanisms</i>
12. Information needed to inform case-by-case consent and investment decisions affecting the achievement of shared objectives should be available to relevant agencies in a form that is readily usable (e.g. detailed spatial mapping, on accessible systems).	This has not been done.	Detailed risk maps meet this requirement and are potentially also able to inform other processes that affect aquatic ecosystems beyond the scope of WSPs and CAPs such as land-development approvals by local government.
Monitoring and review		
13. Aquatic ecosystem condition monitoring should be shared and coordinated, making most efficient use of cross-agency skills and resources.	Information at a whole-of-catchment scale has been shared and collection is being coordinated through interagency working groups accountable for state natural resource monitoring and reporting against the State Plan.	The RCI approach developed provides a means for substantially improving river condition monitoring and could potentially feed into state-wide reporting. It pulls together several monitoring and assessment programs across multiple agencies to achieve an integrated result at a detailed level.
14. Reviews of effectiveness of plans in achieving aquatic ecosystem objectives should include assessment of effectiveness of cross-plan alignment and coordination in achieving optimal return on investment.	Both types of plans are required to be assessed for effectiveness in contributing to common state NRM targets. Inclusion in such assessments of effectiveness of cross-plan alignment in delivering improved effectiveness has not been considered.	Shared river condition monitoring, risk assessments and linked program logics provide a mechanism by which overall effectiveness in achieving shared outcomes could be assessed. (Note that this does not replace the need for current programs designed to verify assumptions in WSPs concerning ecological response to flows.)

4. Conclusions

Integration through alignment

The National Water Commission has identified improving integration of water allocation and catchment planning as a key issue for implementing the National Water Initiative.

The condition of aquatic ecosystems is dependent not just on water management or land-use management, but on both. On the one hand action in one area may be defeated by inaction in the other; on the other hand action in one area can be greatly enhanced by coordinated action in the other. Additionally, because of the overlap in purpose in the planning processes, there is potential for duplication in some areas that can be eliminated, and agency resources/processes/knowledge that can be shared so as to deliver a greater return on investment.

Improving integration of water allocation and catchment plans can help greatly in addressing these things and, in doing so, improve community respect for and confidence in the plans and the regulatory and investment actions that derive from them, and in the government agencies responsible. It does this by demonstrating unity in approach and objectives; efficiency and effectiveness in use of community and government resources; and greater integrity in the decisions embodied in the plans.

Dictionary definitions of 'integration' indicate it means a unifying or bringing together into a whole. However, it can be achieved through approaches ranging from simply aligning and linking parallel processes through to combining processes into one. In practice, the potential benefits identified above can be realised without requiring the amalgamation of planning processes.

Given that these two types of plans, while overlapping, serve different purposes, and that large-scale institutional change would be required to bring both of these types of plans into a single planning process, the framework in this report aims to deliver a more integrated approach through improving alignment of these existing processes, with minimal change to institutions and legislation.

Recognising that the term 'integration' for many people implies amalgamation, the term 'alignment' has been used in the title of this report, because this gives a better sense of what is intended. Nonetheless the expected outcomes of alignment are those that the NWI is seeking when it refers to integration.

A framework for alignment

This report presents a framework for aligning water allocation and catchment plans that was trialled in New South Wales. The framework consists of 14 principles that address alignment in the different aspects of plan development. The greater the level of compliance with these principles, the greater the level of alignment and the more the benefits of alignment will be realised.

The focus for alignment is the overlapping area of managing freshwater aquatic ecosystems. It does not therefore consider aspects of catchment plans relating to other themes such as vegetation and land use, except in so much as they impact on aquatic ecosystem health. Nor does it consider the aspects of water plans relating to equitable and efficient sharing of water.

Underlying the framework is the premise that state and community resources cannot address all the threats to aquatic ecosystems, and so prioritisation is required. *Alignment* in this report is taken to mean *the alignment of planning and coordination of action so as to deliver the maximum return for regulation and investment*. Within any planning area some ecosystems are more highly valued than others, some are more under threat than others, and some have greater potential for protection or recovery from damage. Alignment requires action to be planned and coordinated in a way that takes these factors into account so as to yield the maximum benefits.

The trialling of mechanisms to implement the framework in the Hunter Valley demonstrated the viability of the framework. In relation to applying the framework in New South Wales, the trial determined:

- the feasibility of a regional interagency aquatic team and its potential value in terms of improving natural resource outcomes and leveraging much greater return from existing investments by agencies
- that it is possible to develop detailed maps of river condition, value and risk using already available information, and that these have a range of potential beneficial uses
- that alignment of objectives and strategies between CAPs and WSPs using a combined aquatic health program logic and risk based action priority maps is definitely achievable.

The trial was not able to fully address the technical veracity of the methods used for condition, value and risk assessments, and several limitations were noted. Further work is required before they are rolled out further. Additionally, for state-wide rollout, there are gaps in datasets that will take time and funding to fill. A complete plan and costing for doing so remain to be done.

The trial did not attempt to address operational alignment and coordination, though during the theme team meetings ideas for improved operational coordination came up in discussions (e.g. taking hold of opportunities when landholders change, or licences are transferred). The same is true for monitoring programs. These could be a role of standing regional interagency aquatic teams.

Under current NSW institutional arrangements, success in alignment is heavily reliant on interagency cooperation and having standardised methods. The trial identified that significantly improved alignment and coordination, with substantial potential NRM benefits, is achievable. To realise these benefits, governance and interagency protocols that will withstand institutional and staff changes need to be put in place.

At a more general level, the trial showed that:

- development of a shared, spatially expressed approach to river ecosystem condition, value and risk assessment is the key underpinning for most of the alignment principles
- robust state and regional-level mechanisms for cross-agency coordination and cooperation are essential and achievable
- the presence of state-driven aquatic ecosystem objectives, to which both types of plans and the responsible agencies were expected to contribute, provided a focus under which alignment could be built
- the development of linked program logics for each type of plan is feasible and provides a coherent and logical framework for constructing plans that are defensible and demonstrate alignment
- the realisation by agency staff that the potential benefits of alignment for their own accountabilities are real and significant engendered enthusiasm to contribute time and resources, and to make accommodating adjustments.

Given this, while all of the framework principles are relevant, the following are likely to make the biggest difference and drive achievement of most of the other principles:

- There should be jurisdictional policies and objectives for managing freshwater aquatic ecosystems that apply to both types of plans.
- There should be governance arrangements to support ongoing coordination between relevant agencies at a state and regional level in both plan development and implementing actions that contribute to shared objectives.
- Freshwater aquatic ecosystem condition, value and risk assessments should be done in a single, shared process.
- Spatial representation of assessments should be sufficiently detailed to inform within-region prioritisation decisions for both types of plans.

- A paired program logic mapping for both planning processes in each region should be developed and include shared, freshwater aquatic ecosystem objectives that are aligned through shared, spatially defined priorities to protect and restore freshwater aquatic ecosystem assets.

Overall, the framework, if applied, has potential to substantially improve water ecosystem outcomes and the return on investment by governments in catchment and water planning, and in related activities such as monitoring and assessment programs.

Additionally, the approach to developing the framework could be used for developing similar principles to align other plans that share a common area of outcomes.

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Appendix A: Evaluation of river condition index

Consistency with FARWH method

The FARWH method recommends a range of factors to be taken into account when developing a condition index. Each requirement of FARWH is outlined below and commentary is provided on how the approach taken in the trial satisfies the criteria.

Indices to be relative to a reference condition.

The GCI scores are based on expected assemblages of geomorphic features for particular river types. The Office of Water has also been compiling a reference-reach dataset for a River Styles in New South Wales to establish benchmark geomorphic condition. This project is ongoing.

An attempt was made to develop a reference condition for the NRVI scores. These were expressed as the coverage of vegetation relative to a benchmark for the particular vegetation type (Keith class) assigned to the river reach. However, there are some limitations with the scale of these classes. However, it may be possible with further funding to derive regionally based data on the reference condition of riparian vegetation at the River Styles reference reaches, using DECCW's vegetation assessment protocol. This will be further investigated.

Since there is limited historical extraction data, it is difficult to accurately determine natural river flows relative to a reference condition for the HSI. Therefore post-extraction flows were used. In most cases, hydrological stress equated to the ratio of peak daily demand for extraction to the 80th percentile for the critical month. The critical month is the month when demand is highest relative to river flow.

The RBCI uses predicted macro-invertebrate condition by extrapolating sampled data using an upstream–downstream disturbance model. The sampled data is assigned values according to AUSRIVAS method that scores sites based on the observed/expected ratio linked to a reference condition.

Indices to be linear and range standardised 0–1 and in increments of 0.1.

All of the subindices and the RCI are range-standardised, using methods and formulas described in FARWH manuals.

Indices divided into condition bands

The subindices were split into 10 condition bands for GCI, NRVI, RBCI, and five for HS. The RCI is divided into five condition bands that match the bands described in FARWH.

Indices weighted to the finest scale—usually stream length or wetted area.

The RSC and RVC subindices are based on reach–scale mapping and use the River Styles stream layer. This layer is mapped at approximately 500 m-reach lengths. The RBCI index uses data mapped for 9,140 subcatchment units, using a digital elevation model. This scale could allow conversion of RBCI data to the River Styles river-reach units, if the RCI needed to be completed at a river-reach level. The HS index is determined for all 174 planning units. However, the macro-planning process was undertaken at a coarser scale of 33 water source catchments. Accordingly, the GCI, NRVI and RBCI scores received a higher overall weighting than the HS score.

Euclidean distance recommended where inverse ranking is not possible.

Euclidean distance was used to determine the RCI score and was considered the best method of integration.

Undertake sensitivity analysis to determine which indices contribute most to evaluations.

A sensitivity analysis was not undertaken as part of the trial.

At least three of the six component indices should be present before an overall assessment can be reported.

The RCI used input index scores that aligned with four FARWH categories: 'physical form,' 'fringing zone', 'hydrological change' and 'aquatic biota'.

At least 5 per cent of river reaches or wetlands should be represented for each water management area.

The actual percentages of river reaches were not calculated. However, given the GCI and NRVI scores were determined for all streams of fourth order and above for each of the 174 planning units and the named stream in the planning unit was mapped to its source, it is assumed that greater than 5 per cent is represented.

The specific reach coverage of the HSI score cannot be determined as the stress value applied to the entire WSP water source (33 in the trial area).

Dataset coverage

All of the datasets used for the RCI in the trial have complete coverage for the Hunter catchment. However, coverage of the rest of the state is not complete.

River Styles

- Approximately two-thirds of New South Wales is completed except for the Murray, Lachlan, Far West and Murrumbidgee, parts of the Snowy and the south coast.
- The Office of Water is negotiating with CMAs to complete the mapping through the CMA knowledge budgets.
- This dataset is not exclusive to the process and can be used in a number of applications, e.g. CMA investment in river rehabilitation, NSW water planning process in identifying drought refugia (physical habitat) and recovery potential (under special features). There are also cases where the Department of Industry and Investment uses the data to plan improvements in fish passage.

Riparian vegetation

- Riparian vegetation mapping has been completed for all coastal CMAs, the Murray–Murrumbidgee and parts of the Border Rivers, Namoi and Central West CMAs. The Office of Water is pursuing additional funding to complete the mapping for the remainder of the state. This dataset is used in a number of applications, e.g. CMA investment in riparian vegetation benchmarking.
- All CMAs have Keith vegetation canopy benchmarks for each Mitchell Landscape. Specific local riparian canopy benchmarks do not occur for all areas.

River biodiversity condition

- Currently, the information is only available in the Hunter River catchment. However, it can readily be expanded to cover the rest of the state.

Hydrologic stress

- At present 45 WSPs have been gazetted in New South Wales. These plans cover the most inland and coastal regulated rivers and some unregulated rivers and groundwater sources, inland and on the coast.
- All remaining regulated rivers, unregulated rivers and groundwater sources in the Murray–Darling Basin are being developed. Following significant progression of these inland plans, the planning focus will return to the coast to finalise outstanding unregulated river and groundwater plans. WSPs will eventually cover all of the state.

Limitations of datasets

Hydrologic stress

The macro-planning process in the Hunter determined hydrologic stress at the scale of 33 water sources for the whole Hunter. Assuming this level of stress applies homogeneously within each water source, it is likely to overestimate or underestimate the hydrological stress for component planning units (174) or individual river reaches. In the current case it appears to have resulted in an unreasonable proportion of the Hunter being in poor hydrologic condition. The Office of Water is currently working on calculating hydrologic stress at a river reach level.

Additionally, there are some areas for development.

- The hydrologic stress data is determined assuming the rate of water extraction is a proportion of entitlements rather than actual metered extraction information, which is currently unavailable. As metering is introduced better data will be available
- The hydrologic stress rating is based on estimated peak daily demand in the peak demand month, as compared to flows in the peak month. It is based on coastal catchments where there are few off-river storages and crop water is supplied from rainfall supplemented by irrigation in dry times—thus peak demand occurs at times of low flow. The Office of Water is considering how the rating may need to be adapted for inland rivers where off-river storages are more common and harvesting of water in moderate and higher flows is significant.

Riparian vegetation

Benchmark values for vegetation types require further refining to improve the accuracy of the RVC index score. In particular, a full range of riparian vegetation class ranges should be developed locally for each CMA. An option may be to use the riverine theme and River Styles geomorphologic reference reaches in good condition as reference reaches for the vegetation benchmarks.

Additional datasets

The index could be further bolstered by additional types of data.

A reference-based scoring process for fish, based on data collected for the Murray–Darling Basin sustainable rivers assessment, needs to be developed for inclusion in the RCI assessment. This would provide a more representative assessment of biotic health, as we are only looking at one aspect at present—macro-invertebrate data.

It would also be valuable to investigate incorporating regionally defined spatial data sets, such as the regional water quality guidelines being developed by the Office of Water, and to incorporate a catchment disturbance index.

Future update of base datasets

The index is drawing its data from different government databases. There is potential for the index to be a live layer that reassesses index scores as changes are made to the subindex layers. This means that the best available data is always being used to calculate the RCI. For example, if a large water entitlement is transferred out of an area, this would adjust the hydrological stress score and therefore provide the opportunity for a CMA to invest in the same area.

<i>Input data set</i>	<i>How updated</i>	<i>Cost</i>
River Styles	Remote sensing	Low
Riparian vegetation	Remote sensing	Low
Macro-WSP—hydrologic stress	Re-evaluation of distribution of water entitlements Revision of flow statistics through modelling, etc.	Low High
River Biodiversity Condition Index	Update regressions using latest AUSRIVAS data	Low

An assessment needs to be undertaken on optimal ways to update datasets. For example, River Styles could be stratified into those areas that will show change only as a result of common investment. Hydrological data can be updated almost instantaneously as entitlements are traded into and out of areas. This would require a link between the spatial data and the Office of Water water-licensing dataset. CMA investment works can be used as an overlay to determine macro-invertebrate and River Styles updates.

Weighting and sensitivity analysis

The integration of information into indices incorporates assumptions about the weighting given to each component as they are combined. This has been done rapidly due to time constraints and without thoroughly assessing the validity and implications of doing so. The validity of combining the subindices into a single RCI was questioned and, indeed, it may not be necessary to do so. Further work is needed in this regard.