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Independent inquiry into the Clarence River System : progress  
report : specific challenges for river, floodplain and estuary  
health



# **Independent Inquiry into the Clarence River System**

## **Progress Report: Specific Challenges for River, Floodplain and Estuary Health**

December 1998

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# Overview

## Introduction

The Healthy Rivers Commission was established to conduct Independent Public Inquiries into selected river systems. Its task is to help the community and the NSW Government to make informed decisions about ecological, social and commercial goals for river systems. This involves identifying objectives for water quality, river flow and other aspects of river health, and ways of achieving them cost effectively and with a fair sharing of the benefits and costs.

In developing recommendations for river health, the Commission is guided by the concept that a healthy river encompasses a broad range of biophysical, economic and social characteristics which, in total, describe the river's environmental status *and* its ability to support patterns of commercial activity and the social amenity to which the community aspires. Thus the Commission's considerations relate not only to water quality and environmental flows, but also to the many other aspects of a healthy river that are encompassed within that broad concept.

'River health' is a function of the status of aquatic habitat (including wetlands), flows, water quality, riparian corridors, riverine biota and socio-economic aspects, all of which are impacted by the demands for water supply, sewage disposal, stormwater management, mining and extractive industries and land uptake. These, in turn, are driven by the various demands (including recreation) emanating from rural and urban land use within the catchment. The relationships are multi-directional and generally not linear. Current river health can be characterised as deriving from the collective actions of citizens, enterprises and government over time, all of which actions were influenced by the prevailing state of knowledge. The Commission observes that little of this action appears to have been guided by an understanding that river health can only be secured by treating rivers as whole systems.

This Healthy Rivers Commission Inquiry into the Clarence River system has incorporated an extensive consultation program in the Clarence catchment, to provide interested citizens with the opportunity to present their views on what factors are affecting the health of the river and what actions should be taken to address these. The consultation program to date has involved formal and informal processes, including meetings, site inspections, public hearings and the receipt and analysis of written submissions.

In each of its previous Inquiries the Commission has distributed a Discussion Paper, a Draft Report, and a Final Report, with formal and informal interaction with the community at all stages. In the case of this Clarence Inquiry, the usual Discussion Paper has been issued and the Draft Report is now in preparation. However, for the reasons explained in the following sections, the Commission believes it is necessary to augment its usual consultative processes, through the issue of this Progress Report which is intended to:

- inform the community about the factors that have been presented to the Commission in the Clarence Inquiry;
- describe the nature and key findings of the assessments that have been undertaken to date;

- signal the direction of further analyses and the likely nature and/or possible approaches that could be put forward in the Commission's Draft Report; and
- seek further input from the community on key factors affecting the health of the river system.

## Matters Raised in the Clarence River Inquiry

Members of the community, councils, county councils and state agencies have alerted the Commission to a broad range of factors which they consider are affecting the health of the Clarence River, including the social and commercial activities that are dependent on it. There were many points in common, although of course not everyone held the same view on each factor and/or what action should be taken to address the impacts.

The following key factors have been raised. They are grouped according to the major source of concern and/or debate surrounding them.

Matters of major concern about **water quantity** (river flows) include:

- impacts on the river, and its ecology, of water extractions for towns, irrigation and industry; and
- the adequacy of water supplies for viable and diversified agriculture, in light of emerging demands associated with new enterprises.

Matters of major concern about **riverine water quality** include:

- the impacts of soil erosion and siltation, including that from past and present mining activities;
- pollution attributable to stormwater and sewage entering the river from sewered and unsewered towns, rural residential development and boat use; and
- impacts of agricultural runoff, including some in areas where stock have access to water courses and some areas where specific poor land management practices occur.

Matters of major concern about **estuarine water quality** include:

- disturbance of acid sulfate soils associated with drainage systems, canal estates, dredging, and road causeways in and around the estuary; and
- aquaculture and resulting water quality impacts.

Matters of major concern about **drainage and flood mitigation works** include:

- the effectiveness of drainage and floodgate systems in the coastal floodplain in affording flood protection for agricultural activities; and
- the impacts of drainage and flood mitigation works on the environment and on recreational and commercial fishing.

Matters of major concern about **vegetation** include:

- the adequacy of the riverbank vegetation in terms of its habitat value, pollution filtering capability and effectiveness for erosion control;

- the impacts of terrestrial and aquatic weeds for river health and agricultural productivity; and
- the implications of changing patterns of land use, including the expansion of forestry and the associated fire management and weed management requirements.

Other matters of concern include:

- the effectiveness with which the responsibilities of councils, county councils and state agencies are defined and discharged; and
- the adequacy of the recognition given to Aboriginal cultural values as they relate to river access, for water supply and traditional hunting and gathering activities.

## The Commission's Key Assessments and Findings to Date

Most of the factors listed above are major determinants of river health in all coastal river systems. They have been raised in each of the Commission's earlier Inquiries, and in each Inquiry report they have been the subject of recommendations which aim to bring about new management approaches including altered decision making criteria and, in some cases, changed priorities for funding river protection and restoration activities. Those recommendations, have, in a sense, now become this Commission's 'generic recommendations for coastal rivers'. The key themes of those recommendations are as follows.

- The need for **integrated management** of rivers which requires that many complex interrelationships are recognised and dealt with *early* in decision making. The Commission's recommendations mean that decisions about any one part of the system must be rigorously tested to ensure that there would be no unintended or intolerable impacts elsewhere in the system. Equally, management of any one element must not preclude the realisation of benefits to the overall system that could be achieved by broadening the perspective and combining activities and decisions in alternative ways.
- The importance of clear and explicit **accountabilities, for river health and public health outcomes**, with commensurate decision making powers, and resources to implement necessary actions. This is particularly important in the area of sewage management, where the Commission's recommendations are for local councils to be both empowered and required to implement wastewater management plans that will rapidly achieve reductions in the adverse impacts on rivers of sewage, stormwater and agricultural runoff.
- The need to recognise river health costs (and other environmental costs) *early* in the processes of **land use planning**, and to incorporate them into planning decisions wherever there are trends towards displacement of agriculture by rural residential development. In such circumstances, the Commission's recommendations would lead to more explicit evaluation of the ways in which councils might be assisted to make decisions that are fully informed as to the true long-term costs of alternative development scenarios.
- The new emphasis that must now be placed on equitable arrangements for the **sharing of river water**, given that flows to meet environmental requirements must have greater security and that under some conditions there is competition among consumptive users for the remaining water available for extraction. The Commission's recommendations for managing river flows promote combinations of demand management initiatives and

restrictions on extractions that are designed to 'share the burden' when supplies from river flows are limited.

- The potential benefits to be derived from allowing the riverine corridor to fulfil, as far as practicable, its natural drainage and water purification functions, so protecting water quality and flows, as well as social and visual amenity. The Commission's recommendations in this area point to strategic planning and management of vegetation, with particular reference to weeds. They also advocate measures to protect stream beds and banks from the siltation and erosion resulting from rural roads and creek crossings, or from boating and sand and gravel extractions. Other recommendations in relation to the riverine corridor promote adoption of best practice farming, especially in areas of particularly sensitive riverbanks. Incentives rather than regulation are emphasised, and nowhere has the Commission promoted total exclusion of stock from riverbanks as the only, or primary, measure to improve water quality.

All of the evidence considered and analysis undertaken to date within this Clarence River Inquiry has led the Commission to the conclusion that the recommendations of previous Inquiries, as outlined above, will retain a high degree of relevance in the Clarence River context. *The Draft Report of this Inquiry will repeat the broad thrust of those recommendations, although there will be some (relatively minor) changes in emphasis, and in the finer detail of certain recommendations, to reflect particular local circumstances.* A description of other issues that the Commission will address in the Draft Report is addressed later in this Progress Report. The following examples demonstrate how the Commission's more 'generic' approaches will be adapted to address local circumstances.

- Recognition will be given to the vigorous growth of various types of weeds in the Clarence River system, within the context of the favourable climatic conditions. For example, priority could be given to managing camphor laurel and cats claw creeper in the Orara Valley.
- The application of flow management arrangements, including the measurement of use and restrictions on water extractions for existing and new users, will be adjusted to meet the known circumstances and requirements of different ecosystems and groups of water users within the Clarence River system. For example, it could be possible to fully satisfy the reported requirements of those landholders that occasionally draw water from the upper reaches of the Clarence River to irrigate canola and other crops. That is, many of these water users, for economic reasons, presently only draw water for around two weeks in some relatively wet summers, in order to 'finish off' a good crop. It could therefore be possible to accept a brief 'artificial drought', on the basis of achieving a higher level of flow protection at other times.
- The identification of priorities for managing wastewater, including sewage, will recognise the relative impacts on water quality in the various freshwater and estuarine reaches of the river system, in addition to the pressures associated with accommodating the needs of growing population centres. For example, the Commission has been advised that significant improvements in water quality could be achieved by upgrading the treatment of the sewage discharged into the upper reaches of the estuary.

The Commission's recommendations relating to priority actions for specific locations within the Clarence River system will have regard to the relative importance of the various elements affecting the health of the river. For example, the recommendations for the Dorrigo area will reflect the fact that, from the perspective of protecting instream ecosystems and the viability of commercial activities, there is greater urgency to address the impacts of stormwater runoff from farms, than to apply high restrictions on water access for existing irrigation operations.

## Specific Challenges Presented by the Clarence Inquiry

In the course of this Inquiry it has become evident that some of the matters relating to the health of the Clarence catchment and river system demand special attention and analyses that have not been required in the previous Inquiries in the more southern parts of NSW. It is clear that a number of the issues raised by the community and/or uncovered by the Commission's Inquiry processes present specific and complex challenges for river management<sup>1</sup>, and necessitate a new set of analyses by the Commission, so that appropriate 'Clarence-specific' recommendations may be formulated in relation to them. They include:

- the impacts of agriculture on coastal floodplain and estuary health;
- the impacts of canal estates and road causeways on estuary health;
- the impacts of aquaculture on estuary health;
- the interrelationships between fishing (commercial and recreational) and estuary health;
- the opportunities to achieve better river health outcomes by improving the integration of the provision of town water and sewerage services;
- the interrelationships between forestry and river health; and
- the interrelationships between proposed greenhouse gas actions and river health.

Each of these issues raises a number of specific, unique and complex questions about what objectives and strategies are most appropriate to secure a healthier Clarence River system. For instance, the Commission has assessed the impacts of residential development on river health in other Inquiries, but it has not assessed the impacts of canal estates. The issue of coastal floodplain management has been addressed in the Draft Report for the Shoalhaven River Inquiry, yet it is a more complex issue in the Clarence catchment given the size of the floodplain, the intensity and variety of development and the many institutional arrangements. With respect to forestry, fishing and greenhouse gas actions, the Commission's investigations to date indicate that there are many factors associated with these activities that are not fully considered at present, and that may pose benefits and disbenefits to river health.

Thus the Commission is convinced that further consultation about these issues with the community, agencies, councils and other groups is warranted, to ensure that the Commission's interpretation of the community's interests and concerns is accurate, and to provide for well-informed discussion of the various management options. This Progress Report therefore further describes those issues and outlines the Commission's preliminary analyses of them. Those analyses draw on the many pertinent existing studies, reports, plans, policy documents, on the community advice as expressed in submissions and discussions the Commission has had with groups and individuals, and on some specialist studies/consultancies the Commission has commissioned to shed further light on some of the more complex aspects.

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<sup>1</sup> Some of these newer issues may prove to be *unique* to the Clarence, although it is more likely that they will be revisited in subsequent Inquiries into the northern rivers of NSW. Therefore in analysing these issues the Commission is able both to draw on its earlier Inquiries and also to foreshadow matters that will be of major importance in its future Inquiries.

In some instances, the Commission has identified further technical analyses that will be critical, for its development of recommendations for river health objectives and future management strategies, but which have not yet been completed. This is particularly the case with regard to assessing the implications of introducing measures to protect river flows on town water supplies. Those further analyses, which have been delayed by a number of factors beyond the Commission's control, are described in this Report in order to signal the Commission's intentions and indicate areas where additional community input is sought.

# Agriculture

*In considering the implications of agriculture on coastal floodplain and estuary health, the Commission has had regard to both technical and management issues and initiatives. The Commission has been encouraged by the range of technical changes currently being implemented and recent management responses. Its assessment indicates that there is a need for an overall management framework for the effective integration of the management of coastal floodplains and estuaries that build on current initiatives in this area.*

## Agricultural Land Use and Impacts

The Commission received numerous submissions concerning the impact of agricultural activities on the health of coastal floodplain and estuarine ecosystems. It is evident that all sectors of the community place a high value on the coastal floodplain and estuary as an ecosystem and as the resource base for viable agricultural, fishing, tourism and recreational activities. This issue is of significant importance in the Clarence, as well as several other coastal catchments, but has not been as major an issue in other Inquiries the Commission has undertaken. Analysis to date indicates that agricultural use of the coastal floodplain presents several specific and complex issues for the Commission's investigation. These include the large scale and degree of river health impacts, the complex institutional arrangements that exist at present and the lack of an appropriate and effective management regime to allow implementation of technical responses and other actions.

Large amounts of land on the Clarence coastal floodplain are used for beef grazing and sugar cane growing, with smaller amounts used for dairy farming, tea tree cultivation and prawn farming. Extensive flood mitigation and drainage works were constructed from late last century to the early 1970s to enable increased use of the land. Much of this work was supported and/or undertaken by successive governments. The works are presently owned and operated by a range of individuals, drainage unions, councils and county councils, thus increasing the complexity of the institutional arrangements involved in the management of the coastal floodplain. A further concern is the lack of adequate funds for maintenance of the existing infrastructure, resulting in reduced asset value.

It is evident that many past flood mitigation and drainage works were constructed when their environmental implications were not well understood, and that past practices are having significant detrimental impacts on current river health. These include a reduction in the number and area of floodplain wetlands; reduced areas of habitat for fish and other estuarine species; fish disease and deaths due to acid discharge; and the alienation of some agricultural land due to acid scalding.

In addition to their environmental implications, these impacts have different implications for various stakeholders, including those involved in farming, fishing and aquaculture. These differences are the source of ongoing conflict about the management of the coastal floodplain and estuary. The core of this conflict relates to the way the impacts or costs of the present arrangements are distributed between different user groups and the environment. That is, the benefits of the existing works and practices generally accrue to landholders, while the costs are passed on to the instream ecosystem and those enterprises that are reliant on it. There are significant management challenges in dealing with the land use conflicts, the

patterns of required change and the need to arrive at a balanced result for users and for the sustainable health of the catchment and river.

## Technical Responses

The Commission heard evidence about the range of possible technical responses that could be implemented to improve the health of the coastal floodplain and estuary<sup>2</sup>. These include: changing the drainage system by laser levelling of land, making drains shallower, reducing drainage density and relocating drains away from acid sulfate soil hotspots; retaining aquatic vegetation in drains where their hydraulic capacity is sufficient and/or designing new drains to provide sufficient capacity; modifying the opening and closing operation of floodgates to provide protection for farmers as well as benefits for river health, or removal of floodgates where possible; neutralisation of acid using seawater or lime; reversal of the oxidation process of acid sulfate soils by applying organic matter; rehabilitating key wetlands on the floodplain and developing alternative farming techniques with less drainage requirements<sup>3</sup>.

Examples of specific technical changes include the opening of some floodgates in the Tweed catchment, allowing fish to migrate over 36 kilometres of waterway, and the implementation of measures such as laser levelling, drain shallowing and widening and the application of lime to land by some sugar cane farmers to reduce the impact of acid sulfate soils.

## Management Responses

Recently there have been several actions aimed at improving the management of elements of coastal floodplains and estuaries. These include the work being undertaken by the Acid Sulfate Soils Management Advisory Committee (ASSMAC), the preparation of various state and national guidelines in relation to acid sulfate soils, the initiation of the Clarence Floodplain Project, the amendment of the Hastings Council Local Environmental Plan to require development consent for agricultural work on acid sulfate soils, and the implementation of a self-regulatory approach between the NSW Sugar Mill and sugar cane growers.<sup>4</sup>

Each of these actions has the potential to provide benefits for river health, but none provides an overall framework for the effective integration of the management of coastal floodplains and estuaries. The reason is that these actions are borne out of a focus on a specific issue or the role of a specific initiative, rather than the management needs of the system as a whole. Further, the inadequacies of the existing management approach often act to impede and/or prevent the implementation of alternative technical responses. For example, people have advised the Commission of critical impediments including: difficulties in reconciling the benefits gained for instream ecosystems, and other river users, with the increased risks borne by landholders (for example, salinisation of land); the degree of effort that must be directed towards entering the 'funding lottery', rather than into effective on-ground actions, and incongruence in the allocation of management responsibilities and distribution of risks between the county council, councils, agencies and landholders. These problems also relate to the narrow focus, because funds are difficult to pool and powers and actions are not concerted.

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<sup>2</sup> The Commission engaged several independent people with expertise in the technical and management aspects of coastal floodplains and estuaries to assist its analyses of these issues.

<sup>3</sup> When assessing possible technical responses, consideration must be given to the impacts of changes on the total system.

<sup>4</sup> Other innovative measures are gradually being adopted. For example, in Victoria, a financial lease agreement has been developed between commercial fishers and a farmer, whereby the fishers are paying the farmer \$50 per hectare per year for the rehabilitation of a former salt marsh (Black Swamp).

## Alternative Management Framework

Given the considerable concerns and issues described above, the Commission considers that it is now timely to explore some fundamental changes in the framework for managing coastal floodplains and their interface with estuaries.

In consultation with technical experts and other stakeholders the Commission has identified the following criteria as a basis for evaluation of alternative management approaches.

- Addresses the objectives of protecting river health, including giving recognition to the scarcity of the resource, in terms of acid assimilation capacity or estuarine habitat.
- Ensures that the benefits and costs are equitably distributed between user groups and the environment, including giving recognition to the public good. This will require the allocation of sufficient funds by all parties.
- Provides a means to ensure involvement and commitment of stakeholders (particularly land users) at all key stages, including initiation, development of solutions and implementation, monitoring and review. This would include appropriate incentives and sanctions, such as contractual and/or regulatory arrangements and the specification of financial arrangements.
- Establishes clear accountabilities for agencies, councils and relevant groups.
- Ensures that clear and definite implementation, review and audit mechanisms are in place. Someone has to have lead responsibility.
- Provides consistency with other natural resource requirements (flood, estuary, catchment and river management plans) and other land planning (such as local environmental plans).
- Ensures that those carrying the risks inherent in the operation and management of the flood mitigation and drainage systems have an appropriate involvement in decision making and accountabilities.
- Creates the necessary planning framework based on resource capability, to facilitate the adoption of land management changes (such as drainage and changes to floodgate operations).
- Separates the functions of the resource manager/regulator from those of the operator.
- Provides the opportunity for third parties to be involved in the decision-making process and to invest in measures to improve the health of the floodplain and estuary.

The Commission has examined a range of alternative mechanisms for the management of coastal floodplains and their interface with estuaries. These include: the use of planning instruments under the provisions of the *Environmental Planning and Assessment Act, 1979*; the ISO 14000 environmental management system approach; market mechanisms involving credits and trading schemes and the Land and Water Management Plan/Contract<sup>5</sup> (LWMPC) approach that has been used in inland NSW irrigation areas.

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<sup>5</sup> The Commission is using the term plan/contract to describe this approach to stress that it involves not only the preparation of a thorough and detailed plan, but also the specification and use of various forms of 'contracts' between stakeholders.

In the course of this analysis, the Commission has identified significant similarities between the issues surrounding some inland irrigation areas and those relating to agricultural use of coastal floodplains. In inland irrigation areas key natural resource problems include the impacts of water extractions, increasing levels of soil and water salinity and the loss of instream and wetland habitat. Increasingly, farmers have recognised that there were likely to be greater productivity and environmental problems if they continued their historical patterns of land and water use. Additionally, it became clear that government alone could no longer carry the cost of maintaining the extensive network of irrigation infrastructure. Land users recognised that they needed to share this responsibility in order to protect the integrity of the assets upon which their enterprises were dependent. The issues that exist at present in relation to coastal floodplains are very similar, in principle if not in detail. For example, whilst water salinity is an issue in inland areas, acid sulfate soils and acid discharge is the comparable issue for coastal floodplains. These similarities are detailed further in Table 1.

To address these issues in some inland irrigation areas the LWMPC approach was developed in the 1990s. Key elements of this approach include: that the plan is both detailed and strategic with clear obligations for all stakeholders; cost sharing arrangements are determined prior to plan finalisation with costs divided between landholders, state and federal government; ability for third party comment and involvement; clear audit, accountability and review requirements including licences and contracts binding landholders, the irrigation company and other stakeholders to their obligations; and an irrigation company board of management comprised of elected landholders. In summary the Commission notes that the LWMPC approach embodies all the previously listed elements that an effective management framework should include. This is indicated further in Tables 1 and 2.

Therefore, the Commission's analysis to date indicates that the LWMPC approach provides the best reference for developing an alternative framework for the management of coastal floodplains and their interface with estuaries. There are however some key differences between the two areas that would necessitate the development of a Coastal Floodplain Management Contract specifically for coastal floodplains.

The Commission is aware that significant funding would be needed to undertake a new framework, as proposed, for coastal floodplain management, and to encourage effective participation by all stakeholders. The Commission notes that, given the recent focus of the Federal Government on inland issues, increased attention may *now* be directed towards coastal issues, such as coastal floodplain management (and the Commission advocates such a change). Such attention, including both resources and funding will, however, be likely only if a well considered and developed framework and approach exists for coastal floodplain management. Therefore the Commission believes it is timely and appropriate to initiate development of such a framework. Further stages of this Inquiry will be directed to that end through a number of forums with stakeholders.

**Table 1: The Problems  
(Past) Inland Irrigation Areas and (Present) Coastal Floodplain Situation**

Inland (Past)	Coastal Floodplains (Present)
Scarcity of resource base not recognised (eg capacity of the ecosystem to assimilate elevated salt levels and sustain loss of wetlands).	Scarcity of resource base not recognised (eg capacity of the ecosystem to assimilate acid, loss of fish habitat and loss of wetlands).
Poor definition of accountabilities, with regard to the adverse impacts on the environment and other users.	Poor definition of accountabilities, with regard to the adverse impacts on the environment and other users.
Poor definition and management of land with regard to natural/infrastructure systems (eg subcatchments).	Poor definition and management of land with regard to natural/infrastructure systems (eg subcatchments).
Reduced value of infrastructure assets due to insufficient funding for maintenance.	Reduced value of infrastructure assets due to insufficient funding for maintenance.
Poor definition and allocation of risks because the major irrigation infrastructure is in public ownership (NSW Government), while the risks of failure are borne by private users. Minor infrastructure in private ownership.	Poor definition and allocation of risks because the major drainage and flood mitigation infrastructure is in public ownership (county council), while the risks of failure are borne by private users. Minor infrastructure in private ownership (individuals and drainage unions).
Primary beneficiaries of the irrigation infrastructure are the land users (eg rice, wheat, beef and dairy).  Adverse impacts of the irrigation infrastructure are borne by land users (eg soil and water salinity and water logging) and downstream users (eg instream ecosystem, other irrigators and Adelaide water users).	Primary beneficiaries of the flood mitigation and drainage infrastructure are the land users (eg sugar, beef, dairy and tea tree).  Adverse impacts of the flood mitigation and drainage infrastructure are borne by downstream users (eg estuarine ecosystem and fishers).
Poor definition of resource manager and operator accountabilities and functions, because state government is the regulator and operator of the infrastructure.	Poor definition of resource manager and operator accountabilities and functions, because state/local government is the regulator and operator of the infrastructure.
Uncertainties amongst land users and regulators about resource security and the use of regulations, with regard to water access and salinity discharges.	Uncertainties amongst land users and regulators about resource security and the use of regulations, with regard to operation of floodgates and acid discharges.
Inadequate mechanisms to reconcile the requirements of different land users with regard to the operation of the infrastructure (eg rice and citrus).	Inadequate mechanisms to reconcile the requirements of different land users with regard to the operation of the infrastructure (eg sugar cane and grazing).
Inadequate opportunities for other groups to influence resource management outcomes (eg downstream water users, Aboriginal communities, fishers and environmentalists).	Inadequate opportunities for other groups to influence resource management outcomes (eg estuarine fishers, Aboriginal communities and environmentalists).
Weak mechanisms for redistributing resource entitlements towards higher 'value' uses, including the environment and new development.	Weak mechanisms for redistributing resource entitlements towards higher 'value' uses, including the environment and new development.

**Table 2: The Management 'Solutions'  
(Present) Inland Irrigation Areas and (Potential) Coastal Floodplain  
Situation**

Inland (Now with LWMPC)	Coastal Floodplains (Potential)
Scarcity of resource base recognised via the introduction of maximum limits on water extractions and salinity levels.	Scarcity of resource base would be recognised via the introduction of maximum limits on acid discharges and the loss critical habitats (eg wetlands and estuarine tributaries).
The accountabilities of government and users clearly defined via a contract.	The accountabilities of government and users would be clearly defined via a contract.
Comprehensive planning and management undertaken on the basis of the capability of the resource base and infrastructure design.	Comprehensive planning and management would be undertaken on the basis of the capability of the resource base and infrastructure design.
Joint funding arrangements negotiated between government and land users for the refurbishment of infrastructure, including the transfer of full funding responsibility to land users in the longer term.	Joint funding arrangements would be negotiated between government and land users for the refurbishment of infrastructure, including the transfer of full funding responsibility to land users in the longer term.
Strong definition and alignment of risks established by transferring the ownership of major infrastructure to land users. The ownership of infrastructure is vested in a corporatised or private body in which land users are shareholders.	Strong definition and alignment of risks would be established by transferring the ownership of major infrastructure to land users. The ownership of infrastructure would be vested in a corporatised or private body in which land users are shareholders.
Beneficiaries of the refurbished water supply and drainage infrastructure are the land users (eg decreased salinity and lowered water tables) and the instream ecosystem and other downstream users.	Beneficiaries of refurbished flood mitigation and drainage infrastructure would be the land users (increased area of productive land) and the estuarine ecosystem and other river users (eg fishers).
The transfer of ownership of infrastructure creates clear definition between the roles of regulators and operators.	The transfer of ownership of infrastructure would create clear definition between the roles of regulators and operators.
Resource security and the use of regulations clarified via the negotiation of licences for bulk water supply and saline discharges.	Resource security and the use of regulations would be clarified via the negotiation of licences for acid water discharge or other mechanisms.
Requirements of different land users resolved via their involvement in the decisions made by a board of management.	Requirements of different land users would be resolved via their involvement in the decisions made by a board of management.
Opportunity for other groups to influence resource management outcomes is provided via participation in the Government's negotiation of the contract with land users.	Opportunity for other groups to influence resource management outcomes would be provided via participation in the Government's negotiation of the contract with land users.
Introduction of trade in resource entitlements via market mechanisms (eg water and salt).	Trade in resource entitlements would be introduced via market mechanisms (eg acid and habitat).

## *The Next Steps*

- The Commission's analysis to date indicates that the Land and Water Management Plan/Contract approach adopted in inland NSW irrigation areas provides the best reference for developing an alternative framework for the management of coastal floodplains and their interface with estuaries.
- Given the complexity of the institutional, funding and other issues surrounding this possible new approach, the Commission wishes to discuss the appropriateness of the approach, and issues related to a suitable structure and implementation mechanisms with stakeholders in the Clarence catchment.
- The Commission intends to hold forums in the Clarence catchment in early 1999 to discuss these issues further.



# Canal Estates and Road Causeways

*The development of new canal estates is now prohibited in NSW, under the provisions of the State Environmental Planning Policy 50, 1997 (SEPP 50). However the construction of new canal estates that had been granted development consent prior to the introduction of SEPP 50 is not precluded by that policy. One such development is presently in progress at Yamba, 'Crystal Waters', and that development has been the subject of a number of submissions to this Inquiry, as have the ongoing impacts of existing canal estates.*

*This is the first Inquiry in which the Commission has considered in any detail the implications for floodplain/estuary health of canal estates, road causeways and other structures that impede tidal flow and fish passage. The Commission's particular attention to these issues has been necessitated by the extent of community concern and interest in them, as expressed formally and informally during the Inquiry process. The Commission's preliminary analyses in these areas have highlighted a number of specific issues that have not been fully explored in previous Inquiries.*

## Canal Estates

The matter of greatest concern to citizens and of immediate relevance to this Inquiry is the reported discharge of highly acidic water from canal estates, due to the disturbance of acid sulfate soils<sup>6</sup>. The Commission's assessments to date suggest that the community's concern is warranted and that action should be taken to mitigate existing, and reduce future impacts. Impacts of particular importance, in river health terms, include:

- direct loss of wetland habitats and other sensitive aquatic systems, (with consequential impacts on instream ecosystems and the activities, such as fishing, that depend on them);
- discharge of acidic water as a result of the disturbance of acid sulfate soils;
- poor water quality and sedimentation (attributable to inadequate hydraulic design of some canals combined with the concentration of stormwater contaminants from residential areas); and
- sewage discharge and foreshore erosion caused by boat wash, associated with the localised concentration of boats within the canals<sup>7</sup>.

As for other components of the overall strategy for improving and protecting the health of the Clarence River system, there are equity considerations that underpin the Commission's conclusions about the need for enhanced management of canal estates. Many of the reforms and adjustments currently being advocated, in the interests of river health, will impose costs

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<sup>6</sup> Maclean Shire Council has reported the measurement of acid levels of less than pH 3.

<sup>7</sup> Other issues include noise, ongoing maintenance dredging and impacts on seagrass beds.

on farmers and other residents (for example via obligations on councils to better manage stormwater and sewage). For reasons of equity, then, it is imperative that reforms are also applied to canal estates. Further, failure to address the impacts of canal estates on the health of the river/floodplain/estuary could even *offset*, to a significant degree, the river health gains made through the actions required to be implemented by others.

Expert advice provided to the Commission indicates that it is technically possible to mitigate the discharge of acid from canal estates, although some of these techniques are in the early stages of development<sup>8</sup>. Different mitigative measures and arrangements for distributing the associated costs need to be determined for new and existing canal estates, given the differing constraints associated with the existing developed estates and the one that is presently under construction.

### ***New Canal Estates***

For new estates, a range of mitigation measures are available. The Commission advocates that their costs be borne by the developers of canal estates, thereby ensuring that the costs are internalised into the sale price of the lots within the subdivision<sup>9</sup>. The costs of any ongoing operational measures should then be incorporated into the rate structure for the lots in the subdivision. As the Commission has observed in previous reports, the costs cannot be avoided. If not dealt with early in the planning phases, they *will* be borne, by the wider community, eventually.

For the 'Crystal Waters' canal estate at Yamba, the Commission's analyses to date suggest that there is a need for Maclean Council and the Environment Protection Authority to work together with the developer to ensure that appropriate measures are implemented, and proven to be effective, *before* the canals are opened to the estuary. This Inquiry's Draft Report will contain recommendations along such lines, subject to further consultation as to the most effective mechanisms to achieve that outcome.

### ***Existing Canal Estates***

The responsibility for implementing mitigative measures in existing canal estates clearly rests with local government, given its designated role in granting approval for such developments and its responsibility for ongoing management of stormwater in residential areas.

It is unlikely that it would be technically or financially feasible to treat acid sulfate soils *in situ* in existing residential areas, given the potential disturbance of established homes. However the possibilities of mitigating the impacts of acid discharges by treatment at the point of discharge into receiving waters and/or in the canals warrant investigation, for the reasons of equity and the effectiveness of other strategies for improving river/estuary health advanced in the previous section.

The Commission believes that this Clarence Inquiry should be a catalyst for such investigations, with the canal estates already in the Clarence estuary being made the subject of trials of new management approaches, including both technical and institutional aspects. Given the statewide incidence of adverse environmental impacts related to canal estates, the

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<sup>8</sup> The Commission engaged several independent people to provide advice on the management of coastal floodplains and estuaries. The design of remedial measures would need to be determined for each specific location.

<sup>9</sup> This is a particular application of the Commission's philosophy relating to residential development in general. In its previous reports, and especially in the most recent, the Draft Shoalhaven Inquiry Report, the Commission has stressed the need for a state-wide policy which would require greater recognition and internalisation of the 'hidden' river health costs of rural residential development.

Commission envisages recommending that the Environment Protection Authority assist Maclean Council, by way of the provision of expertise and cost-sharing, to develop and test mitigative measures (including treatment of acid sulfate soils and control of acidic water discharges) for the canal estates, with a view to extending their application to other locations<sup>10</sup>. Revised regulatory and new institutional arrangements, which build on those that already exist, could then be determined leading to the implementation of appropriate mitigative measures for canal estates generally.

## Road Causeways

Throughout the coastal floodplain of the Clarence River there are several major structures, including road causeways, culverts and small bridges, that have been reported to have adverse impacts on estuarine health. These structures impede, or in some cases prevent, the exchange of tidal waters and the passage of fish and other estuarine species. Restriction on the exchange of tidal waters is particularly important because it can cause significant changes in the salinity level of the water body on the upstream side of the structure. The consequences can include algal growth, degradation of seagrass beds and the loss of key nursery habitat for fish<sup>11</sup>. Such impacts can be exacerbated in situations where stormwater from urban areas discharges into the restricted water body. Where new structures are being planned, measures needed to contain those potential impacts clearly should be addressed in the design stages. The Commission will make recommendations accordingly.

For existing structures, the Commission has been advised that modest changes (in particular structural changes to allow sufficient tidal flow to pass through them) could achieve significant improvements in the health of the estuarine ecosystem. Again, the need for such adjustments can be argued on equity grounds, in light of the suite of management reforms that is currently being introduced, at some cost to other river users. It can be argued that the costs of the necessary works should be borne by the relevant councils, with some contribution provided by the Roads and Traffic Authority, given that the need for the works results from the adverse impacts of roads, which benefit road users at the local and state level.

The Commission notes that it is possible, in some rare circumstances, that adjustments to road structures would *not* be desirable, because the modified ecosystem that has been created by the structure has significant and unique value, warranting its protection. Thus, following the identification of those particular circumstances, the Commission will recommend a strategic program for some modification of others.

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<sup>10</sup> Following a state-wide audit of the impacts of all other existing canal estates the Environment Protection Authority could direct or encourage relevant local government authorities to incorporate proven mitigative measures in their Stormwater Management Plans.

<sup>11</sup> Shallow Crossing on the Yamba Road is reported to cause this type of problem.

## *The Next Steps*

- The Commission considers that acid discharge mitigative measures need to be considered and put in place for both existing canal estates, and those canal estates being constructed at present.
- It will undertake further discussions with relevant stakeholders in relation to technical, regulatory and institutional issues relating to canal estates.
- The Commission considers that new structures such as road causeways should be designed to ensure they do not obstruct tidal flow and fish passage, and that a strategic program needs to be developed for existing structures that do have such adverse impacts.
- It will formalise its recommendations on this matter following further consultation with relevant councils, agencies, and the community concerning priorities, accountabilities, cost-sharing arrangements, time frames, and monitoring/evaluation processes.

# Aquaculture

*In considering aquaculture in the Clarence catchment, the Commission has taken into account the discussion paper titled Northern NSW Land Based Coastal Aquaculture Industry Overview and Future Directions prepared by the Northern NSW Aquaculture Industry Steering Committee in May 1998. This Steering Committee was established in July 1997 to create an investment climate conducive to the development of the northern NSW land-based coastal aquaculture industry<sup>12</sup>. This report highlights the needs and impacts of the industry, as well as its potential for growth.*

## Potential Impacts of Aquaculture

Aquaculture is a significant emerging industry in the Clarence catchment<sup>13</sup>. The primary forms of saltwater and freshwater aquaculture are prawn and silver perch farming, respectively<sup>14</sup>.

The discussion paper referred to above identifies the potential for further development of the aquaculture industry in the northern NSW region, particularly in prawn cultivation. For example, the industry estimates conservatively a five-fold increase in the area of ponds for prawn farming in the northern NSW coastal region. The goals suggested in the paper include achieving an industry culture that incorporates ecological sustainability measures, such as the optimal siting of new aquaculture enterprises.

As noted in the discussion paper, there are some problems between the aquaculture industry and other stakeholders, arising from differing perceptions about the potential impacts of land-based aquaculture activities on estuarine health. Several submissions to this Inquiry raised concerns along those lines.

The Commission's analysis to date has led it to the preliminary conclusion that while those concerns have some justification, the potentially adverse impacts of aquaculture on river/estuary health can effectively be contained.

*Potential* adverse impacts are attributable to the following aspects of aquaculture.

- The discharge of wastewater with elevated levels of nutrients and/or chemical residues into the estuary and/or groundwater systems. This could be of concern in situations in which farms discharged their effluent into small channels within the estuary, that is, those with limited tidal exchange. On the other hand, operators argue that the nutrient concentrations of the effluent will be less than some anticipate because of the need to retain nutrients in the ponds, in order to promote the growth of the prawns.

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<sup>12</sup> The steering committee contains representatives from various State agencies and from the aquaculture industry.

<sup>13</sup> The industry produced over \$3 million of prawns and fin fish during 1996/97.

<sup>14</sup> Oyster farming activities also are undertaken in the estuary on a relatively small scale. The evidence presented to the Commission indicates that it is adversely affected by other activities in the catchment (eg sewage discharge) and does not adversely affect the health of the estuary itself.

- The disturbance of acid sulfate soils associated with the construction and maintenance of the ponds. Operators endeavour to avoid disturbing potential acid sulfate soils by limiting the depth of the excavated ponds, treating any potential acid sulfate soils that are excavated with lime and preventing the exposure of potential acid sulfate soils by ensuring that ponds are kept full of water. Difficulties arise if the ponds are left dry for extended periods. This has the potential to become a matter of some concern in circumstances where farms are abandoned.
- The possibility that, through aquaculture, diseases might be introduced into the wild stock communities in the estuary.

## Improved Management

Submissions from the aquaculture industry to this Inquiry stressed that such potential impacts are already well managed, through self regulation by operators and because the industry is subject to stringent regulatory controls, via council consent and Environment Protection Authority licences. These requirements often exceed those applied to other river users.

The Commission's recommendations will promote intensification of the current research and development effort, and further application of the industry's *Environmental Code of Practice*. The Commission will also advocate that the Environment Protection Authority continue its present program to promote wastewater recycling in prawn farms, thereby reducing both water extractions and wastewater discharges.

The Commission is convinced that rigorous criteria<sup>15</sup> must be developed, for incorporation into planning instruments and licences, to specify the requirements for new aquaculture developments in the establishment, operation and closure stages. It will undertake further consultation and analyses to determine the scope and nature of appropriate criteria, for inclusion in its draft recommendations. Additionally, it will examine the desirability and feasibility of mechanisms requiring new developments to post a bank guarantee (or bond) to cover the cost of rehabilitating sites that are subsequently abandoned.

### *The Next Steps*

- The Commission's recommendations will promote increased research and development, and the further application of effective and appropriate controls, either via the environmental code of practice or other planning and licensing mechanisms.
- In formulating its recommendations, the Commission will discuss further with the aquaculture industry the measures that operators could implement to mitigate any potential impacts on the health of the estuary.

<sup>15</sup> These would include the basis for identification of sites that are unsuitable for aquaculture development, in terms of the risk of disturbing actual and potential acid sulfate soils and the sensitivity of receiving waters.

## *Specific Challenges for Estuary Health*

# **Fishing (Commercial and Recreational)**

*In its considerations of the implications of commercial and recreational fishing activities on estuary health, (with the particular focus of this Inquiry on the Clarence) the Commission has had regard to the substantial initiatives emerging through current government policies and processes for managing estuarine fisheries. Relevant documents are the Clarence River Restricted Fishery Draft Management Plan, the NSW Fisheries Discussion Paper on the review of saltwater recreational fishing laws, the Fish Habitat Protection Plan No. 2 (Seagrasses) and the NSW Indigenous Fishing Strategy. The Commission endorses those initiatives, which it believes will contribute significantly to resolution of the issues raised in this Inquiry. Its focus on those matters in this Inquiry represents an intention to build on, rather than substantially amend them by placing the river/fisheries health nexus within the context of an overall strategy for achieving and maintaining a healthy Clarence River.*

## **River Health and Fishing**

'River health' is often described as a primary indicator of catchment health, since all catchment activities ultimately impact on the river, whether beneficially or adversely. Likewise, the condition of estuarine ecosystems, in particular, can be viewed as an indicator of the health of the estuary and a signal, like the coalmine canary, of the sustainability or otherwise of the processes taking place in the river and estuary. In this Clarence River Inquiry, the Commission has paid particular attention to the interrelationship between river/estuary health and the fisheries component of the estuarine ecosystem, for two reasons. One reason derives from the commercial and social significance of fishing in the Clarence region. Many submissions to this Inquiry expressed concern about the longer term viability of the industry in the light of changes in river and estuarine health conditions. The second reason for the Commission's attention to this matter is that while a healthy river is generally regarded as a precondition for a healthy fishing industry, the fishing industry itself can, under some conditions, pose some threats to river and estuarine health. Such threats were also the subject of submissions and advice to this Inquiry.

In its analyses of catchment and coastal floodplain management and their importance in terms of the sustainability of fishing in the Clarence estuary, the Commission has regarded protection of 'healthy fish stocks' as a primary goal, because of the environmental *and* commercial benefits they underpin. Its tentative conclusions about the management changes that are needed to assure this aspect of river health are outlined in the sections relating to agriculture, canal estates, road causeways and aquaculture presented in this Progress Report. They are briefly summarised again in this section, in recognition of, and to emphasise the *two-way* relationship between river and fisheries health.

Drainage works and flood mitigation structures for agricultural and urban development alienate significant areas of habitat from migratory estuarine species and can result in the disturbance of acid sulfate soils, thus delivering acid water to the estuary. There is little argument that the extensive flood mitigation and drainage structures throughout the

Clarence floodplain have adversely affected estuarine ecosystems, although the consequent impacts on commercial and recreational fishing has not been fully quantified. The Commission's preliminary conclusions are that a new approach to floodplain management could better deal with the interests and needs of both agricultural and fishing enterprises, to the overall benefit of the regional economy and the environment. The Commission's likely recommendations in this regard are foreshadowed in the section related to agriculture.

## Fishing and River Health

Commercial and recreational fishing are major industries in many of the river catchments along the North Coast of NSW. Both activities make a significant contribution to the regional/local economy centred on the Clarence River. The commercial fishing industry in the Clarence is conservatively valued at around \$10 million per year<sup>16</sup>. Recreational fishing attracts many tourists to the area and is a valued leisure activity for members of the Clarence community.

Initiatives to protect fishing resources (either directly, or indirectly through river improvement measures) will impose costs and adjustment burdens on other users of the coastal floodplain. It is important therefore that the potential adverse impacts of fisheries on river health are contained and managed, for both equity and efficiency reasons.

The potential adverse impacts that are matters of concern include loss of biodiversity through disturbance of seagrass beds<sup>17</sup>, and reduction or alteration of fish stocks due to 'by-catch' and/or overfishing. Traditional methods of prawn fishing are thought to impact adversely on seagrass beds, although the scale of their impact in the Clarence (in comparison to other influences) is a matter of some debate<sup>18</sup>. There are also differing views on what action, if any, should be taken to address this issue. The major options that are suggested involve limiting access to varying degrees, and promotion of alternative catch techniques. It is clear that further research and assessment of the implications of various management options is needed before recommendations can be formulated with confidence.

The Commission notes that many commercial fishers in the Clarence have already contributed to the development of alternative techniques to mitigate their impacts on estuarine ecosystems. For example, a number of local prawn trawler operators have recently assisted NSW Fisheries in the development of cost effective by-catch reduction devices<sup>19</sup>. These devices, which are part of the nets, have significant benefits for both users and juvenile fish stocks<sup>20</sup>. Many other operators in the Clarence have now adopted by-catch reduction devices.

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<sup>16</sup> This value is the annual amount paid to commercial fishers and does not include the multiplier effect and substantially wider financial benefits provided by the commercial fishing industry to the Clarence community.

<sup>17</sup> Previous studies indicate that there has been up to a 60 percent decline in the area of sea grasses in the Clarence estuary since the 1940s.

<sup>18</sup> For example, seagrass changes in Lake Wooloweyah, which are a matter of particular concern, may be the result of episodic prawn trawling in the Lake, natural growth cycles of some seagrass species or increased water turbidity, and is most likely to be a combination of these and possible other factors.

<sup>19</sup> The use of these devices has recently been made compulsory in the Botany Bay and Port Jackson fisheries.

<sup>20</sup> It is estimated that the use of these devices reduces by-catch by up to 90 percent, results in increases in the size of the prawn catch and reduces the time required for sorting the catch. The by-catch devices cost about \$100 each, although this could vary depending on the type required for specific estuaries.

## Commercial and Recreational Fishing

The 'competition' between commercial and recreational fishing in the Clarence has been raised as an issue of concern in this Inquiry. The Commission's focus is on *river/estuary* health and in one sense the distribution of fishing entitlements between the two categories is not a matter of primary concern to the Inquiry. A healthier river may increase the sustainability of the catch to be shared between the two groups. However, the Commission is required to consider the distribution of the impacts of its recommendations. Thus, in light of the need to contain the *total* impact of fisheries on river health, it notes that recreational fishing should not be exempted from the obligation to contribute to river health.

Preliminary studies indicate that the catch size by recreational fishing may be similar to that of commercial fishing<sup>21</sup>. Fish and other aquatic resources are considered a 'common property resource' and the Government has the task of determining how the resource may be sustainably and equitably allocated among the various user groups and within user groups<sup>22</sup>. The Commission believes that the allocation of entitlements should confer commensurate obligations on the various user groups to contribute to the maintenance of river and ecosystem health. Thus entitlements and obligations should be jointly determined, with regard to both the sustainability and equity of alternative options, and also the feasibility of monitoring (and minimising) the activities that pose threats to the river.

A matter that may require particular attention is the distribution of the benefits, in terms of improved fish stocks, that could be expected to occur if floodplain management were enhanced in the ways being considered by the Commission (See section relating to agriculture and coastal floodplain and estuary health). The most appropriate distribution of those gains among the environment, commercial and recreational fishers would need to be determined. These, and related matters will be subjects of the further discussion of floodplain and fisheries management options that the Commission will undertake in the development of its recommendations.

### *The Next Steps*

- The Commission will further assess opportunities and impediments to increasing the part played by estuary health objectives in the determination of optimal management of fisheries.
- Having considered the various relationships between commercial and recreational fishing and estuary health, the Commission is convinced that some new approaches are required to enhance the way in which these activities are managed with regard to the protection of estuarine ecosystems and the entitlements of the different user groups.
- The Commission will hold further discussions with stakeholders as the Inquiry process continues and in the formulation of its draft recommendations.

<sup>21</sup> These studies have generally involved indirect measures of fish catch based on estimates of the number of hours that recreational fishers spend fishing.

<sup>22</sup> User groups include commercial and recreational fishers and Aboriginal communities. Also, 'future generations' represent a further interest group.



## *Specific Challenges for River Health*

# **Integrated Water and Sewerage Services**

*Water and sewerage services for towns have several impacts on river health. The impacts of water extractions on river flows, and of discharges of sewage effluent on water quality are particularly important. These services have been traditionally designed and operated as separate activities. More recently, however, various initiatives have been implemented to integrate these services, through an increased emphasis on total water cycle management. In a parallel change, the past emphasis on provision of major infrastructure as the primary vehicle for ensuring the adequacy of services has given way to a new focus on alternative means of satisfying demands at the user interface. Re-focusing of the major public funding program, the Country Towns Water, Sewerage and Drainage Program, has reflected those changes.*

*The Commission's preliminary analysis of the implications of water and sewerage services for river health, in this Clarence Inquiry, aims to build on a number of recent initiatives and current government programs, processes and policy statements, including the Water Reform Program, NSW Tackles Greenhouse and the NSW Greenhouse Action Plan 1998. Its analysis draws on a system view of river health, in which the many interrelationships among the multiple activities and processes are explicitly recognised and addressed. The Commission's goal is to identify the mechanisms through which the 'optimal' river health outcomes may be achieved. However, 'optimal' in this context refers to the most favourable outcomes that are attainable without jeopardising the achievement of other important goals and while maintaining consistency with other important government policy intentions, such as those relating to local government independence, regional development, and equity in service availability and costs.*

*Much of the following discussion concerns the proposed Clarence Valley/Coffs Harbour Regional Water Supply Scheme (RWS). The Commission's detailed consideration of the scheme reflects its significance as a potential influence on river health, the opportunities it appears to present for strongly integrated management of water and sewerage services, and the level of community interest and concern about the scheme that was expressed to this Inquiry. The Commission recognises the extensive planning and investigation that has already been done for the scheme, and the now-advanced state of the proposal. It firmly intends to avoid any capricious dislocations to the scheme's progress. It will focus on those issues which might most influence river health, and articulate any concerns in ways that maximise the opportunity to deal with them smoothly, by utilising the flexibility incorporated in the scheme's design.*

## The Clarence Valley and Coffs Harbour

A major river health issue in the lower Clarence catchment concerns the allocation and management of river flows in two important tributaries, the Orara and Nymboida rivers. These two rivers already support a set of diverse water interests, with complex inter-linkages and significant alterations to natural flow patterns. The most important of these are illustrated in Figure 1. A Regional Water Supply Scheme for the Lower Clarence County Council area is proposed to meet the water needs (to 2021) of this growing region, by utilising the resources of the Nymboida and Orara rivers.

The rationale for the scheme has depended heavily on the presumption that increasing water requirements (largely, but not solely due to population growth), and the episodic restrictions on the extractions of water for towns that could result from the adoption of new rules to protect environmental flows, would together jeopardise, to an intolerable degree, the security of existing town water supply systems. That is, it would be impossible for the existing town water supply systems to guarantee, under all anticipated climatic conditions, that water supplies would be adequate to satisfy public health needs and community expectations.

The proposed scheme, which is now at an advanced stage of design and assessment, would link and augment the existing town water supply systems serving the Clarence Valley<sup>23</sup> and Coffs Harbour through a new dam on Shannon Creek (a relatively undeveloped tributary of the lower Orara River) and a series of water pipelines. It would increase the volume of water currently extracted from the Nymboida River several-fold<sup>24</sup>, thereby intensifying competition for an already scarce resource.

In addition to the environmental impacts of further manipulation of river flows, operation of the scheme would also have implications for the activities of many other water users in the system. The most notable of these is the hydroelectric power station, which extracts water from the same point on the Nymboida River. The amount of water available to the station in turn determines the volume and pattern of flows in Goolang and Blaxland creeks and the lower Orara River, which influences the activities of the canoe course and irrigators in these streams<sup>25</sup>. The extraction at Nymboida Weir also effectively limits the availability of water for any new or expanded water uses in the streams that replenish flows in the river below the weir<sup>26</sup>.

As it comprises both a substantial capital works program and a water efficiency strategy<sup>27</sup>, the scheme also has implications for the planning, costs and 'affordability' of sewerage and energy services in the region<sup>28</sup>. These implications are complex and require careful analysis within this Inquiry because they, in turn, may generate other impacts on river health.

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<sup>23</sup> The Clarence Valley includes Grafton and the towns along the lower Clarence River, east to Yamba and Iluka.

<sup>24</sup> Although it is intended to avoid pumping from the Nymboida River when flows are low (below the 80<sup>th</sup> percentile condition)

<sup>25</sup> The extracted water is discharged from the Nymboida power station (up to 860 megalitres a day) into Goolang Creek, thence to Blaxlands Creek and the Lower Orara River.

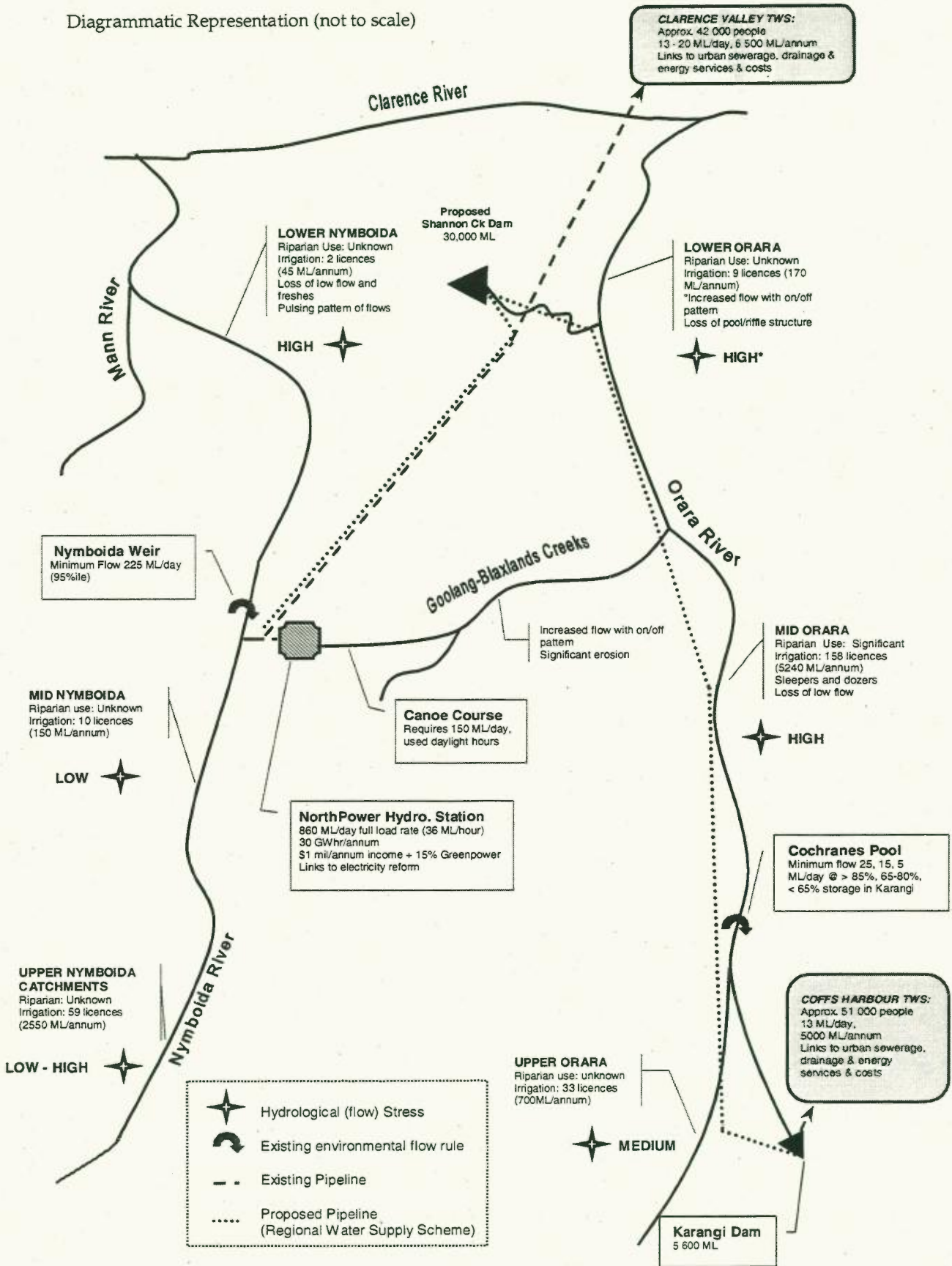
<sup>26</sup> Includes the middle & upper Nymboida and Blicks Rivers and the Boyd and Mann River systems.

<sup>27</sup> The RWS water efficiency strategy focuses on the early identification of options for augmenting the scheme beyond 2021, and a 'water wise' demand management program.

<sup>28</sup> These considerations also apply to a number of water supply infrastructure projects that are ancillary or distinct from the RWS that are currently being developed by the various water supply authorities in the region.

**Figure 1: Nymboida - Orara System Elements**

Diagrammatic Representation (not to scale)



## Healthy Rivers Commission's Preliminary Analysis

In the course of this Inquiry the catchment community initiated a quite detailed discussion with the Commission about the scheme's implications for river health, for the regional economy, and for overall community well-being. Some contributors to this Inquiry have viewed the scheme with considerable concern, believing its implications to be adverse, both in terms of river health and the economic costs to the community<sup>29</sup>. Others, however, have stressed the benefits they envisage arising from the scheme. These include increased security of water supplies, both to meet the needs of a growing population for domestic purposes, and also to underpin regional economic growth via expansions of water-using industry.

Evolution of the scheme, and the community consultation and environmental impacts assessments associated with it, preceded the commencement of this Healthy Rivers Commission Inquiry. In the course of this Inquiry the Commission has maintained close contact with the scheme's proponents, the Lower Clarence County Council, advisers and project managers. That interaction has been undertaken (by both parties) with a view to ensuring that the timely implementation of appropriate measures to secure the relevant town water supplies is not jeopardised by this Inquiry. However, at the same time the Commission is obliged to undertake a full and independent examination of the scheme's implications for river health. Thus it has also liaised with critics of the scheme, in an endeavour to appreciate fully the concerns of those who perceive intolerable environmental risks to be associated with it.

The initial stages of the Commission's analysis have examined the implications of the fact that certain elements of the scheme, as it is presently conceived, have necessarily been based on a number of 'best estimates' in important areas. These include:

- projections of growth in demand for water that are inevitably, to some degree conjectural because of the uncertainty that attaches to population growth and its makeup and to the potential impacts of any demand management measures that might be introduced;
- preliminary projections of the flows that will need to be maintained in the Nymboida and Orara rivers to protect environmental values; and
- a set of assumptions about the water sharing/access arrangements that would determine the shares of water that would be available for power generation (by NorthPower), town water supplies (via the RWS scheme) and other users, after the two rivers' environmental needs had been met.

In each area of uncertainty, the scheme has been based on the prevailing 'best estimates'. However in each case, those 'best estimates' are subject to some challenge and could therefore change. For example, refinements in the accuracy of forecasts, or changes in policy, (for example, introduction of new rules for environmental flows) could lead to substantial revisions to them. Many of the most significant 'unknowns' are matters which are central to this Healthy Rivers Commission Inquiry and on which the Commission will make recommendations. For example, the questions of 'how much water should be left in the river for the environment' and how domestic water uses should 'compete' with power generation are primary elements of the Commission's terms of reference as they relate to the Clarence system.

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<sup>29</sup> Some have perceived a lack of opportunity to influence the form and implementation of the scheme, notwithstanding the extensive community consultation program undertaken by the proponents.

As this Commission's investigations and recommendations contribute answers to those questions, there could be some changes in the underlying criteria which to date have determined important aspects of the scheme. Some adjustments to the scheme may then be indicated. At the same time, the Commission's choice of environmental flow objectives cannot ignore the *scheme's* objectives. That is, as the Commission is formulating its recommendations for environmental flows, it must take into account the ways in which strategies to achieve alternative (environmental flow) objectives might influence the achievement of the benefits to be delivered by the scheme.

The Commission's preliminary analysis of the river health issues surrounding the scheme, and its discussions with the community and with independent advisers have led it to the conclusion that the pattern of existing and proposed water uses, and the actual and potential conflicts in water management, exemplify the need for a systems view, in terms of both river health and institutional arrangements. (See Figure 1.)

A matter of particular concern to the Commission has been that the studies (to date) which have examined the potential impact of the scheme on the health of the river have tended to view alternative flow protection rules as access conditions for only the individual operator under consideration. There has been only limited recognition of the implications of the cumulative effects of the various operators, *for each other, and for the river itself*. A satisfactory level of protection of river flows cannot be achieved in the Nymboida-Orara River systems without considering *all* water users. The Commission considers that it is important, from an equity perspective, that all beneficiaries of the river's resources contribute to its health. For its Draft Report, the Commission will develop a range of measures to ensure that the potential river health benefits from modifying the activities of any single operator are not eroded by a 'business as usual' approach to other users, or groups of users.

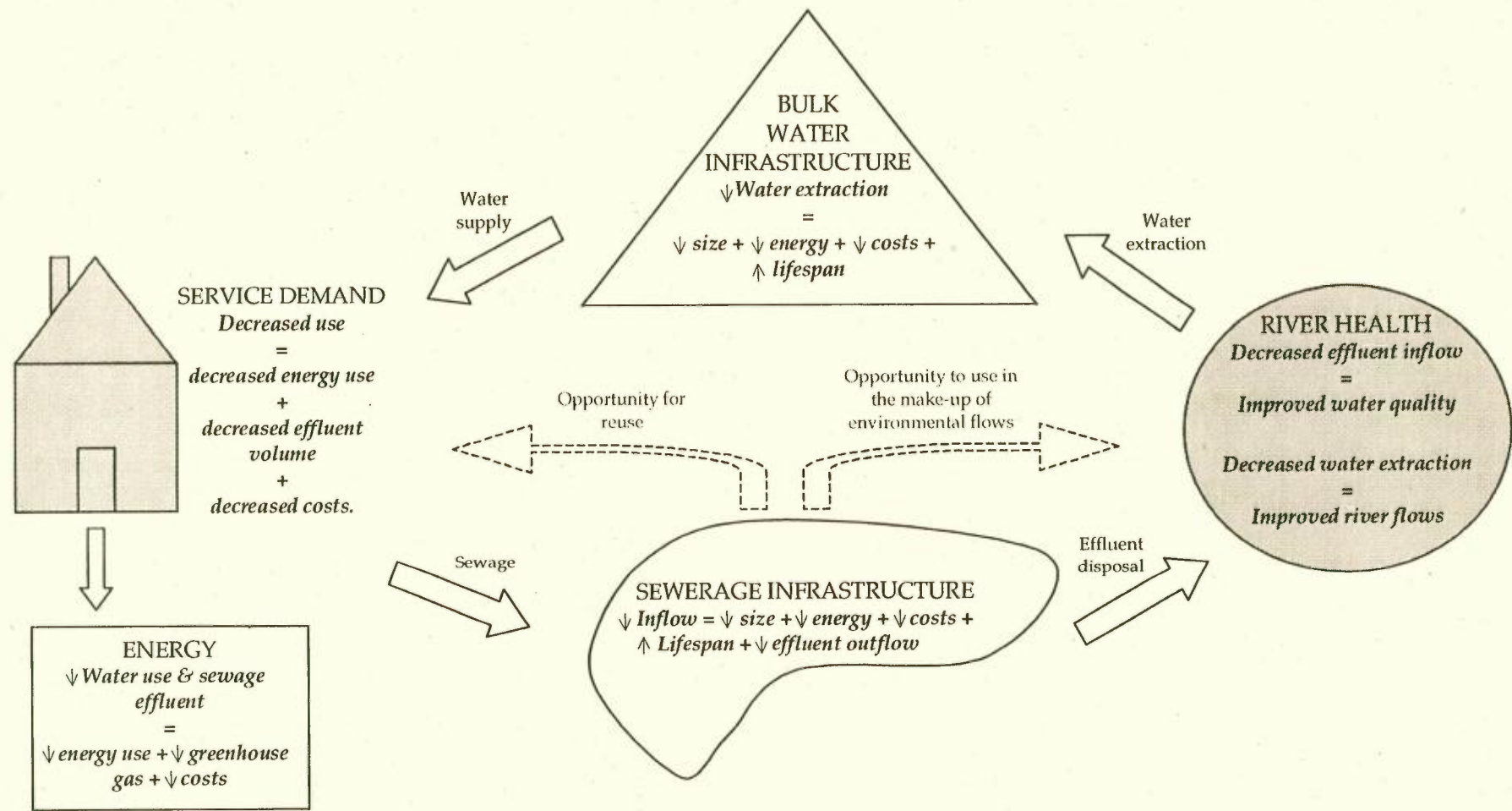
The need for a greater regard to *cumulative* impacts is increased when there is a limit on the *total* impact on river flows that is regarded as acceptable or tolerable. The concept of such a 'ceiling', and the proximity of the existing flow regime to it, are matters that are central to the Commission's analysis of river health issues in all rivers. The evidence presented to this Inquiry suggests that the tolerable ceiling on flow extractions (under lower flow conditions) has been reached in parts of this Clarence River subsystem. Thus the Commission is obliged to include, in its consideration of river flow objectives, a particular examination of the cumulative impacts that could result from the proposed scheme's further manipulations of river flows.

Other issues that are suggested by a system-based review of the scheme concern the relationships between augmented water services and sewage and energy management. For example, extension of reticulated water supply to new areas in the region may affect the volume of wastewater generated and give rise to new sewage management issues and potential costs. Similarly, the construction and operation of water and sewerage services have subsequent effects on the level of energy consumed and the associated costs borne by the community<sup>30</sup>. Those interrelationships are shown schematically in Figure 2.

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<sup>30</sup> Reduced consumption of water by households and businesses could also reduce energy use, and costs, such as by reducing the amount of energy required to heat water for a shower. Water use reductions achieved across the community also can result in reduced sewage flows, and consequently the energy used to transport and treat these. These approaches have the associated benefit of reducing greenhouse gas emissions. More substantial cost savings may also be realised by being able to defer the need to augment sewage treatment plants and transfer pipes in growing areas. Additionally, this creates the opportunity to design and construct 'smaller' water supply and sewerage systems in the future.

Figure 2: Systems View of Water Supply, Sewerage and Energy Services and River Health.



*Response to water efficiency measures (and/or alternative water supply strategies) is shown for each element in italics*

The Commission is making considerable efforts to flesh out such relationships. It envisages highlighting, in its Inquiry Draft Report, some key specific instances in the Clarence Valley where there are opportunities for overall cost savings and/or achievement of demonstrable river health benefits such as reduced river extractions or discharge of pollutants. The Commission's interest in the optimisation of the cost-effectiveness with which utility water and sewerage services are delivered derives from its belief that any savings in public expenditures could usefully be applied to priority river health issues (if not targeted to other Government priorities).

## Further Analysis

The Commission has initiated several studies to examine more closely the interrelationships within the Nymboida-Orara River system and to identify any opportunities (or impediments) that there may be to the achievement of a combination of water access rules, capital works, demand management measures and operational practices (in relation to town water supplies and power generation) that would be optimal from a 'system-wide' viewpoint.

That is, the Commission's intention is to test thoroughly the 'feasible' options to identify the combination of measures that would deliver the best combination of the following outcomes.

- River health in the *full* sense of the term as applied by the Commission<sup>31</sup>.
- Secure<sup>32</sup>, lowest-cost (and energy efficient) water supplies and sewerage services to the RWS scheme's client community.
- In-built mechanisms to protect the longer term sustainability of the total system (that is, the natural river and the water supply utilities and other water users drawing on it).
- Commercial viability of continued hydropower generation by NorthPower, and maintenance of the regionally significant tourism and recreational facility represented by the Blaxlands Creek canoe course.
- Effective and efficient application of the public funds made available through the *Country Towns Water, Sewerage and Drainage Program*.
- Other environmental benefits that could be realised through 'green power' generation and/or energy saving measures.
- Consistency with other Government initiatives and programs, such as those for energy efficiency.

The Commission has initiated the following actions to aid its analysis of the proposed RWS scheme and other water use activities in this system, with a view to determining the extent to which they would deliver the outcomes listed above. (This analysis will build upon the extensive documentation on the scheme, and other aspects of the system, which the various stakeholders have provided to the Commission.)

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<sup>31</sup> Equity considerations are central to the Commission's investigations into river health issues and their potential solutions. Costs and benefits of achieving river health goals need to be apportioned in ways that the community would regard as fair and tolerable.

<sup>32</sup> That is, adequate in terms of quantity, and the reliability of supplies under the driest conditions that could reasonably be expected to occur and the acceptable level of disturbance to water services under these conditions.

- Independent experts have been engaged to identify opportunities for improved integration of the planning and provision of water, sewerage and energy services in the Clarence Valley and Coffs Harbour region. The investigations will focus on the implications for river health<sup>33</sup>, particularly those concerning flows and water quality, of existing and proposed management approaches and infrastructure options.
- Options for linking the various operators' extractions from Nymboida Weir (to achieve an improved volume and pattern of flows in the downstream section of the river) are being investigated. The options were developed by the Commission in consultation with representatives of relevant authorities<sup>34</sup>. Testing of these scenarios will require complex hydrological and related modelling to be undertaken jointly by participating groups<sup>35</sup>. (The specifications for the scenarios are presented in Appendix 1.)
- An independent review of the ecological and hydrological studies prepared as part of investigations for the scheme and its forerunners, and in relation to the operation of the Nymboida hydroelectric power station will be commissioned. That review will include evaluation of the studies' methodology and key findings, with particular reference to cumulative impacts and a systems-based approach.

In undertaking the further studies and analyses it has commissioned, the Commission is cognisant of the stage of development of the scheme proposal in its current form, and of the incipient EIS assessment processes. However, notwithstanding the terminology in common use which refers to 'the scheme', the current proposals do in fact embody a reasonable degree of flexibility. The Commission is advised that there are opportunities for adjustment in terms of the size and timing of construction of the proposed dam on Shannon Creek, river access rules and the timing and magnitude of investment in water efficiency and other demand management measures. The Commission's analyses are thus both timely and relevant to the determination of final design parameters.

The Commission intends that its preliminary conclusions and draft recommendations relevant to the scheme will be available in time to supplement comments on the EIS for the scheme, and to inform any possible inquiry that may focus on specific planning aspects of the scheme<sup>36</sup>. In this regard, it is critical that the results of the alternative water management scenarios sought by the Commission, are available to inform its determination of its draft recommendations and to inform community input into a possible planning inquiry. The Commission will therefore discuss with the Department of Land and Water Conservation the ways in which those critically important studies might be expedited.

At this point in its Inquiry, the Commission's analyses confirm that, based on lowest recorded or probable flows in the Nymboida River and current levels of demand, the towns of the Clarence Valley need to augment their water supply. This Inquiry may therefore confirm that the proposed regional scheme is the most sensible option, from the perspective of available water and efficient use of the resources of the *regional* community. However, the Commission would then assert that for the longer term protection of river health, it *will* be essential to ensure that augmentation of the water supply system does not result in a loosening of those water use standards that have already been achieved in some parts of the

<sup>33</sup> These arise in the Nymboida and Orara Rivers where the major water extractions occur and in the estuary and lower reaches of the Clarence River, where the majority of the catchment population resides and disposes of their waste.

<sup>34</sup> Attended by representatives of the Lower Clarence County Council, NorthPower, Coffs Harbour City Council, Regional Water Supply Project and the NSW Departments of Land and Water Conservation, Public Works and Agriculture. Participants were selected on the basis of their knowledge of the technical and financial aspects and operation of water supply and hydro-electricity infrastructure.

<sup>35</sup> This includes balancing against potentially conflicting needs of water users and aquatic ecosystems in Goolang-Blaxlands Creek and the Orara River system.

<sup>36</sup> The scheme proponents anticipate that an EIS will be placed on exhibition in late January 1999, and that a Commission of Inquiry (at their request), conducted under the planning legislation, could commence approximately two months later.

region. Improvement in water use efficiency and demand management will be required. That is, there must be an acceptance of limits on the future growth of water requirements, whether this is achieved by containing population and industrial growth rates or by rigorous application of demand management measures (or both). The inequities in access to river flows that are currently perceived to arise from different growth rates within the region, could be offset, at least partially, by such demand management efforts.

Thus the Commission will recommend a suite of measures to promote 'river health consciousness' in the ways that the water supply authorities of the Clarence Valley and Coffs Harbour use the water extracted from the Nymboida and Orara rivers and provide leadership in this area to their client communities. The Commission expects also to suggest institutional arrangements that would facilitate better integration in the provision of water and sewerage services in the region, including the establishment of greater accountability for water use performance in the region. Measures to ensure the alignment of public funding programs with these objectives will be noted in the Inquiry Draft Report.

### *The Next Steps*

- Analysis of the advice provided by the independent experts engaged by the Commission, with regard to the opportunities for improving the integration of the planning and provision of water, sewerage and energy services in the Clarence Valley and Coffs Harbour region.
- Modelling of various water management scenarios for the Nymboida-Orara Rivers. The Commission will discuss opportunities to expedite this task with the Department of Land and Water Conservation.
- Independent review of the ecological and hydrological studies prepared as part of the investigations for the RWS scheme and the Nymboida hydroelectric power station.
- Continuing and effective dialogue with the RWS scheme proponents to ensure that, as the Commission's assessment advances, they are able to harness the flexibilities of the current proposal to test and modify the final design and operational parameters.
- The Commission will prepare its draft recommendations on this matter following further consultation with relevant county councils, councils, agencies and the community.

# Forestry

*In formulating its recommendations concerning forestry management and river health, the Commission is cognisant of the overall benefits, both to the environment and to the regional economy, of the recently completed Regional Forestry Agreements. The Commission's recommendations will be designed to build upon those benefits, and the Commission will ensure that this Inquiry's consultative processes are complementary rather than dislocative to the broader on-going discussions of forest management.*

## Forestry and River Health

An important conclusion reached by the Commission in its previous Inquiries is that, in selected locations, notable improvements in river health (and agricultural viability) could be achieved by replacement of grazing with plantation forestry. Thus the Commission has recommended the establishment of incentives and other measures to assist/encourage landholders to make such adjustments. Similar recommendations will be pertinent also to this Clarence Inquiry. However, in light of the particular circumstances identified by this Inquiry in the Clarence catchment (and expected to prevail in other coastal catchments), the Commission believes that careful management will be required to ensure that plantation forestry's potential benefits to river health are realised. There are several key management challenges, including the determination of mechanisms for specifying water access arrangements, mitigating the input of sediments and nutrients into rivers, and managing weeds. These are addressed in the following sections.

Forestry is a major land use activity in the Clarence River system. Forests currently cover around 30 percent of the catchment area and could expand with the establishment of new plantation forests, possibly in response to the incentives created by carbon credit markets and other policy initiatives promoting plantation forestry.

The Commission's preliminary analysis of the implications of forestry activities on river health, with a particular focus, in this Inquiry, on the Clarence, has been undertaken with regard to the current government processes for developing Regional Forestry Agreements (RFAs). The Commission's analysis focuses on the relationships between forestry and river health, with the aim of building on the RFA process to maximise the opportunities for forestry activities to assist the achievement of river health improvements, and vice versa.

Forestry activities can affect river health in a number of ways. They can change the magnitude of river flows, modify water quality, via input of nutrients and sediments, and create opportunities for the invasion and spread of weeds. The nature of those impacts varies with the type and phase of the forestry activity. Although they are not well quantified, and although plantation forestry is widely perceived to be an 'environmental good', its impacts *can* be either beneficial or *adverse* in terms of their consequences for river health. The following sections address, in turn, each of the major avenues through which forestry can impact on river health. They point to the need to ensure that forest management both maximises the realisation of the potential benefits *and* minimises the potential disbenefits associated with the activity.

There are real opportunities to improve Clarence river health through establishment of well-managed plantation forests in appropriate locations. For example, the establishment of plantations on marginal agricultural land can assist the stabilisation of eroded soils, and, by enhancing the economic viability of farms, can increase farmers' capacity to implement on-farm practices that are favourable to river health.

At the same time, forestry management should address potential negative impacts on river health, in the interests of both sustainability and equity. Other river users are increasingly being required to implement measures to improve river health. For example, farmers are expected to modify their operations to reduce the entry of nutrients into rivers, and restrictions on water access to protect environmental flows require other adjustments in many locations. Failure to manage the potentially adverse impacts of forestry activities could offset much of the benefit generated by the adjustments being implemented, or soon to be required, by other river users.

## Forestry-induced Changes in River Flow

Forestry activities can change river flows through processes associated with deforestation and reforestation.

### **Deforestation**

Deforestation (or forest clearing) causes an increase in the proportion of rainfall that runs off the land and enters rivers, thereby raising all levels of river flows (that is low, medium and high flows)<sup>37</sup>. This increase in river flows generally peaks in the first three years following the clearing of the forest. Flows return to pre-cleared levels as the forest grows again. This usually occurs within four to ten years, although full recovery may take up to 25 years.

Increases in *higher* river flows induced by forest clearing could have adverse impacts on the physical condition of the river channel. Increases in peak flood flows can cause erosion of the river bed and banks<sup>38</sup>. This often results in the enlargement of the river channel and the loss of riparian vegetation.

Increases in *low* flows generally would benefit and/or have no net impact on river users located downstream of existing forestry areas. That is, the temporary increase in flows would provide more water for other consumptive users and/or instream ecosystems. Conditions would then return to 'normal' once the forest became re-established and the longer-term benefits of the vegetative canopy were restored. Given the emphasis that is now placed on 'resource security' by water users, especially in the context of water reform initiatives which are changing resource-sharing rules, the Commission notes that advice to users about water entitlements should stress the temporary nature of any forestry-induced flow increases<sup>39</sup>. Conversely, resource security for forest operators should not be taken to imply that they have an unfettered entitlement to alter flows without due regard to the implications for other water users.

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<sup>37</sup> A recent review of various studies has confirmed this general response, although there is considerable variation in specific situations.

<sup>38</sup> Other land clearing activities have a similar effect, particularly in urban areas.

<sup>39</sup> The Commission understands that this is a central issue in discussions among water users and forest operators in the Bega River catchment. It will refer again to it in the Bega River Inquiry, which is now in progress.

## **Reafforestation (and Reforestation)**

Reafforestation (or forest regrowth) causes a decrease in the proportion of rainfall that runs off the land and enters rivers, thereby reducing all levels of river flows (that is low, medium and high flows)<sup>40</sup>. The fact that *new* plantations would effectively draw more water from the system has an important implication for the implementation of recommendations relating to environmental flow objectives for rivers. This derives from the fact that flow management relies heavily on the imposition of licence restrictions on extractions to protect environmental flows in the river. That powerful flow management instrument is unavailable in the case of forests, because the extraction of water by trees, once planted, cannot be governed by licence restrictions. This has two important implications, as follows.

Reafforestation of the catchment may represent a change towards a more *natural* hydrologic regime, and in that sense be perceived to be unequivocally beneficial to river health. However, *natural* flow regimes are not necessarily those which are required for a healthy ecosystem, given that substantially modified ecosystems now exist in many locations. Modified ecosystems often incorporate elements that are highly valued in environmental terms, even though they are 'new' or different from those of the natural regime. The Commission will consider such environmental values in determining its recommendations on river flows. Under some circumstances, a return towards natural flows, as could be induced by forest expansion, could present some challenges to the achievement of the environmental flow objectives established by the Inquiry process, given that a major instrument for managing flows is not available.

Additionally, and perhaps of more immediate concern to this Inquiry, is the fact that new forestry plantations could have significant impacts on other water users, particularly in rivers where there is already a high level of water use<sup>41</sup>. New forests effectively increase the competition for water that is in limited supply under low flow conditions and could thus, in principle, reduce the commercial viability of other water using activities. While such impacts would be eased, briefly, in the period between clearing and re-establishment of a plantation, they could be significant enough to warrant some concerns on equity grounds.

In this regard, the equity issues arise from the critical difference between forest plantations and other commercial activities, which are dependent on a reliable water supply (such as irrigated crops), namely that forest plantations do not involve the direct application of water and are not required to obtain a water licence. For example, a farmer growing potatoes around Dorrigo is required to obtain a licence to irrigate water, with the licensing process involving some analysis of the implications of the operation for other users and the river itself. Because the operator of a forest plantation elsewhere in the Clarence catchment is not obliged to undergo a comparable licensing process, those assessments are not made, notwithstanding their potential importance for the reasons outlined above.

While the water used by forestry activities has not been formally specified in the past, the Commission believes that the potential for forestry to adversely affect environmental flows and the entitlements of other users is sufficient to warrant examination of the ways in which water access arrangements for forestry might be clarified and formalised.

The Commission believes that any potentially adverse impacts of forest expansions can be contained through careful management. It believes that establishment of a carbon credit

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<sup>40</sup> Some studies have indicated that the regrowth of forests can reduce annual river flows by as much as 30 percent within specified subcatchments. This effect has reputedly been as high as 50 percent in relatively dry summer months in southern NSW.

<sup>41</sup> This would be particularly significant in situations in which plantations replace dryland agricultural activities. However, these impacts need to be balanced against the benefits for river health of establishing plantations on degraded land.

market which incorporates river health as well as atmospheric health considerations will be an important catalyst for the desirable management approach. This matter is further discussed in the section relating to greenhouse actions.

## Forestry-induced Changes in Water Quality

Existing and new plantation forestry activities can affect water quality by altering the amount of sediments and nutrients entering rivers. The major sources of sediment include unsealed roads and snig tracks, with the peak contributions of sediment tending to occur during and immediately after the clearing of a forest. Increased nutrient inputs to rivers from forests are attributable largely to runoff following prescribed burning and/or wildfire.

Although the water quality impacts of forest plantations are generally thought to be less than those of some other land use activities, they signal the need for appropriately integrated catchment management, which includes recognition of *river health* as a key objective.

The impacts of forestry activities on water quality can be partially mitigated through the implementation of various 'best management practices', such as establishment of buffer strips which can retain some of the sediment and nutrients on-site. Again, equity considerations demand that forest operators be included in requirements to contribute to *net* improvements in river health.

The management of the impacts of forestry activities on riverine water quality has traditionally focused on the adoption of 'best practice' techniques to mitigate the entry of sediment and nutrients into rivers. That approach has been formalised through the issuing of pollution control licences by the Environment Protection Authority. This approach has had some success in achieving on-site retention of contaminants.

The Commission is assessing the opportunities and impediments associated with extending this management approach. It believes there may be opportunities to introduce mechanisms through which forest operators could obtain sediment/nutrient 'credits' (to offset the negative impacts of their own activities) by reducing the input of those contaminants at other sites, within a designated subcatchment but including outside the specific forest. For example, an operator could generate 'credits' through assisting another landholder to upgrade the treatment of wastewater from a dairy shed within the subcatchment. Such approaches would utilise the potential of properly structured and managed markets to identify least-cost ways of achieving river health objectives.

## Weeds

Existing and new plantation forestry activities create the opportunity for the invasion and spread of weeds. The current arrangements for the management of weeds generally are thought to be more effective than that for other land uses, given the financial imperative<sup>42</sup> and viability of forestry, and the contractual mechanisms used for establishing new plantations.

The Commission is assessing the need, if any, and opportunities to build on the current arrangements for managing weeds in forest areas. (It will specifically address the management of weeds for all land uses in its Draft Report.)

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<sup>42</sup> Effectively controlling weeds promotes faster growth of trees.

## *The Next Steps*

- Having considered the various relationships between forestry and river health, the Commission is convinced that some new approaches are required to ensure that existing and new plantation forests are managed in ways that are consistent with the protection of instream ecosystems and of the entitlements of other river users.
- Before formulating its draft recommendations in relation to this matter, the Commission will undertake further assessments of various mechanisms through which water entitlements for forestry activities could be formalised so as to recognise river health objectives.
- To that end the Commission will hold further discussions with relevant stakeholders and government agencies. In so doing, the Commission will wherever practicable build on the outcomes of the RFA process with a view to maximising both forestry opportunities and river health gains.

## Specific Challenges for River Health

# Greenhouse Strategies

*The NSW Government has signalled its intention to establish a strong leadership role in the development of a national framework for the management of greenhouse emissions, including the release of its policy statements, NSW Tackles Greenhouse and the NSW Greenhouse Action Plan 1998<sup>43</sup>. The Commission's preliminary analysis focuses on the relationships between controls on greenhouse gas emissions and river health, with the aim of building on current government processes, to maximise the opportunities for controls on greenhouse emissions to assist in the achievement of river health improvements<sup>44</sup>.*

## Greenhouse Gas Strategies

The possible introduction of a cap on greenhouse gas emissions and trade in carbon credits presents new challenges and opportunities for securing river health<sup>45</sup>. In this regard, there are a complex array of positive and negative relationships between the strategies proposed to achieve 'atmospheric' and river health. The challenges are to optimise the positive aspects of these relationships and ensure that appropriate safeguards are implemented to address any adverse impacts on river health.

It is also important that pro-active strategies are developed and implemented to address the impact of the predicted changes in climatic conditions with regard to river health. These changes particularly could modify patterns of river flows and sea level, with potentially significant impacts on the way riverine and estuarine resources are allocated and protected.

There are several possible responses to the introduction of controls on greenhouse gas emissions. Those that have particular relevance to river health include energy efficiency strategies, new energy generation opportunities/technologies and vegetation 'carbon' sinks. These have varying implications (some positive and some negative) for river health.

## Energy Demand Management Strategies

Achieving greater energy efficiencies in industrial, urban and agricultural production processes could provide the opportunity to reduce carbon emissions, riverine water extractions and sewage effluent disposal at all stages of the urban water cycle. For example, the *NSW Greenhouse Action Plan* identifies the opportunity to reduce energy consumption and water use by installing 'high efficiency' shower roses and washing machines in residences<sup>46</sup>. When combined with other measures such as the installation of dual flush

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<sup>43</sup> The NSW Premier released *NSW Tackles Greenhouse* in 1997. More recently, the NSW Government released its *Greenhouse Action Plan* and the report *Greenhouse Trading: An Operational Specification for the phased Introduction of a Nation-wide Greenhouse Emissions-trading Framework for Australia*. The Commonwealth Government also has released various reports and policy statements in this regard.

<sup>44</sup> The Commission has made some initial recommendations, in its Draft Report on the Shoalhaven Inquiry, on the potential to use the trade in carbon credits to create incentives for landholders to re-establish vegetation in priority areas, such as along rivers.

<sup>45</sup> The introduction of a cap on greenhouse gases and trade in carbon credits was the key outcome of the Framework Conference on Climate Change held in Kyoto, Japan, in December 1997. This is yet to be ratified by governments.

<sup>46</sup> The adoption of such measures can reduce energy, water and sewage costs for various user groups and service providers. The NSW Sustainable Energy Development Authority (SEDA) is promoting those measures in conjunction with various energy suppliers and businesses.

toilets, this can lead to reductions in the total volume of water and sewage that operators need to extract, store, treat, transfer and dispose, thereby further reducing energy consumption and carbon emissions.

It would be important particularly to incorporate these efficiency measures at the design stage of new water supply and sewerage infrastructure, by including an appropriate degree of operational flexibility, given the longevity of such infrastructure projects. The Commission is assessing the mechanisms that could be used to maximise both energy efficiency and also river health benefits. Some amendments to existing public funding programs such as the *Country Towns Water, Sewerage and Drainage Program* should assist in this regard (see section relating to integrated water and sewerage services).

### ***Alternative Generation Technologies***

The deregulation of the electricity sector and the introduction of 'green power' accreditation schemes have created both opportunities and incentives for existing and new operators to develop alternative energy generation technologies, which may have benefits for river health<sup>47</sup>. For example, water supply operators could seize the opportunity to offset the cost of implementing environmental flows by installing mini hydro-electricity turbines, to take advantage of the additional releases from storages that are required to meet river health objectives. For example, Hunter Water Corporation is presently designing such a system for Chichester Dam, near Newcastle, to take advantage of the environmental flow releases that the Commission recommended in its Williams River Inquiry.

However, alternative generation technologies present some risks to river health. For example, it would be important to ensure that mini hydro-electricity schemes are designed and operated in a way that optimises the benefits for riverine ecosystems, such as providing a variable pattern of river flows<sup>48</sup>.

### ***Vegetation Carbon Sinks***

The incorporation of vegetation as an element in the possible trade in carbon credits has both positive and adverse implications for river health, with regard to reforestation (establishment of carbon sinks) and land clearing (removal of carbon sinks) activities.

Reforestation undertaken on a wide scale could provide many positive outcomes for riverine ecosystems, particularly if the activity is guided towards high priority areas for restoration, such as riverbanks, wetlands, degraded catchment lands and areas with salinity problems.

Trade in carbon credits raises an important opportunity for farmers to derive an alternative source of income by 'farming' (planting and maintaining) vegetation as part of their overall farm management<sup>49</sup>. The financial attractiveness of such opportunities could be enhanced by including appropriate conditions in the terms of trade for carbon credits, and by the strategic use of public funding for ecosystem restoration<sup>50</sup>. Specifying the carbon credit 'exchange rates' and market rules so that they provide a higher level of credits for revegetation in

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<sup>47</sup> SEDA introduced the Green Power program to accredit alternative energy technologies. Accreditation enables operators to obtain a higher price for the electricity that they generate through alternative 'greener' means.

<sup>48</sup> The alternative would be to optimise operations to maximise generation during the day to take advantage of peak electricity prices.

<sup>49</sup> Recently reported 'trades' in carbon credits through the establishment of carbon sinks are speculative, given that the market has not yet been established.

<sup>50</sup> Some modification of other policies may be needed to create a consistent set of signals.

priority areas<sup>51</sup>, would facilitate the direction of revegetation efforts to locations favourable to river health.

Various public funding schemes associated with the management of natural resources also could be used strategically to maximise the opportunities to restore priority ecosystems. For example, funds from schemes such as *Rivercare* and the *Natural Heritage Trust* could be used to supplement the returns to farmers for replanting and/or vegetation protection in priority areas.

Recognition of the value of *existing* vegetation as a carbon sink could also alter the economics of land clearing, if there were a greater internalisation of costs. That is, land clearing (to permit other land uses) would become less financially attractive, if 'carbon debits' were incorporated in relevant benefit/cost comparisons. Containment of land clearing activity could benefit river health by preventing changes in catchment hydrology and limiting soil erosion and the invasion of weeds. Beneficial implications for river health include prevention of increases in flood peaks, soil erosion and raised groundwater tables.

Notwithstanding the significant benefits of re-establishing vegetation on a wide scale, some potential adverse implications for river health need to be addressed. Potential consequences such as the proliferation of weeds, changes in catchment hydrology, the creation of new demands for water extractions from rivers (such as for co-generation schemes<sup>52</sup>), disturbance of soils (when plantation forests are subsequently harvested), and wildfire will present new challenges for catchment managers<sup>53</sup>. (See also section related to forestry).

## Climate Change

The predicted changes in climatic conditions arising from increasing greenhouse gases in the atmosphere have a number of significant implications for river health. A recent study undertaken by the CSIRO indicates that it is likely that there will be an increase in the frequency and intensity of drought and higher rainfall episodes, with subsequent changes in river flows<sup>54</sup>. Such changes could result in increased competition for water access during droughts, increased flood peaks and increased erosion and enlargement of river channels. Additionally, climate change could induce a rise in sea levels, which could have particularly significant implications for low-lying areas adjacent to estuaries. Some of these factors may have significant implications for land use planning in areas adjacent to rivers, such as determining land use zoning in areas subject to flooding<sup>55</sup>.

Precautionary measures have already been incorporated, to varying degrees, into a number of NSW policies and programs, such as that for development in coastal areas. As this Inquiry proceeds, the Commission will maintain its interest in the policies being developed to modify greenhouse gas emissions and its efforts to ensure that river health objectives are incorporated at the early stages of those policy processes.

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<sup>51</sup> The magnitude of any such credit weightings also would be influenced by the capacity of different types of vegetation communities to sequester carbon.

<sup>52</sup> Many co-generation schemes require significant quantities of water for purposes such as cooling.

<sup>53</sup> The opportunity to obtain an additional return for carbon sequestration also could promote the expansion of some types of agricultural systems, with associated ecological implications.

<sup>54</sup> The NSW Government recently announced that a detailed study would be undertaken to assess the impacts of climate change in NSW, with a particular focus on the Hunter catchment and adjacent coast.

<sup>55</sup> Other implications include the potential demand to construct engineering works to protect assets from erosion.

## *The Next Steps*

- The Commission considers that the possible introduction of a cap on greenhouse gas emissions and trade in carbon credits presents new challenges and opportunities for securing river health.
- The Commission will liaise with relevant agencies to access further the mechanisms for integrating measures for 'greenhouse' and 'river' gains.

# Other Issues to be Addressed in the Draft Report

This Progress Report is being issued to inform the community, signal the direction and allow further discussion on specific issues being addressed by the Commission in its Clarence River Inquiry. All of the issues discussed in detail in this report are complex. This complexity arises out of many factors including the size of each issue in the Clarence River system, inadequate management and institutional arrangements and the general uncertainty about the scientific facts relating to the issues.

The Commission also has received submissions and evidence regarding many other issues. Many of these have been assessed in other Inquiry reports, and there are several recommendations that the Commission has made before that will be reiterated for the Clarence River Inquiry. The Commission is however addressing these issues in detail by taking into account the specific circumstances that prevail in the Clarence River system. In many cases, it will make Clarence specific recommendations in a subsequent Draft Report. The direction of the Commission's assessment of these other issues is described briefly below.

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|------------------------------|---|
| <b>River flows (general)</b> | A framework similar to that used in the Hawkesbury-Nepean and Shoalhaven Inquiry Reports will be adopted. This will include recommendations on access restrictions for existing users, specific entry levels for new users, measurement of use, best practice trade-offs, volumetric conversion and arrangements for farm dams. |
| <b>Water quality</b>         | Recommendations from this Inquiry in relation to water quality objectives will be based on community preferences. Modified ecosystems, such as Plumbago Creek and Alumy Creek will be assessed to determine achievable water quality objectives and link future objectives with improved management.                            |
| <b>Dredging</b>              | The Commission will assess and investigate the impacts on river health of dredging in small channels and tributaries of the Clarence estuary, including impacts of dredging, transporting and use or placement of acid sulfate soils.   |
| <b>Weeds</b>                 | The Commission's assessment will be similar to that undertaken for the Shoalhaven River Inquiry, with reference to specific areas of priority.  |
| <b>Erosion</b>               | Recommendations from this Inquiry will relate to a strategic management framework (similar to that proposed for weeds). Links to water access and vegetation approvals, and a consistent set of incentives and sanctions will be addressed.   |
| <b>Aboriginal interests</b>  | The Commission will consider and make recommendations in relation to traditional hunter and gathering entitlements, as well as assessing river health aspects of the institutional and management issues relating to water provision and sewage management for Aboriginal communities.  |

- Wastewater** Assessments will incorporate all sources of wastewater in the Clarence catchment including domestic sewage, on-site sewage management, sewage from boat use and urban and rural stormwater. Recommendations will suggest priorities for managing wastewater. Issues related to the integration of water, sewage and energy will also be addressed, as discussed earlier in this Progress Report.
- Rural residential development** The Commission will assess the river health implications of rural residential development. For the Orara subcatchment in particular, issues of land and water capability will be examined.
- Sedimentation** Measures to manage sedimentation problems, which derive from old mining sites in the Timbarra catchment will be investigated.
- Mining** This Inquiry will assess the adequacy of measures to protect river health proposed for the new gold mine under construction in the Timbarra catchment.

# Where to Next ?

The Clarence River Inquiry Progress Report has been issued to:

- inform the community about the factors that have been presented to the Commission in the Clarence Inquiry;
- describe the nature and key findings of the assessments that have been undertaken to date;
- signal the direction of further analyses and the likely nature and/or possible approaches that could be put forward in the Commission's Draft Report; and
- seek further input from the community on key factors affecting the health of the river system.

Prior to finalising the Draft Report for the Clarence, the Commission will be undertaking further discussions with key stakeholders in relation to particular issues, and holding other forums and meetings. As discussed in this Report, the Commission is also awaiting the results of various analyses, modelling work and consultancy reports to allow it to make informed decisions on various complex issues.

The Commission is not seeking formal submissions on this Report, as a Draft Report will be released in the near future. Should community members, councils, agencies or other groups wish to discuss issues or forward comments to the Commission in relation to this Progress Report they will be welcomed till 12 February 1999. The Commission's contact details are listed below.

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The Commission's Draft Report into the Clarence River catchment will be released in early 1999 and will address in detail all the key and specific issues, as well as other issues addressed in this Report.

# Nymboida-Orara Water Management Scenarios

## Common Parameters for Scenarios

*The selected flow management scenarios, which are to form the primary basis for the Healthy Rivers Commission's assessment of the implications of the diversions from the Nymboida River on river health, will be modelled on the basis of the following common parameters, as discussed at the technical workshop<sup>56</sup>. The scenarios are presented in two groups, being those designed to test a range of different levels of flow protection and a second set to assess a representative range of changes in the underlying assumptions. Any additional assumptions that are utilised in the modelling are to be documented and provided to the Commission.*

- a) Daily flow data from the gauge Nymboida River at Nymboida (204001) to be used to derive the estimate of 'natural' flow at the Nymboida Weir, in accordance with the dataset used in the IQQM model developed for the Regional Water Supply<sup>57</sup>. (The model is understood to include an allowance for upstream extraction and adjusts observed flows to reflect flows at the weir. The allowance for upstream use is to remain constant for the base case and 2021 scenarios).
- b) The existing Nymboida Weir is taken to be in place for the 'natural' flow condition, and existing and proposed development scenarios. The weir is believed to have a storage capacity of 210 ML.
- c) All existing and proposed extractions from Nymboida Weir to be assessed in terms of their cumulative impact on flows passing downstream.
- d) All users are subject to the restrictions on access to flows from the Nymboida River as specified in the scenarios (ie no other access arrangements apply), including during the filling period for the Shannon Creek storage, construction of which is part of the Regional Water Supply Scheme.
- e) Any new or increase in water use for town water supply (TWS), beyond that associated with the existing level of development<sup>58</sup>, is accessed via the trade of water entitlements. For modelling purposes, it is assumed that any transfer of entitlement would be purchased at a price to compensate NorthPower for its foregone income and other associated costs (eg foregone electricity sales, changed maintenance costs and penalties for thermal substitution).
- f) Carbon debits incurred through the substitution of thermal for hydro generation by NorthPower or through the operation of the RWS to be valued at \$30/tonne carbon dioxide equivalents<sup>59</sup>. Any carbon credits created by either operator to be costed in the same way.
- g) GreenPower accreditation to be reinstated for the Nymboida Power station (ie station output counted in NorthPower's Ecoplus program portfolio) if it satisfies the specified flow protection criteria.
- h) NorthPower operates its diversion on a continuous basis, up to its maximum capacity of 860ML/d, to the extent enabled by prevailing flows in the Nymboida River (except for

<sup>56</sup> Some amendments have been made since the workshop to include the preliminary results of the Commission's independent studies.

<sup>57</sup> The dataset is believed to differ slightly from that used in the Macoun (1998) in respect of the length of record, the method for adjusting observed flows @ 204001 to reflect flows at the weir and by incorporating an allowance for upstream irrigation use.

<sup>58</sup> The existing level of development is defined as that level and pattern of water use demand, allowing for climatic variation, associated with the existing level of domestic, industrial and agricultural activity supplied from the Nymboida River, via the Clarence Valley water supply system. (It is not the capacity of the present water supply infrastructure itself.) For modelling purposes, this can be simplified by using the 1996 monthly volumes of water diverted by the scheme, as presented in Macoun (1998; See table relating to Town Water Supply Extractions – Clarence Valley).

<sup>59</sup> Mid range cost estimate for greenhouse gas emission credits in: ACIL 1998, *Appendix A6- Overview of Economic and Financial Analysis to the Snowy Inquiry*, Sept 1998, Higher estimates of \$45 & \$60/ tonne were used in sensitivity testing of financial analyses. The lowest estimate of \$15/ tonne was considered too conservative.

shutdowns associated with normal maintenance procedures)<sup>60</sup>. As such, it is assumed that the weir pool remains full at all times (ie only the specified portion of inflows are accessed).

- i) The extraction rule for Coffs Harbour TWS from the Orara River (to be maintained at the gauge downstream of Cochranes pool - 204025) to be the 80 percentile flow condition (~22 ML/d)<sup>61</sup>.
- j) Utilise the level of water demand and growth projections adopted in the design of the RWS at the 2021 level. (Refer to the request for details of the relevant assumptions for TWS shown in the section on requested information.)
- k) The minimum flow for the canoe course (canoeing and rafting) is taken to be 430 ML/d with the power station operating on a continuous basis. The minimum flow is taken to be 152 ML/d (18 ML/hr) for those other scenarios that involve pulsing of extractions. (Figures are based on the estimated minimum requirements of the Canoe Course operators of 50% of full load rate and 8.5 hours operation per day.)

## Base Case Data

### NorthPower Operations

Pre 1996 Nymboida River and power station operation, ie:

- 40 ML/day passing weir (ie riparian flow from outlet works and seepage)
- approximate weir storage of 210 ML
- no restrictions on access to river flows from the Nymboida River
- continuous diversion and operation of power station up to its capacity of 860ML/d
- 30 GWhr/annum output power station
- pre electricity industry deregulation

### Town Water Supply Extractions

- Clarence Valley

Extractions from the Nymboida River to supply the Grafton and lower Clarence community at the existing (1996) level of demand, using average daily volumes by month to reflect seasonal variation in demand, are:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
19.6	19.0	16.6	16.3	14.7	14.4	13.7	15.2	17.5	18.4	19.8	20.2

(Source: Macoun and Associates 1998, *Nymboida Hydroelectric Scheme Options for Environmental Flow Management*. Draft, May 1998)

Note: The above estimates will be adopted subject to confirmation that these are consistent with data used in IQQM analyses carried out for the Regional Water Supply investigations.

- Coffs Harbour

The present restrictions on extractions from the Orara River for the Coffs Harbour TWS apply. That is, stepped restrictions of 25, 15 and 5 ML/d (at the gauging station downstream of Cochranes pool [204025]) apply when storage levels in Karangi Dam are > 85%, 65-80% and <65%, respectively.

<sup>60</sup> Subsequent consideration may be given to the need for further modelling of alternative activation and deactivation procedures for the power station.

<sup>61</sup> The 80%ile access condition for Coffs Harbour TWS is preferred for modelling purposes. However, to expedite the modelling process, it would be acceptable to adopt the current stepped access regime of 25, 15, 5 ML/d corresponding to Karangi Dam storage levels of >85%, 65-80% and < 65%, if this reflects the existing configuration of the Department of Land Water Conservation/Regional Water Supply IQQM model for years after 1996. (DLWC to advise).

## Information Requested on Modelling of Scenarios

*(All assumptions used in the modelling of scenarios are to be documented and all outputs described in terms of the gross outcomes and change relative to the base case situation.)*

### Hydrology [To be provided by DLWC]

#### *Assumptions*

- Provide details of all other relevant modelling assumptions.

#### *Outputs*

- A table listing the flow duration data for the estimated 'natural' daily flows for all months and annual for the Nymboida R. at Nymboida gauge and at the weir.
- Estimated flow duration curves for the natural, existing (ie. 'base case') and each scenario flow case, shown on the same plot, for the each of the following sites:
  - Nymboida Weir (estimated from observed flows for the Nymboida R. at Nymboida gauge.)
  - Lower Orara River (Bawden Bridge gauge)<sup>62</sup>
  - Blaxlands Creek gauge<sup>6</sup>

Only provide plots for December, March, June and September for those scenarios that involve monthly flow access rules (ie in order to limit the number of plots required).

*Note: DLWC hydrologists will liaise with NorthPower counterparts to determine the precise form of the hydrological data NorthPower require for their modelling purposes.*

### Town Water Supply and Sewerage Services [To be provided by DLWC]

#### *Assumptions (unless explicitly varied, as documented)*

- Relevant details of all elements of water demand and associated growth projections for the Clarence Valley and Coffs Harbour communities for the existing and estimated 2021 case, for each major use sector (eg domestic, urban commercial, tourism and agricultural<sup>63</sup>). Note in particular any variations from the base case due to recent changes in demand that may have arisen from the closure of major industrial activities (eg the Grafton brewery) or other events, and the implications of such on water supply.

#### *Outputs*

- Implications for the security of supply, with reference to the 5, 10, 20 rule for:
  - i. the existing Clarence Valley TWS
  - ii. the existing Coffs Harbour TWS, and
  - iii. the proposed RWS scheme<sup>64</sup>including the projected date at which schemes fail to comply with the security rule, and any changes in the timetable and cost of augmentation for each scheme. (Assumes that the built elements in i – iii are fixed for all scenarios).
- Any changes in the design and operation of the infrastructure and associated costs (eg potential changes in the size of the required storage) for (i) - (iii) above.

(Assumes schemes are designed so as to meet the 5, 10, 20 rule for all scenarios)

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<sup>62</sup> 'Natural' flows in these cases are observed flows less the Nymboida power station diversion

<sup>63</sup> Or comparable sectoral breakdown possible using available data.

<sup>64</sup> As described in: *Regional Water Supply – Strategy Options Review* (June 1998) by the Department of Public Works and Services. Includes a 30,000 ML dam on Shannon Ck, a pipeline connecting this to Karangi dam, duplication of the existing water pipeline between the Nymboida River and Grafton, and pumping stations along the route.

- Implications, opportunities and costs that may arise for the management of sewerage schemes (for example, potential offsets in sewerage capital and operating costs achieved through water demand management) in the Clarence Valley and Coffs Harbour regions.

Note: It is expected that a range of cost effective options for managing sewage effluent that has been considered in recent regional sewerage planning exercises, will be considered in this analysis. The Commission will provide specific advice on the nature and scope of the analyses sought to the project officers undertaking this work.

#### **Nymboida Power Station** [To be provided by NorthPower]

- Description of scheme operation pre and post electricity deregulation and pre and post interim environmental flow rule, including any change in cost structures.
- Describe the nature of the model used, including all assumptions relevant to this analysis.
- Targets and timeframes for reduction of greenhouse gases in retail licence and other contracts and agreements
- Relevant details of the electricity price regime (eg peak price, spot price variation)
- Foregone electricity generation (megawatt hrs/yr) and associated foregone income, at the Greenpower rate<sup>65</sup>.
- Estimated tonnage and cost of carbon debit for thermal substitution.
- Estimated cost(s) of alternative substitution technologies (eg renewable energy)<sup>66</sup>.
- Estimated change in maintenance and/or other operating costs compared with base case.

#### **Canoe Course** [To be provided by DLWC]

- Provide details of all other assumptions.
- Gap analysis of number of days and length of sequences when diversions would not meet the specified minimum flow requirements compared to the base case.
- Number of occasions when diversions would not meet the flow requirements for weekends and scheduled events compared to the base case.

#### **Irrigation and Riparian Use in Goolang, Blaxlands Creek and Orara River**

[To be provided by DLWC in association with NSW Agriculture]

##### *Assumptions*

- Authorised area and estimated daily, monthly and annual volume of diversions for licensed irrigation, by major category of use (eg pasture, crops, horticulture).
- Changes in authorised area over the last 15 years.
- Estimated critical watering frequency for each major use category for plant survival and optimum production.
- Opportunities and impediments, including costs, of accessing alternative water supply sources (eg off-stream storage, bores, re-regulation structures).
- Estimated daily, monthly and annual volume of diversions by riparian users.

##### *Outputs*

- Gap analysis of number of days and length of sequences when licensed users could not access sufficient water to sustain a crop compared to the base case.
- Implications for access by riparian users.

<sup>65</sup> The estimate provided at the workshop was that a 13.5% premium is added to the retail price of electricity.

<sup>66</sup> The estimate provided at the workshop was \$50 - \$60/MWhr.

## Scenarios to be Modelled

Priority initially is to be given to modelling the annual 95th percentile scenario and its variants, in order to build on the existing modelling work. All scenarios are to be modelled using the common parameters specified above, except for the variations shown for the 95th percentile, in order to test the sensitivity of changes in the common parameters. The scenarios have been simplified for the purpose of modelling major responses to adjustments in the underlying parameters. The Commission's draft recommendations will draw on elements of the scenarios. (Additional adjustments may be warranted in light of the model results.)

Threshold for Total Low Flow Protection <sup>67</sup>	Proportion of Higher Flows Protected <sup>68</sup>			
	Primary scenarios	20%	50%	80%
No minimum flow threshold		X	X	
Monthly 98th percentile sequence		X	X	X
Monthly 95th percentile sequence			X	
Monthly 90th percentile sequence			X	
Monthly 80th percentile sequence			X	
Annual 95th percentile		X	X	X
Annual 80th percentile			X	X
<b>REPRESENTATIVE SENSITIVITY TESTS USING THE ANNUAL 95TH PERCENTILE</b>				
a) with carbon debits @ \$15/tonne CO <sub>2</sub>			X	
b) with Orara TWS extractions restricted at Cochranes pool to: <ul style="list-style-type: none"> <li>i. 15 ML/d threshold access</li> <li>ii. Bishop recommendations<sup>69</sup></li> </ul>				
c) with Coffs Harbour sewage effluent used to satisfy Orara environmental flow requirements downstream of Cochranes Pool <sup>70</sup>			X	
d) with no access to flows during August – November for all users (Results to be provided for each month)			X	
e) with 'pulse' operation of power station to maximise electricity generation during peak periods			X	
f) with a residential water efficiency program <sup>71</sup> implemented in the Clarence Valley and Coffs Harbour to achieve a 40% reduction in regional demand			X	
g) with Nymboida weir raised 1 metre (+150 ML capacity) to enable limited 'pulsing', in addition to maintaining a continuous flow over the weir			X	
h) with a combination of c, f, g			X	

<sup>67</sup> Or natural inflow, whichever is the lesser.

<sup>68</sup> Higher flows' refers to daily flows greater than the 'low flow' threshold specified in column 1. Scenarios are defined in terms of the portion of higher flows that are protected (left in the river), as opposed to portion that can be accessed. In this table the annual 80%ile/80% scenario is equivalent to the 80%ile/20% Nymboida River flow rule proposed for the RWS.

<sup>69</sup> Critical flows determined in Bishop's 1993 and 1996 studies assessing the impact of enlargement of Karangi Dam, ie:

- \* maintenance of aquatic communities excluding passage for large fish → 25 ML/day (Jan-March) = approx 80%ile
- \* passage for spawning populations Eastern Cod → 80 ML/day (Aug, Sept) = approx 50%ile flow
- \* support passage and spawning needs adult Aust. Bass, catfish & similar size fish → 50 ML/day (Oct-Dec; Apr-July)

It is understood that DPWS has developed a surrogate scenario to simplify the modelling of this scenario.

<sup>70</sup> Differing views were presented to the Commission about the opportunities and implications of returning waters, via the discharge of highly treated sewage effluent, previously extracted from the Orara River for the Coffs Harbour water supply. This sensitivity test therefore has been included to establish a factual basis for assessing the implications of such an approach.

<sup>71</sup> Permanently occupied residences only. In existing dwellings, retrofit of shower roses, toilets and tap flow regulators, fix indoor leaks plus front-loading washing machine subsidy program. Water efficient fittings required in all new dwellings. Also assumes reductions in all sectors due to natural attrition of toilets, and 20% fall in Grafton demand due to pricing reform.



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