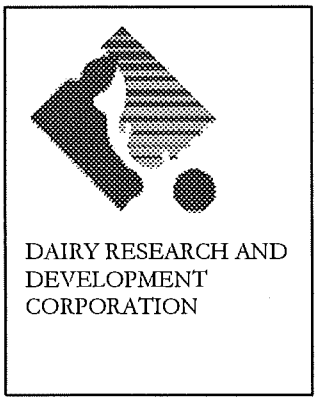
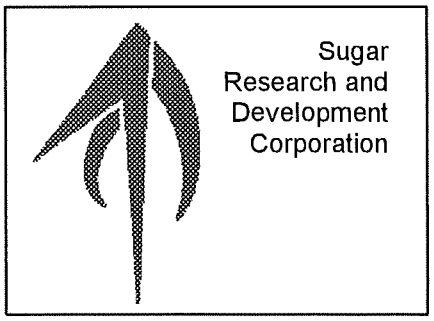
Improving the Land and Water Management of Coastal Plains of New South Wales

Adrian Webb





Project No. 95/172

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NON TECHNICAL SUMMARY

95/172 Improving the Land and Water Management of Coastal Plains of New South Wales

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OBJECTIVES:

1. To identify the issues which impact on land and water quality of the NSW coastal catchments and plains by consultation with stakeholders and reference to existing reports, strategic plans, and current projects and programs.
2. To identify the priority natural resource management issues in a focus catchment of coastal northern NSW using the adaptive environmental assessment and management (AEAM) approach, and develop strategies for addressing them, indicating who has responsibility for particular actions.
3. To identify the opportunities for application of the findings from the focus catchment study to other catchments of the coastal plain, with particular emphasis on management options.
4. To identify the options for ongoing coordination of natural resource management activities of the coastal plains of New South Wales.

NON TECHNICAL SUMMARY:

In response to a commissioned project by the Fisheries, Sugar, Dairy and Land & Water Resources Research & Development Corporations, a report was provided on the environmental management issues relating to land and water management of the coastal floodplains and estuaries of NSW. The report is aimed at assisting the Corporations in identifying how they might contribute to improved integrated management of land and water resources in the floodplains and estuaries.

Subsequently a collaborative project with the Clarence River Catchment Management Committee developed a series of activities and R&D projects to address priority issues in the catchment. Aspects of coordination and wider use of project outcomes were considered during the project.

Since the floodplains and estuaries along the New South Wales coast remain focal points for commerce, population growth and recreation industries, the natural resources have come under much increased pressure from urban, tourist, industrial and agricultural development in recent years. The result has been degradation and sometimes the loss of these resources. Improved management of the natural resources of the floodplains is essential if development is to be sustained.

The major environmental management issues of the coastal floodplains of NSW were categorised under four interrelated headings:

- Water
- Land
- Riparian Zones
- Land Use Planning and Management

Several of the issues identified are highly relevant to the responsibilities of the Corporations. In many cases, the issues cannot be handled separately because of the dynamic relationships between land and water and the local communities. Consequently, R&D for land and water management practices must be able to be integrated into the resource management systems of

the major stakeholders such as agricultural landholders, developers, fishers, and local government.

Priority areas requiring further work to achieve improved environmental management of the floodplains are listed below.

- Geomorphic studies to identify pollutant and sediment sources and dynamics in floodplain estuaries.
- Soil water balance in floodplains and its relationship to surface and groundwater hydrology to provide sustainable land management options, particularly for ASS.
- Identification of uncertainties in current knowledge of coastal floodplain ecosystems.
- Biological impacts of dredging in floodplain estuaries.
- Impacts of altering floodgate management and other physical barriers on water quality and fish habitat.
- Knowledge of groundwater processes in barrier dunes for land use decisions.
- More detailed distribution of ASS and identification of risks for land use.
- Development of national standards for ASS hazard assessment.
- Communication of factors involved in acid drainage, the off site effects of acid waters, and the current best management practices.
- Improved methods of community education and technology transfer regarding the benefits of well managed riparian zones.
- Economic assessment of rehabilitation case studies to establish the degree of public and private benefits.
- Wetland pasture management requirements.

Findings of the report have been communicated to a wide range of stakeholders through direct feedback, specific meetings and field trips, and other workshops and meetings as opportunities arose. A poster was presented at the second national acid sulfate soils conference in Coffs Harbour in 1996.

In response to recommendations in the initial report a number of projects were developed by the range of industry and government stakeholders within the Clarence catchment. The Clarence River County Council with the support of the Clarence River Catchment Management Committee has now taken the coordination role in the implementation of the series of projects. The projects have been incorporated into an overall program to ensure coordination, and focus of outcomes aimed at improving aspects of floodplain management. Some of these are expected to be able to be applied to other catchments on the coastal floodplain, and relate particularly to floodgate structure management and associated impacts on agriculture and fish movement and habitat.

Coordination of the efforts in natural resource management of the coastal floodplains tends to occur through government led regional committees and catchment management committees. The coordination of R&D, and integration and development of information from the R&D could be improved by specific communication efforts to produce best management practice or guidelines for the various land and water management systems. For example, the dairy industry could well focus its attention on development of pasture management guidelines / best practice for the wetlands and areas with a high acid drainage risk. An important requirement is that all of the stakeholders be involved. Local Government and the EPA for instance could be key groups to involve at an early stage of development of guidelines for dairy or beef pasture management of wetlands, since drainage is often one element of the practice.

Another communication activity which needs further promotion is annual workshops for reporting of R&D progress to catchment/regional stakeholders with specific attention to the application of the outputs of the R&D. This may well include R&D from outside the coastal floodplains. To achieve this successfully a coordinator is required to ensure networking across regions, industries, disciplines and R&D organisations.

Improving the Land and Water Management of Coastal Plains of New South Wales -Final Report January 1999

BACKGROUND

The Fisheries, Dairy, Sugar and Land & Water Research and Development Corporations support a number of projects important to agricultural and fishing industries on the coastal plains of New South Wales. In 1995, they agreed to review the range of issues of the coastal plains to ensure that they had not overlooked any major ones, and to coordinate their activities so that there is minimum overlap, and improved integration of the results. Three examples of the issues or topics already identified were:

1. identification and management of acid sulphate soils for sustainable agriculture and fisheries habitat,
2. improved management of floodgates and other river barrages to minimise the impacts on fish habitats,
3. rehabilitation and sustainable management of riparian vegetation for erosion and flood control as well as fauna conservation.

It is generally recognised that several of the natural resource management issues along the coast are a consequence of increasing land use pressures, as well as accumulated impacts of land management practices. Urban and new tourist development pressures and associated infrastructure demands, and flow on support industries have been highlighted as part of this intensified land use pressure. This has led to increased competition for land and water with the already established rural and tourist industries.

The four rural R&D Corporations recognised that there are many government and industry programs addressing issues of the coastal plains and estuaries, and that there would be efficiencies in having a coordinated approach to their R&D programs. The corporations agreed to a collaborative project aimed at improving management of the land and water quality by identifying:

- priority issues which impact on land and water quality of coastal plains and estuaries, and strategies for addressing them,
- R&D gaps or overlap in current research effort,
- possible processes for coordination of activities across the R&D corporations, research agencies and other groups with responsibilities.

As a first step the corporations commissioned Adrian Webb of Webbnet Land Resource Services Pty Ltd to work with the major industry groups, government agencies and other R&D groups with interests in the management of the coastal plains with the aim of collating information on the current issues and programs, and checking that there are no important gaps.

OBJECTIVES:

This project was implemented in two stages. The first involved identification and collation of environmental management issues on the coastal floodplains of New South Wales, and the second involved collaborative development of a program of activities to address high priority issues in a focus catchment.

Specific objectives were:

1. To identify the issues which impact on land and water quality of the NSW coastal catchments and plains by consultation with stakeholders and reference to existing reports, strategic plans, and current projects and programs.
2. To identify the priority natural resource management issues in a focus catchment of coastal northern NSW using the adaptive environmental assessment and management (AEAM) approach, and develop strategies for addressing them, indicating who has responsibility for particular actions.
3. To identify the opportunities for application of the findings from the focus catchment study to other catchments of the coastal plain, with particular emphasis on management options.
4. To identify the options for ongoing coordination of natural resource management activities of the coastal plains of New South Wales.

Objective 1 resulted in a major report in May 1996 "*Environmental Management Issues of the Coastal Floodplains of New South Wales*". This is presented as appendix 5 to this report. A number of recommendations were made on future priority activities for the four R&D Corporations who commissioned the study.

Objectives 2-4 were addressed in the subsequent collaborative project with the Clarence River Catchment Management Committee. Specific objectives for this stage were:

1. Provide feedback on outcomes from phase one to major groups consulted.
2. Assist the Clarence River Catchment Management Committee (CMC) to develop further the strategies for addressing the high priority environmental management issues in the catchment, with an emphasis on implementation of actions based on current knowledge and stakeholder capabilities.
3. Negotiate with the Clarence CMC, the implementation of priority projects out of the recommendations of the report on "Environmental Management issues of the Coastal Floodplains of New South Wales".
4. Identify the opportunities for application of the findings in the proposed studies to other coastal catchments.
5. Identify the options for ongoing coordination of natural resource management activities of the coastal plains of New South Wales.

METHODS

Phase 1:

- *A scoping study*: The approach involved collation and review of a wide range of technical reports, strategic plans, outputs from workshops etc. plus consultation with specific stakeholders and information providers in the rural and fishing industries, natural resource management agencies, Local Government and research agencies. The issues for each sector were fed back to the groups and individuals consulted, and following further analysis, conclusions and recommendations developed where appropriate.
- *Report promotion*. The report was sent to those consulted plus a number of other key groups or individuals nominated by industry or government personnel. At least 60 reports have been distributed by the author. Informal discussions were held with a number of those consulted as well as others who made contact after hearing about or reading the report. A poster was prepared for the Second National Acid Sulfate Soils Conference in Coffs Harbour in late 1996.

Phase 2:

- *A collaborative development of responses to priority issues in the Clarence River catchment*: The original project description for the project "Improving the Land and Water Management of Coastal Plains of New South Wales" (95/172) had, as a second phase, the objective of identifying the priority natural resource management issues in a focus catchment of coastal NSW, using the Adaptive Environmental Management and Assessment (AEAM) approach, and developing strategies for addressing them, indicating who has responsibility for particular actions. This part of the project was considered to be phase two of the project, and was to proceed only if the stakeholders of a catchment were fully supportive of implementing it. At the end of Phase one, it was concluded in consultation with the Project Steering Committee that the catchment stakeholders consulted did not support an AEAM approach. The Steering Committee agreed to the development of a modified version of Phase two, which involved identifying a catchment committee in the north coast region of NSW and negotiating a collaborative approach for pursuing the priority recommendations out of the initial project report, and the high priority issues identified by the catchment committee.

  Initial discussions with several key Government agency and industry representatives led to a meeting with the executive of the Clarence River Catchment Management Committee (CMC). The priority issues developed in the initial report on management issues for the coastal floodplains and those of the Clarence CMC were used as the basis of discussions. In the two years following phase one, specific meetings and workshops were convened to develop the project areas. In addition, aspects such as coordination of activities and development of guidelines or best practice to address the priority areas were considered. A close working relation was developed with the Clarence CMC executive and key people in government agencies, the fishing industry and the sugar industry. More limited interaction occurred with the beef and dairy industries.

  The steering committee for the second phase was the same as for the first phase. However with the retirement of John Craven from the Dairy research and Development Corporation, the DRDC representation on the steering committee lapsed.

- *Coordination of R&D.* In conjunction with the Clarence CMC and the Clarence River County Council, workshops and meetings were convened for developing a cohesive set of projects in the Clarence floodplain. Aspects of coordination were addressed and agreed on at an early stage. Following these meetings, out of session discussions ensured that the projects were developed and key stakeholders involved. Technical rigour was enhanced by involving key people in reviews of the proposals.

Performance Indicators

The indicators, negotiated with the Clarence CMC were:

1. An agreed list of objectives and processes for collaborative action between the Clarence CMC and the Corporations.
2. Demonstration sites for managing acid sulfate soils identified for the cane lands of the north coast region, and a range of management options agreed to.
3. Benefit /cost studies on riparian zone rehabilitation in the Clarence river commissioned.
4. Project proposals prepared for water balance studies for the major land use practices of the floodplains.
5. Opportunities identified for assessing the biological impacts of dredging.
6. Identification of locations where research can be carried out on the impacts of floodgate and other physical barriers on hydrologic processes and impacts on fish habitat.

RESULTS/DISCUSSION

Environmental management issues

The major environmental issues of concern to management of the coastal floodplains of NSW can be categorised under four interrelated headings:

- Water
- Land
- Riparian Zones
- Land Use Planning and Management

Many of the issues identified cannot be handled separately because of the dynamic relationships between land and water and the local communities. Consequently, R&D for land and water management practices must be able to be integrated into the resource management systems of the major stakeholders such as agricultural landholders, developers, fishers, and local government.

The list of issues identified in the report (appendix 5) is wide ranging and indicates a context within which the R&D Corporations are operating. Whilst there are important knowledge gaps, causes of these degradation issues are sufficiently well understood to achieve better water quality and riparian zone condition with application of current best practices. *The uncertainty lies in whether or not the best management practices being considered are long term solutions to the problems.*

After considering the issues and the projects underway at the time, the major needs listed in the initial report were:

- Geomorphic studies to identify pollutant and sediment sources and dynamics in floodplain estuaries.
- Soil water balance in floodplains and its relationship to surface and groundwater hydrology to provide sustainable land management options, particularly for ASS.
- Identification of uncertainties in current knowledge of coastal floodplain ecosystems.
- Biological impacts of dredging in floodplain estuaries.
- Impacts of altering floodgate management and other physical barriers on water quality and fish habitat.
- Knowledge of groundwater processes in barrier dunes for land use decisions.
- More detailed distribution of ASS and identification of risks for land use.
- Development of national standards for ASS hazard assessment.
- Communication of factors involved in acid drainage, the off site effects of acid waters, and the current best management practices.
- Improved methods of community education and technology transfer regarding the benefits of well managed riparian zones.
- Economic assessment of rehabilitation case studies to establish the degree of public and private benefits.
- Wetland pasture management requirements.

The recommendations in the initial report led to the development of the collaborative project with the Clarence River Catchment Management Committee. The Clarence CMC catchment vision statement includes a wide range of outcomes for natural resource management in the catchment. There is very good agreement between the CMC priorities and those from the initial report which were agreed to by the R&D Corporation Steering Committee. These were reinforced during discussions between Stan Pitkin (Chair of the Clarence CMC) and the FRDC Board during their field trip to Coffs Harbour in June, and at the LWRRDC Board workshop with the Clarence CMC and regional stakeholders in June. Feedback following both of these events indicated that Board members and regional people appreciated the opportunities for discussing issues related to coastal floodplains, and the establishment of communication links.

The cross corporation project assisted considerably in providing a link with R&D groups and specific skills and experience outside the catchment.

Project Development

A major activity in the project has been coordinating/facilitating the development of R&D projects aimed at achieving both improved fish habitat/access through floodgate structures, assessing the

hydrologic effects of floodgate management on coastal floodplain agriculture, and the costs and benefits of riparian zone management.

A workshop was convened to clarify the details of a coordinated program (see minutes April 23 1998 at appendix 3), and other meetings were convened to clarify objectives and methods of individual projects. The projects which have been implemented or approved for implementation are:

- Identification of the economic costs and benefits to landholders from riparian zone management practices.
- Audit of floodgate management options for improving water quality, fish habitat and access in the Clarence river tributaries.
- Improved fish access through structures
- Hydrologic effects of flood gate management on coastal floodplain agriculture

Possible demonstration sites for managing acid sulfate soils were identified for the cane lands of the north coast region, and a range of management options agreed to. NHT funding was achieved for two sites in the Clarence catchment. However, the NSW Sugar Milling Cooperative had difficulties getting final agreement on suitable sites, decided that they could not effectively implement the project, and surrendered the funds. Hence no formal demonstration sites have been developed.

Opportunities for assessing the biological impacts of dredging have been discussed, but no formal projects have been implemented. The Clarence CMC have not given this topic as a priority for their catchment, and there has been no pressure from any stakeholder group in the catchment. It remains a topic for further consideration.

Coordination and Communication

In dealing with the range of agency, industry and Catchment group members either in their regular meetings or in specific meetings and workshops, it was possible to identify how technical support, R&D priorities and information flow is coordinated and delivered. In addition, the review of information and consultation associated with the first phase provided valuable insights into how information was used and developed. Involvement in the Clarence CMC meetings and one of the regional planning meetings enabled identification of the complexities facing agency managers, CMC's and regional committees, in regional planning activities.

The commitment of the Clarence River County Council to coordinating the floodplain management suite of projects developed over the last 18 months, has been a major step forward. The projects have been incorporated into an overall program to ensure coordination and focus of outcomes to achieve best practice implementation. The process of using a stakeholder group as a steering committee appears to be working well. There are good linkages with the Clarence River Catchment Management Committee and the priority activities outlined in their vision statement. Where appropriate, each of the current projects is expected to contribute recommendations on best practice or to identify experience that can be used in the development of best practice.

An issue raised in the workshop of the 23 April 1998, was the ongoing funding of a coordinator for the floodplain management program. A bid for NHT funding was successful, and Alan Cibilic will continue as the program coordinator. A program overview prepared by Alan Cibilic and others is attached as appendix 4.

The development of the coordinated program under the umbrella of the Clarence River County Council appears to be a good model for other catchments to consider. It promotes the development of projects aimed at specific management issues within an integrated program. The linkages between projects and the need for appropriate outputs are emphasised. Specific reporting and information development workshops will be required to capitalise on this good foundation.

Key factors for success in bringing about desired changes in land and water management practices are the communication of necessary information, and technical and process support for those involved in land and water management. Coordination mechanisms exist in the form of

Catchment Management Committees, County Councils, Estuary Management Committees and Acid Sulfate Soil Management Advisory Committees, and these provide frameworks for development and implementation of priority projects.

One of the difficulties the Clarence CMC is facing (and is shared by other catchment groups) is the coordination and management of the range of projects and other activities in the catchment. It requires more time than is available by the catchment coordinator, and in some cases requires a different set of skills, particularly where R&D development and coordination is required across groups and projects. The government cutbacks, loss of experienced staff and short-term staff appointments have eroded the skills base and ability of agencies and CMC's to establish and maintain key roles. This project played an important role in bringing a range of people (skills) together to assist in the development of the Sugar CRC project on land management effects on acid production and drainage, and to develop projects related to floodgate management and the hydrology of different land use systems in the Clarence floodplain.

These activities require specific resources particularly if activities are to remain coordinated. There is a need for regular review workshops in each of the catchments and sub-regions to allow stakeholders and technical support staff (R,D&E) to keep abreast of progress and the implications of findings for them. There is a strong case for an annual workshop/conference in the Clarence catchment to allow this to happen.

This type of R&D coordination, facilitation and communication of results / outcomes need to occur in a wider context than catchments, and regions. It has become quite apparent that there is a role for a person or persons to act as coordinators/facilitators across government agency, local government staff and the R&D Corporations and other established research agencies such as CSIRO. It is an issue that the R&D Corporations should consider in more depth.

One of the broader related issues raised in the initial review document identifying environmental management issues for coastal floodplains was communication of information in a form to suit those making planning and management decisions. This cross Corporation project has been an interesting exercise in trying to address the R&D priorities of specific stakeholders, and to facilitate the adoption/use of information out of R&D into practical approaches to addressing natural resource management issues. Some of the issues of information flow, format and availability have been highlighted during the project life, and I believe remain an important area for improvement. It warrants further consideration by the R&D Corporations as well as the technical support providers.

BENEFITS AND BENEFICIARIES

The beneficiaries from this project are seen to be :

- the fishing industry in terms of more focused identification of the management issues and R&D which need addressing to improve the habitat and water quality aspects for sustainable fish production. It will provide an opportunity to collaborate with other stakeholders in the catchment areas to identify the more readily implemented resource management options, as well as the more intractable options which might require further R&D.
- the sugar and dairy industries in terms of identification of constraints to sustainable management practices, and the options for addressing them.
- Local Government and State Government in terms of identification of issues relevant to urban and tourist developments, water supply and waste management, and nature conservation.
- the tourist industry in terms of identification of resource management issues for sustainable development and management.

The direct beneficiaries of the second stage are likely to be those within the Clarence River catchment. However, it is anticipated that substantial benefits will be accrued to stakeholders in other coastal catchments of NSW, through transfer of information and knowledge about management options and processes.

FURTHER DEVELOPMENT

The initial report on environmental management issues of the coastal floodplains identified a number of issues and major needs that should be given some priority by Government, industry and R&D Corporations. Only a few of the recommendations could be addressed by the R&D Corporations in the collaborative project with the Clarence River Catchment Management Committee. Remaining issues which still need addressing include:

- Geomorphic studies to identify pollutant and sediment sources and dynamics in floodplain estuaries.
- Identification of uncertainties in knowledge of coastal floodplain ecosystems.
- Biological impacts of dredging in floodplain estuaries.
- Knowledge of groundwater processes in barrier dunes for land use decisions.
- More detailed distribution of ASS and identification of risks for land use.
- Development of national standards for ASS hazard assessment.
- Enhanced communication of factors involved in acid drainage, the off site effects of acid waters, and the current best management practices.
- Improved methods of community education and technology transfer regarding the benefits of well managed riparian zones.

The project has highlighted the need for improved coordination of R&D activities across catchments and regions, and the need for more focussed attention to information development and communication. This remains a priority requirement. Development of recommended (best) management practices by each of the stakeholder groups requires development and should be promoted as the preferred strategy for achieving improved land and water quality. Specific support is required from industry and government to underpin the process.

CONCLUSIONS

The project has achieved the overall aims of the Corporations in providing a common view of the environmental management issues, and in getting improved integration and coordination of specific RD&E work on the floodplains of NSW. The project has:

- highlighted for stakeholder groups, the range of issues facing natural resource managers in coastal floodplains of NSW. (Objective 1).
- highlighted the need for coordinated approach to addressing the issues, and the need for integration at some level of R&D projects or R&D outputs. (Objectives 4&5)
- highlighted the benefit of workshopping these issues across stakeholder groups when identifying the specifics of R,D&E activities, and the benefits in identifying possible funding partners. (Objective 4&5).
- influenced the development of a coordinated program of activities in the Clarence River catchment floodplain, and fostered strong links between Clarence River catchment projects teams and the community. (Objectives 1,2&3)
- provided an opportunity for groups from other catchments on the coastal floodplains to attend workshops and seminars to assess the applicability of information and approaches to other catchments. (Objective 4).

The report on environmental management issues (appendix 5) presented in August 1996 provided conclusions and recommendations to the R&D Corporations funding the project. The conclusions are detailed in section 7 of the report, and are still highly relevant. Two statements from the conclusions are extracted to emphasise them:

'Whilst there are important knowledge gaps, causes of these degradation issues are sufficiently well understood to achieve better water quality and riparian zone condition with application of current best practices. However, there is still uncertainty about whether or not the application of current best management practices are long term solutions to the problems.'

'There is no shortage of information upon which better natural resource management decisions could be made. A major issue is that many of the people who need to be aware (and have ownership) of this information are not. As was pointed out by one clear thinker

"unless people know firstly that there is a problem, they are unlikely to realise that certain information should be important to them".'

APPENDIX 1:

INTELLECTUAL PROPERTY

There is no specific intellectual property emanating from this study.

APPENDIX 2:

STAFF

Adrian Webb carried out the project. He was assistance by Bob Smith (R.J.Smith and Associates) in a desk top study of existing information, and Dr Greg Bowman (then CSIRO Division of Soils) provided expert advice on acid sulfate soil issues.

APPENDIX 3

Actions from Meeting to Review Projects Related to Improved Fish access, Improved Water Quality and Agricultural Production in the Clarence Floodplain – 23 April, 1998

South Grafton RSL Club

Objectives

The objectives of the meeting were:

1. Review the revised proposals from Phillip Gibbs (fish access), Peter Slavich (hydrology impacts of drainage structures, and pasture management options), and to consider the relationships between these projects and other activities on the floodplain, with respect to provision of land and water management information to resource managers.
2. To consider constraints to and opportunities for funding and integration of the proposed projects and any other activities identified as required to achieve the aim of "development of strategies to improve/enhance the aquatic environment without detrimental impacts to agricultural production or flood protection".

Participants at the meeting are given in the attached appendix.

Agenda

The agenda for the meeting was:

Chairperson	Adrian Webb in lieu of Stan Pitkin	
11am	Welcome & clarification of Objectives of the meeting -	Adrian Webb
11.10am	Recap on current projects, with brief clarification and discussion. 1. Alan Cibilic – Clarence floodplain projects 2. Angela Ridgway – economics of riparian zone management 3. Krissy Auld – evaluation of wetland restoration opportunities 4. Alan Munro – acid sulfate management demonstration project 5. Vince Castle - acid soil survey of cane farms 6. Bob Smith – relevant projects in Hastings etc.	
12.00	Brief recap on proposed projects: 1. Phillip Gibbs – fish access through modified structures 2. Peter Slavich – hydrologic impacts of structures on agricultural production, pasture evaluation for floodplains (The project on prediction of surface inundation on floodplains was not discussed as Professor Ian White could not attend).	
2.15pm	Discussion on integration of project activities to ensure information relevant to decisions by landholders and resource managers is produced. Funding constraints and opportunities – integration, coordination, delivery	
3.20pm	The meeting closed to allow participants to catch southern flights.	

Issues

A number of points and issues arose out of the presentations and discussions on projects.

- The number of projects/activities being managed by the CRCC is substantial, and represents a major commitment by the CRCC to dealing with the environmental management issues associated with water in the floodplain. An issue out of this is the ongoing funding of the coordination role, which is essential if the local community is to capture the benefits of the projects.
- The data collation required for an audit of the floodgates and drains is substantial.
- Information from the review/assessment of wetlands for rehabilitation should input to future site selection criteria for floodplain projects associated with the structure audit, and management studies.
- Knowledge of management impacts on the hydrology of the floodplains and fish habitat is deficient.
- Water quality data of the main river is essential for the development of floodgate opening regimes to ensure that damage is not done to agricultural land during trials.
- Mapping of drains and condition of floodgates is an urgent requirement.
- Identifying options for modification and retrofitting of floodgates is a priority activity.
- An overview document is required to detail the linkages and dependencies of the fish access - water quality project (Gibbs), the impacts of changed hydrology on agricultural systems project(Slavich-Hughes), the surface hydrology prediction project (White), and how they contribute to the Clarence Floodplain Management project. This overview should detail the criteria for site selection and the project implementation (timing, outputs) requirements. It should also identify who has what responsibilities in terms of coordination, management and delivery of outcomes.
- Alan Cibilic has prime responsibility for development of this overview statement with help from Adrian Webb and Matt Foley. Development of a GIS for the suite of projects is a high priority to ensure ability to relate and integrate data cross the various activities and to ensure that information is not "lost". Some agreement for collaborative support may be able to be negotiated with the Department of Land & Water Conservation.
- A preliminary desktop study and field inspection of the likely benefits or constraints of more frequent inundation of drains and controlled creeks in terms of riparian zone function, fish habitat, and agriculture may be useful as part of the site selection process.
- A protocol detailing the criteria for site selection is required for comment by the majority of participants at the meeting, prior to identification of potential sites by Alan Cibilic and project leaders, and negotiation with landholders.
- There may be a possibility of co-locating the proposed studies with the acid sulfate soils caneland demonstration site still to be established by Peter Neilsen in the Clarence catchment.

Actions

1. Outputs/conclusions from the assessment of wetlands will be sent to Alan Cibilic for inclusion in the site selection process by ***Krissy Auld by mid May.***
2. A draft overview statement which explains the role of the various projects in the floodplain management project, the linkages, the site selection protocols, the timetable/sequencing required, and the management and coordination responsibilities for the overall program is to be prepared by ***Alan Cibilic by the end of May.***
3. The project on hydrologic impacts of increased water levels on agricultural systems is to be drafted in LWRRDC project submission format, including references to cane production, and sent to LWRRDC by ***Peter Slavich by the end of May.*** Funds required should indicate the relative breakdown for productivity, rehabilitation and hydrologic studies to assist in the brokering of support from other organisations such as SRDC, MRC, and ASSMAC.
4. Sources of funding for development of modifications and retrofitting of modifications to floodgates, will be pursued by **Alan Cibilic in liaison with Bob Smith**.
5. The possibility of the acid sulfate soil demonstration site in canelands being located in an area suited to the hydrology and floodgate management studies will be investigated with Peter Neilsen by **Peter Slavich and Alan Cibilic.**

Adrian Webb

6 May 1998

APPENDIX 4

CLARENCE FLOODPLAIN PROJECT-OVERVIEW

GENERAL BACKGROUND

The Clarence River County Council is responsible for managing 157 "floodgated" drains and natural watercourses on the Clarence River floodplain. Most of the approximately 300 floodgates were built prior to 1970, with the primary function of mitigating the effects of flooding. Over the past decade it has become increasingly evident that improved management of these structures during non-flood periods would result in enhanced water quality which could have significant positive flow-on effects.

This understanding has not been restricted to the Clarence River area. Landholders, fishers and the community at large have become very aware of the range of major environmental issues that threaten the sustainability of productions systems and biodiversity on all coastal floodplains of NSW. It is quite apparent that many of the stakeholders in coastal floodplains understand that changes in land and water management systems are required.

In most catchments this has directly resulted in a range of research, data collection, and field trial projects. Due to the discrete nature of most funding sources these projects have largely been developed separately, and often by different organisations - both government and non-government - in the same large catchment. The integration of these projects into one coordinated river management project has not occurred for most of the larger river systems.

Since December 1991 Clarence River Fishermen's Cooperative has been meeting with CRCC to discuss such issues as floodgate management, weirs, wetland assessment, herbicide use, siltation etc. At that time it was noted that stakeholder attitudes to wetland rehabilitation and tidal flushing of drains was changing, and also that government departments such as NSW Fisheries and Public Works were willing to assist. By 1993 agencies responsible for the Clarence floodplain were initiating projects aimed at rehabilitating wetlands and improving the management of floodgates and acid sulfate soils (ASS) risk areas.

These projects included community consultations, data collection and collation, ASS assessments and management plans, floodgate structural modifications, and the development of floodgate management strategies. Progress was slow, but ongoing.

In early 1997, NSW Fisheries asked CRCC to collaborate in a joint venture with the Department of Land & Water Conservation (DLWC) to assess the technical issues surrounding floodgate management, and also to apply for funds via the joint industry Research & Development Corporations for the development of best practice floodplain management designs. About the same time, at a floodgate management workshop organised by NSW Fisheries, CRCC proposed that CRCC was the body best placed to coordinate the management of Clarence River floodgates, based on it's effective working relationship with all relevant government departments, and it's coverage, as a county

council, of all of the Clarence floodplain. This proposal met with the approval of all delegates associated with the Clarence floodplain.

From this, both NSW Fisheries and CRCC further explored funding opportunities and organisational arrangements with organisations such as Clarence River Catchment Management Committee (CRCMC), Clarence Canegrowers, NSW Farmers, Clarence Fishermen's Cooperative, and NSW Agriculture. This has led to the development of an integrated project termed the ***Clarence Floodplain Project*** (CFP) which Clarence River County Council is coordinating through an appointed officer and a Steering Committee comprised of all major stakeholders. The project addresses the broader objective:

to improve water quality and fisheries and other wildlife habitat whilst maintaining productive agricultural industries and flood control on coastal floodplains, that is, to develop best practice floodplain management.

The coordinator will aim to develop floodgate management plans to optimise beneficial outcomes to fisheries, agriculture, ecosystems and floodplain management.

In addition, the Clarence River Catchment Management Committee (CRCMC) negotiated a collaborative arrangement with four of the Research & Development Corporations (Sugar, Dairy, Fisheries and Land & Water Resources) to develop integrated activities to address some of the priority environmental management and production issues of the floodplains. It was anticipated that case studies would provide management guidelines and "best practices" which would have general application across other coastal floodplain catchments.

CRCC and the CRCMC indicated they were interested in carrying out studies on floodgate management and its effects on the hydrology of agricultural systems with a view to developing means of assessing floodgate management options and ultimately developing guidelines for wider application. A workshop of industry, agency and research personnel, convened by CRCMC and Fisheries R&D Corporation, identified opportunities for assessing floodgate management options and their impacts on agricultural land.

COMPONENT INTEGRATION AND MANAGEMENT

The Clarence Floodplain Project coordinates, at two levels, projects that assist in the achievement of it's objectives:

1. as the front-line manager of the overall project including integration, risk management, environmental monitoring, data collation, community liaison, field trials, and direct management of the core components
2. as the local coordinator of aspects of associated projects including research, field trials, monitoring, data collation, community liaison, and / or environmental assessments

The objectives of the CFP will never be achieved by one organisation in isolation, and in fact the CFP was initiated by a group of organisations with a common goal. The Clarence River County Council was seen as the organisation best placed to manage many of the on-ground works and to coordinate local elements of the associated research together with the necessary community liaisons. However, the CFP is very much a coordinated exercise, bringing together the combined expertise and networks of a large number of agencies, departments, and groups.

CRCC, as local manager and through the steering committee of the CFP, has agreed to manage the Clarence Floodplain Project and to actively pursue the identified objectives.

The CFP Steering Committee can co-opt community representatives as required for specific purposes, and is made up of the following permanent representatives:

Clarence River County Council – 2 representatives
Clarence Catchment Committee
Clarence Canegrowers Association
NSW Farmers
Clarence Fishermen's Cooperative
NSW Fisheries
Dept Land & Water Conservation
NSW Agriculture

This Steering Committee meets bi-monthly and makes recommendations to the CRCC regarding project directions and needs.

CFP COMPONENTS
The broad project has a series of core components managed by CRCC, as well as other associated components, managed by other organisations and developed in close consultation with the CRCC, and which augment the CFP and supply data or other inputs to the CFP.

A) FUNDED CORE COMPONENTS

1. Clarence Floodplain Management – funding secured via other projects below (1998) – CRCC + Dept Land & Water Conservation (DLWC) + National Heritage Trust (NHT)

This is the "umbrella project" with the primary aim of improving the management of the Clarence River floodplain, and specifically to improve water quality and fisheries habitat whilst maintaining productive agricultural industries and flood control.

The project enables better coordination of a number of integrated projects (many of them already funded), and a coherent approach to all Clarence floodplain issues. All relevant stakeholders are involved, through a steering committee, in finding cooperative solutions to the many management issues.

2. Environmental Audit of Floodgates – funding secured (National Heritage Trust via Dept Land & Water Conservation Partnerships Program: 1997/98 - $46,000; 1998/99 – $30,000 estimated) + (CRCC 1997/98 - $23,000 1998/99 - $15,000). Total Funds : $69,000 (1997/98) & $45,000 (1998/99)

It is intended to complete a comprehensive review/audit of Clarence River County Council's floodgate structures in order to determine the impacts that are occurring to the environment on both sides of the gates. It is also intended to prioritise those floodgates for which operation of the gates in between flood events would provide significant reduction in any environmental impact. An assessment is to be made of the location, condition, size, and elevation of floodgate structures, and to undertake physical-chemical and biological monitoring of water quality, especially of dissolved oxygen, pH, salinity, and macro-invertebrates. Habitat and land use assessments will also be conducted. Monitoring sites and sampling procedures will be established. The project will be completed in 1999.

3. **Best Practice for Mechanical Cleaning of Flood Drains** – funding secured: $6,667 - Acid Sulfate Soil Program (ASSPRO); $3,333 – CRCC

To collate all available information on Acid Sulphate Soils (ASS) and flood mitigation drains in the Clarence floodplain, classify drains into risk groups, desktop research to identify best practice mechanical drain weed-cleaning methods, construct operational procedures for each risk group, implement procedures and assess results.

4. **Roberts Creek Management Project** – Funding secured: 1996/97 ($18,591 unexpended); 1997/98 - Department of Land & Water Conservation ($20,000 under 2:1 program), CRCC - $10,000. Total Funds : $48,591

In consultation with landholders and other stakeholders, develop a floodgate management plan designed to improve water quality, wildlife habitat, and to allow fish passage without compromising the productivity of the farms. This plan will be based on research data on floodgate management scenarios and on the sensitivity of cane and pastures to salinity and other water quality factors. The landholders are predominantly cane farmers, with some cattle production. Strategy implementation to commence in 1998.

5. **Everlasting Swamp Feasibility** – funding secured: NSW Wetlands Program (DLAWC - $20,000 under 2:1 program), + CRCC ($10,000). Total Funds : $30,000

The nature of the 12,000+ hectare Everlasting Swamp has been severely altered by past development such as the construction of a weir across Sportsman's Creek and flood mitigation works in the area. Discussions have taken place with relevant landowners with a view to assessing the feasibility of removing the weir and modifying the impact of flood mitigation structures. There is significant opportunity in this area to develop and implement management plans that may include the reinstatement of wetlands and the creation of wet pastures, thus providing habitat for native flora and fauna to re-establish while maintaining agricultural productivity. Stage 1 to be completed in 1998.

6. **Alumy Creek Project** - funding secured Stage 1 ($20,000) – Dept Land & Water Conservation Floodplain Management Program; ($20,000) – CRCC. Total Funds : $40,000

Alumy Creek runs through the City of Grafton and into the Clarence River and is well known for its capacity to contain acidic water – hence the name. Other major impacts such as sewage, stormwater, land use practices, irrigation, aquatic weeds, salinity are all present in this one creek and any management solutions will need to be comprehensive. Many organisations are involved in the above impacts and Council will require significant resources to successfully address all of the issues and all of the stakeholders. Preliminary discussions have taken place with major stakeholders regarding options for developing a plan of management.

Stage 1 will involve an assessment of the current status of Alumy Creek including the sources of the main environmental impacts, and the identification of remediation options. The Alumy Creek Water Users Group is an important partner in this project.

B) NON-FUNDED CORE COMPONENTS

1. **Clarence Floodplain Management** - Natural Heritage Trust Funding application current: NHT - $71,093, CRCC including in-kind - $94,404, Total - $165,497)

This is the "umbrella project" with the primary aim of improving the management of the Clarence River floodplain, and specifically to improve water quality and fisheries habitat whilst maintaining productive agricultural industries and flood control.

The project enables better coordination of a number of integrated projects (many of them already funded), and a coherent approach to all Clarence floodplain issues. All relevant stakeholders are involved, through a steering committee, in finding cooperative solutions to the many management issues.

2. **Coldstream Wetland Project** – funding to be sought 1999/00 (CRCC + NHT)

These significant freehold floodplain swamps of 1,400 hectares are made up of extensive fresh meadows, seasonal fresh swamps, and reed swamps. The current land use is largely cattle grazing especially in areas that have been drained or are only seasonally inundated. Discussions have begun with some landholders with a view to developing a comprehensive sub-catchment management plan. There is significant opportunity in this area to reinstate some wetlands to create more wet pastures, thus providing increased habitat for native flora and fauna to re-establish.

3. **Swan Creek Project** – Natural Heritage Trust funding application current. (NHT - $40,000, CRCC including in-kind - $20,000 Total - $60,000)

Swan Creek is a major sub-catchment and flood mitigation system, taking run-off from Glenugie Peak in the south to Ulmarra in the north. Land use is predominantly cattle pastures, with proposals for possible tea-tree plantations. Water is pumped from the system for irrigation. Fish kills have occurred from low dissolved oxygen levels. On fresh tides, water can be let into the system from the Clarence and Coldstream Rivers to supplement water levels for irrigation purposes.

With regard to the preferred system water level, there are competing interests as follows:
- Flood mitigation requires low water levels to maintain the carrying capacity of the drain
- Irrigators require high water levels for maximum storage capacity
- Graziers divide equally between these levels depending on the level of each property
- The environmental requirements of the system are unknown

The project will involve assessing the environmental requirements of the aquatic system, consulting with all stakeholders, developing and implementing a management plan to optimise outcomes for all stakeholders. Such a plan will include practices to manage the riverbank, reduce fish kills from dissolved oxygen depletion, and to rehabilitate riparian vegetation where possible.

4. **Shark Creek Management Project** – Natural Heritage Trust funding application current. (NHT - $40,000, CRCC including in-kind - $20,000, Total - $60,000)

Shark Creek is affected by impacts such as Acid Sulfate Soils, land use practices, stormwater run off, aquatic weeds, and salinity. This project aims to achieve the following:
- Determine the extent of Acid Sulfate Soils and the sources of acid release in the Shark Creek basin
- Establish a monitoring system to provide baseline information (dissolved oxygen, pH, salinity, macro-invertebrates)
- Consult with landholders and other stakeholders
- Analyse all data and information and design a management/rehabilitation plan for the benefit of the landholders, aquatic environment, and other stakeholders

5. **Wooleweyah Lagoon Project** – Natural Heritage Trust funding application current. (NHT - $36,234 , CRCC including in-kind - $17,392, Total - $53,626)

Wooleweyah Lagoon is a substantial estuarine lagoon, with associated mangrove and saltmarsh areas totalling 24 km^2. There are large areas of sea grasses, mangroves, and saltmarshes that provide important habitat for many species of migratory waders and commercial fish. The area has been disturbed by flood mitigation structures, localised dredging, trawling, Acid Sulfate Soils, as well as urban development, agriculture (grazing and sugarcane) and aquaculture in the catchment area.

This project aims to:
- monitor the physical-chemical and biological state of the lagoon area
- assess the impact and functioning of the ring levee and drains
- assess the impact of commercial and recreational fishing practices
- assess the actual and potential economic contribution of the area (especially fishing and recreation activities)
- consult with all stakeholders
- develop a management plan for the area

6. **Water Quality Monitoring Project – Flood mitigation drains** — Natural Heritage Trust funding application current – (NHT - $9,981, CRCC including in-kind - $9,403, Total - $19,834)

Establish a manual aquatic biological and physical-chemical monitoring program for significant flood mitigation drains. Parameters to include: pH, dissolved oxygen, salinity and macro invertebrates. This project will provide baseline data as input into the development of drain, floodgate, and sub-catchment management plans. The project will establish 20 bi-monthly monitoring sites (5 to be done fortnightly), and identify standard sampling protocols, and continue for two years.

The locations will include the sub-catchments of: Alumy Creek, Everlasting Swamp, Shark Creek, Swan Creek, Coldstream Wetlands. Additional sites to be added as funding permits.

7. **Water Quality Data Logging Project – Clarence River** Funding application for salinity part of this project current as a sub-component of Coasts & Clean Seas project (7)

Water quality data such as salinity (conductivity), pH, dissolved oxygen, and nutrients is unavailable for the Clarence River over extended periods of time. Intermittent data only is currently available. Local management of floodgates to improve water quality requires access to such data if management strategies are to operate most effectively. Farmers require knowledge of salinity before allowing inundation. pH should be assessed before opening floodgates. Data logging will indicate trends and frequencies of occurrence and thus allow management groups to better plan allocation of resources, including scarce funds.

8. **Floodgate & other flow-management structure engineering for improved water quality management** Funding application for part of this project current – (Coasts & Clean Seas - $65,700, CRCC - $31,590, DLWC - $56,552)

Existing floodgates were constructed for flood mitigation purposes only. It is only recently that, in addition to their essential flood mitigation role, frequent manual operation for environmental purposes has been trialled. Structure designs need to be assessed with regard to modifications and changes that might improve water and habitat management

aspects including ease and safety of opening or manipulation, speed of operation, aperture placement and size, fish and other wildlife movement, and regulation of flow.

FUNDED ASSOCIATED COMPONENTS

1. **Drain Mapping Project** – funding secured (DLWC)

This project will use aerial photographs of the Clarence Catchment to map all drains and transfer the data into GIS system that can be accessed by stakeholders. This system will allow easy comparison with, for example, Acid Sulfate Soils risk areas that are already mapped. It will improve the management options available.

2. **Acid Sulphate Soils Assessment of Cane land** - funding secured (NSW Canegrowers + NHT)

All cane farms in NSW are being assessed for their highest Acid Sulfate Soil potential. This data will dramatically improve the resolution of the DLWC ASS risk maps and allow prioritising of potential ASS areas, and focused management of ASS risk drains.

3. **Barriers to Fish Passage Study** – funding secured by the Dept Fisheries from the Fisheries Research & Development Corporation (1998/99 - $182,631; 1999/00 - $211,947; 2000/01 - $206,799), with other contributions from NSW Fisheries and others bringing the total project to $1,654,170 over three years.

Aims to evaluate the relationship between the recruitment of fish and invertebrates, the aperture size, and the frequency and timing of opening of tidal barriers. It will also assess the behaviour of fish to openings in tidal barriers and chronic acid drainage and extend this information to stakeholders. It is anticipated that this project will include some study sites in other catchments to ensure portability of data.

4. **Wetlands Assessment** - funding secured (Ocean Watch + State Wetlands Program)

Using aerial photography (1942 and 1994), changes in size of Clarence floodplain wetland areas over 50 years will be calculated, to assist in the assessment of at-risk wetlands.

5. **Riparian Vegetation Assessment** - funding secured (UNE + DLWC - $50,000 1998/99)

Angela Ridgway, a Masters student, is researching the riparian vegetation at 16 sites in the Clarence catchment, including four on the floodplain), in association with the Clarence Catchment Committee. The study will:

- evaluate the costs & benefits of existing riverine corridor management systems
- describe techniques to improve the management of the riverine corridor
- implement an extension program, including the publication of a report with case studies and practical techniques, to encourage adoption of findings

6. **Managing ASS in NSW canelands** – funding secured (NHT, NSW Sugar Industry)

Aims to establish demonstration sites of ASS best management practices on established and new cane land.

7. Recognition and management of acid sulfate soils - funding secured (NSW Agriculture, NHT).

This project aims to increase awareness and understanding of acid sulfate soils among landholders, catchment management committees and local government. It also provides a focal point for collection and dissemination of information about ASS through the ASSAY newsletter.

D) NON-FUNDED ASSOCIATED COMPONENTS

1. Hydrologic effects of floodgate management on coastal floodplain agricultural systems. (Dr Peter Slavich, NSW Agriculture)

The project has two related sub-projects with specific aims:

(a) Hydrology sub-project - To evaluate the effects of floodgate management on groundwater and surface drainage processes which affect the productivity and water use of agricultural industries on land adjacent to tidal brackish drains.

(b) Wetland grazing species sub-project - To evaluate the agronomy and grazing value of wetland grasses adapted to saline acid coastal floodplain backswamps.

The following outcomes are anticipated:

- Improved recommendations for best management practices to minimise acid formation and export from ASS in backswamps in grazing areas.
- Improved recommendations for wetland grazing of flooded backswamps.
- Increased understanding of the water and salt balance constraints to agricultural production on coastal flood plains with tidal brackish main drains.
- Increased understanding of hydrological processes, and tools for describing hydrological interactions, of drained coastal floodplains.

2. Predicting changes in land inundation (Dr Ian White, funding sought via Australian Centre for International Agricultural Research).

This project will predict the impact of managed floodgate opening on land inundation. A combination of historical aerial photos and survey elevation data, current ground survey checks and local knowledge will be used with climate and tidal analysis to predict changes in land inundation patterns arising from floodgate opening. The project will review and collate maps of floodgates, landuse, elevation, landforms, drains of sub-catchments within a geographic information system (GIS). It is necessary to characterise drainage sub-units in terms of floodplain/upland ratio and drain density (m/m^2) to evaluate sub-catchment water balance models and to predict areas of sub-catchments which would become inundated under specified combinations of rainfall and tide level.

3. Cane Sensitivity to Saline groundwater (Dr Peter Slavich, NSW Agriculture)

Many flood mitigation drains are placed in areas of sugar cane. There are no current guidelines that indicate the sensitivity of cane to saline conditions, or can assist in calculating possible loss of production due to salinity levels. For cane farmers to agree to effective managed opening of floodgates in non-flood periods, this information is essential. The lack of data in this regard ensures that caution prevails, and results in management trials that commence from ultra-low salinity levels.

In addition, the lateral movement of saline water from drains and into cane fields also requires study. Different soil types will need inclusion in the research design.

4. Sustainable land management of coastal floodplains in northern NSW (North Coast Catchment Regional Organisation + NHT + NSW Fisheries – application current; total project $285,900 over three years)

Sustainable land management on coastal floodplains (from the Tweed to the Manning excluding the Hastings and Clarence Rivers which have been funded elsewhere) will be achieved by: 1/ improving farm pasture management 2/ improving drought fodder availability 3/ improving water quality and water discharges 4/. rehabilitating native vegetation on land affected by floodgates or drains.

The three stages of this project are – 1/ auditing all floodgates 2/ prioritising and planning for management change 3/ trialling on-ground works. This project if funded will commence around January 1999 and be completed around December 2001.

5. Clarence Estuary Processes Study (Maclean Shire + NHT + CRCC)

Guided by the NSW Government draft Estuary Management Manual, the proposed Clarence River Estuary Processes Study is an essential precursor to the development of any Clarence Estuary Management Plan. The study will analyse all impacts on the estuary in their historical context, using existing data. Additional targetted data collection will occur to fill gaps in knowledge. The outcome will be a broad understanding of Clarence River estuarine processes including details of significant knowledge gaps requiring further study. The ongoing outcomes of the CFP will be an essential input to the estuary processes study.

6. Floodplain Management Institute (Southern Cross University (SCU) + NHT)

Professor Leon Zann at Southern Cross University, working in close cooperation with NSW Agriculture, NSW Fisheries, and CRCC, proposes to establish a Floodplain Management Institute, based at SCU and with a field research centre located on the Clarence Floodplain. It will allow researchers to target areas of need supplied by floodplain managers and other stakeholders in the Clarence River catchment.

PRIORITIES

The coordination and integration of the various elements of the Clarence Floodplain Project has been considered in the initial planning stages and incorporated in the overall concept. Membership of the CFP Steering Committee reflects these arrangements and provides formal links between the various groups. Informal networks and partnerships provide additional and necessary linkages.

Priorities of the CFP can be summarised as follows:

1. Manage the core funded projects
2. Coordinate the Steering Committee to maintain formal links between members
3. Develop & implement plans to achieve environmental objectives and best practice floodplain management
4. Facilitate external research & programs of assistance
5. Develop an environmental monitoring strategy

6. Inform the community & stakeholders regarding projects & achievements

Specific Action	Essential research/Information	Planning	Imple
Assess existing flood mitigation structures	Evaluate the flood control function of drains Identify drainage and flood control structures Assessment of existing weir structures to identify those with high potential for improved management (ie high environmental benefit, landholder acceptance, options for modified management). Research engineering options to modify drainage and weir structures and their operation.	Map drains Complete register of all structures Identify drain function assessment procedure Identify funding opportunities for relevant research	Trial drain f assessment Modify stru necessary. Obtain fund
Develop management options during non flood periods to address the objectives listed below.	Evaluate potential impacts of changed management on existing agricultural land uses. Develop active floodgate management protocol and blueprint for general application Identify landowners and stakeholders relevant to each drainage structure Identify sites for trials / demonstrations to evaluate the impact of changed management on "typical" structures (eg Roberts Ck, Coldstream Swamps), and to gain landholder acceptance.	Develop floodgate management protocols Develop management options and plans for floodplain creek systems and individual floodgates, with relevant stakeholders. Identify funding opportunities for relevant research Work closely with landowners, industry and researchers	Seek genera of active flo managemen blueprint Trial active managemen Obtain fund Gain cooper landholders Publicise re

Specific Action	Essential research/Information	Planning	Imple
Increase fish passage and access to habitat behind flood mitigation structures.	Establish relationships between fish species, passage / behaviour, and aperture size, placement, and opening regime Research on the impact of changed floodgate/structure management on fish access and fish populations. Identification of areas of "high" value fish habitat on the floodplain. Research the effects of different structure modifications on fish passage. Research other factors effecting the quality of fish habitat in floodplain areas.	As above. Identify trial sites	Obtain baselin data Trial improved and manageme flood periods As above.
Reduce discharge of acid water from	Research the relationship between watertable levels relative to acid sulfate / potential acid	Development of drainage plans by	Use of "best p drainage work

drains and creek systems into the Clarence estuary.	sulfate soils, and acid discharge - also development of practical watertable management options. Detailed mapping of ASS at the farm level. Assess the flood control function of deep and shallow drain designs Identify potential drain maintenance and floodgate management practices which minimise acid discharge and maintain agricultural productivity.	landholders doing new drainage works. Development of drain maintenance procedures based on "best practice". Identify trial sites As above	maintenance. Changes in op design of flood structures, cha agricultural pr possible) and i weir structures boards); to allo of water tables appropriate. As above

Specific Action	Essential research/Information	Planning	Imple
To improve water quality in floodplain creek systems, wetlands, and drains (particularly pH).	Baseline data regarding water quality and ongoing monitoring As above.	As above.	As above.
To improve the habitat value in floodplain wetlands (inc Everlasting & Shark Ck Swamps, and Coldstream /Swan Ck wetlands).	Baseline data regarding habitat value and ongoing monitoring Investigation of grazing systems which are compatible with improved wetland management, and reduce potential for oxidation of PASS (eg increased water levels on wetlands).	Development, with relevant landholders, of management options for flood mitigation structures (drains and weirs) affecting wetlands.	Modification o mitigation stru increased floo where possible
To improve the habitat value of floodplain water bodies.	Research / information collection on factors effecting fish habitat and water quality in water bodies such as Lake Wooleweyah, and the Broadwater Obtain baseline data	Development of management plans for Lake Wooleweyah and the Broadwater, with relevant stakeholders	Implementatio management p recommendati Establish ongo environmental

APPENDIX 5

Environmental Management Issues of the Coastal Floodplains of New South Wales

ENVIRONMENTAL MANAGEMENT ISSUES OF THE COASTAL FLOODPLAINS OF NEW SOUTH WALES

REPORT FOR THE FISHERIES, SUGAR, DAIRY AND, LAND AND WATER RESOURCES RESEARCH AND DEVELOPMENT CORPORATIONS

by

Webbnet Land Resource Services Pty Ltd

August 1996

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EXECUTIVE SUMMARY

This report provides a view of the environmental management issues relating to land and water management of the coastal floodplains and estuaries of NSW. It is presented as part of a commissioned project by the Fisheries, Sugar, Dairy and Land & Water Resources Research & Development Corporations. The report is aimed at assisting the Corporations in identifying how they might contribute to improved integrated management of land and water resources in the floodplains and estuaries.

Approach

The approach has involved collation and review of a wide range of technical reports, strategic plans, outputs from workshops etc. plus consultation with specific stakeholders and information providers in the rural and fishing industries, natural resource management agencies, Local Government and research agencies.

Findings

Since the floodplains and estuaries along the New South Wales coast remain focal points for commerce, population growth and recreation industries, the natural resources have come under much increased pressure from urban, tourist, industrial and agricultural development in recent years. The result has been degradation and sometimes the loss of these resources. Improved management of the natural resources of the floodplains is essential if development is to be sustained.

The major environmental issues of concern to management of the coastal floodplains of NSW can be categorised under four interrelated headings:

- **Water**
- **Land**
- **Riparian Zones**
- **Land Use Planning and Management**

It is critical to point out, however, that the four categories identified cannot be handled separately in many cases because of the dynamic relationships between land and water and the local communities. Consequently, R&D for land and water management practices must be able to be integrated into the resource management systems of the major stakeholders such as agricultural landholders, developers, fishers, and local government.

Water

1. Riverine and estuarine water quality is degraded from urban and infrastructure development, waste disposal, and canal developments, and has impacted particularly on seagrasses and fish.
2. Threshold conditions which control eutrophication of estuaries are not well understood.
3. Sedimentation of streams has created problems for shipping and changed estuarine and river habitats.
4. Impacts of dredging estuaries and lower rivers on the stability of the waterways and the biology are not understood.
5. Disruption to habitat gradients is occurring through physical, chemical and nutrient 'barriers'.
6. Sediment and nutrient runoff from agricultural land periodically degrades waters of the rivers.
7. Impacts of land use on groundwater processes in coastal dunes and estuaries are not well identified.
8. Water monitoring programs lack uniformity in criteria and time frames.
9. Monitoring of water and sediments for pesticides is insufficient to determine impacts from agricultural and urban practices.
10. Adoption of effluent management systems by dairy farmers is disappointing.
11. Community stakeholders (landholders, industry, urban, environmental) have not been effectively involved in the debates and management decisions on water use, environmental flows and mechanisms for achieving them (top down approaches have prevailed).
12. High water demands during low flow conditions affect stream water quality and groundwater levels.

Land

1. Poor understanding of hydrology, groundwater and water balance processes of floodplains is limiting the development and assessment of land management options for sustainable systems.
2. Terrain elevation data are inadequate for assessing the impacts of floodplain rehabilitation management.
3. Acid sulfate soils (ASS) are a natural phenomenon and therefore difficult to assign or get ownership of the impacts (cause/effects).
4. More detailed distribution of ASS is required for urban, agricultural and industrial development.
5. Techniques for assessing ASS hazard are contentious among resource scientists.
6. Current land management practices are generating acid drainage inadvertently, and attempts to encourage and promote sustainable management practices are still at an early stage.
7. Development of appropriate management practices is constrained by limited knowledge about acid production rates and fluxes for different ASS types, groundwater regimes, weather conditions and disturbance situations.
8. Techniques for environmentally sound construction and development on ASS are inadequate

9. Drains designed for wet season flows may be inappropriate for management of ASS (over drained).
10. Long term impacts of the shrinkage and subsidence of ASS following drainage is not understood.
11. Remaining wetlands are still being developed incrementally irrespective of legislation, information on wetland values, ASS drainage and suitability of soils.
12. Reliance on herbicides is posing long term problems for sugar cane production.
13. There is little information on grazing values of wetland pastures.

Riparian Zones

1. Riparian zones of many streams are degraded, but there is little objective information.
2. Insufficient use has been made of existing knowledge in policies, management guidelines, education and rehabilitation.
3. Responsibility and authority for riparian zone management is contentious with farmers.
4. The values of riparian zones (both market and non-market) have not been promoted, and used to establish roles and responsibilities among the stakeholders.

Land Use Planning & Management

1. Implementation of strategies for sustainable use of natural resources is constrained by inadequacies in whole catchment management approaches (structures/authority, information systems, monitoring systems, decision support systems).
2. There is a general realisation that maintenance of habitat diversity has been severely compromised through floodplain development.
3. Planning and management decisions by government and local government could be improved by more use of full economic analysis including market and non-market aspects of natural systems.
4. Communication of information on programs and legislation across stakeholders is large, not coordinated, and complex (numerous bodies responsible, uncoordinated activities usually not on a catchment basis).
5. Rural -urban conflicts are increasing through urban encroachment into traditional farming lands.
6. The cane industry requires full time staff to represent industry interests in regional planning and catchment management activities.

The list of issues above is wide ranging and indicates a context within which the R&D Corporations are operating. Whilst there are important knowledge gaps, causes of these degradation issues are sufficiently well understood to achieve better water quality and riparian zone condition with application of current best practices. The uncertainty lies in whether or not the best management practices are long term solutions to the problems.

Major Needs

Several of the issues are highly relevant to the responsibilities of the Corporations. Priority areas requiring further work to achieve improved environmental management of the floodplains are listed below.

- Geomorphic studies to identify pollutant and sediment sources and dynamics in floodplain estuaries.
- Soil water balance in floodplains and its relationship to surface and groundwater hydrology to provide sustainable land management options, particularly for ASS.
- Identification of uncertainties in current knowledge of coastal floodplain ecosystems.
- Biological impacts of dredging in floodplain estuaries.
- Impacts of altering floodgate management and other physical barriers on water quality and fish habitat.
- Knowledge of groundwater processes in barrier dunes for land use decisions.
- More detailed distribution of ASS and identification of risks for land use.
- Development of national standards for ASS hazard assessment.
- Communication of factors involved in acid drainage, the off site effects of acid waters, and the current best management practices.
- Improved methods of community education and technology transfer regarding the benefits of well managed riparian zones.
- Economic assessment of rehabilitation case studies to establish the degree of public and private benefits.
- Wetland pasture management requirements.

Recommendations

1. ***That geomorphic studies using techniques which will assist in the identification of sediment sources and movement in the floodplain estuaries be implemented to provide a basis for decisions on management options.***

2. ***That the LWRRDC and FRDC hold discussions with the Dept. of Land and Water Conservation and NSW Fisheries to ascertain the potential benefits from monitoring biological impacts after dredging using some of the current dredging projects in the estuary management program.***

3. ***That current and proposed projects assessing the impacts of altered floodgate management, and the removal of physical barriers be reviewed with the objective of identifying opportunities for gaining better understanding of the hydrologic processes affected and their significance for fish habitat.***

4. *That a core group of scientists and engineers with experience in hydrologic/groundwater/water balance studies, be commissioned to develop projects which will allow objective assessment of the hydrologic impacts of land management options for agriculture. This may involve key sites across major landscape units in conjunction with demonstration sites for best management practices.*

5. *That the knowledge of groundwater systems in the barrier and other dunes of the major estuaries be reviewed to identify:*
   - *knowledge gaps in the dynamics and role of groundwater for ecosystem functions*
   - *the condition of the resource (quality and quantity)*
   - *constraints to land and water use to avoid degradation of the groundwater resource and dependent ecosystems.*

6. *That the DRDC review the effectiveness of the advisory services to dairy farmers on effluent management systems.*

7. *That the Corporations liaise with the ASSMAC Technical Committee to review techniques and priorities for future research.*

8. *That the SCARM National Acid Sulfate Soils Working Party be requested to undertake an independent technical review of ASS hazard assessment and to formulate appropriate national standards.*

9. *That following the ASS conference in September 1996, the Land & Water Resources R&D Corporation review the need for further research on ASS management techniques with the SCARM Working Party.*

10. *That a risk analysis be commissioned by the Corporations to assess the likely environmental consequences of continuing to farm ASS where subsidence is occurring.*

11. *That case studies on the benefit/costs of rehabilitation of riparian zone be initiated by the Land and Water Resources R&D Corporation.*

12. *That a working party drawn from discipline groups involved in natural resource management and research, be commissioned to identify where the uncertainties lie in understanding of coastal floodplain ecosystems as a whole, and what significance this has on ESD in these geomorphic units. Such a working party might be asked as part of this task to review the utility of current models and integrating frameworks.*

13. *That the Corporations consider negotiating with stakeholders in one of the regions such as the north coast region, a thorough analysis of the communication requirements for integrated natural resource management, and the development of appropriate strategies to meet the needs identified. Stakeholders would include Catchment Management Committees, Local Government, industries and government agencies.*

14. *That the sugar industry enhance its current communication activities with a focus on informing cane farmers about the factors involved in producing acid drainage, the current knowledge about the off site impacts of the acid waters, the management options which have been proposed and the basis for them, and where technical assistance can be sought. Such activities should involve R&D personnel who have expert knowledge in the various aspects of ASS and their management.*

15. *That the sugar industry consider funding low cost 'best practice' demonstration studies where outcomes such as yield, acid drainage, groundwater levels and costs are monitored and reported to cane farmers.*

16. *That economic analyses be carried out on a number of rehabilitation projects as case studies to ascertain the degree of public and private benefits associated with the outcomes, and to assess the degree of public input which can be justified for the projects.*

17. *That the Wyong Shire Council AEAM study on the Tuggerah lakes and catchment be promoted as a case study among other local governments and catchment management committees with the view of indicating the role and benefits from using a decision support tool based on an integrated catchment management approach .*

18. *That the Corporations develop a second phase to this project which involves:*
    - *negotiating the implementation of priority projects out of the above recommendations with the Clarence Catchment Management Committee (CMC)*
    - *facilitating implementation of priority actions identified by the CMC planning.*

1. PURPOSE OF THIS REPORT

This report provides a view of the environmental management issues relating to land and water management of the coastal floodplains and estuaries of NSW. It is presented as part of a commissioned project by the Fisheries, Sugar, Dairy and, Land & Water Resources Research & Development Corporations. The report is aimed at assisting the Corporations in identifying how they might contribute to improved integrated management of land and water resources in the floodplains and estuaries.

2. APPROACH TAKEN

The approach taken for this project has involved:

- collation and review of a wide range of technical reports, strategic plans, outputs from workshops and conferences, State of the Environment reports, Coastal management Inquiry reports, R&D Corporation research plans (Appendix 1)
- consultation with specific stakeholders and information providers in rural industries, fishing industry, natural resource management agencies, Local Government, and research agencies (Appendix 2)
- feedback and discussion with those consulted on the issues identified and/or the current programs and projects addressing environmental management issues in the coastal region.

2.1 REVIEW DOCUMENTS USED IN THE PROJECT

Several key reports reviewed for this report need to be highlighted:

- The Coastal Zone Inquiry Final Report
- The State of the Marine Environment Report
- The New South Wales State of the Environment 1995 report
- The Ecology and Management of Riparian Zones in Australia
- The Proceedings of the National Conference on Acid Sulfate Soils
- Fixing Problems Caused by Acid Sulfate Estuarine Soils
- Regulating and Restoring Fish Habitat in Australia

They are comprehensive statements on particular aspects of environmental management pertaining to the estuaries and floodplains of NSW. Collectively they identify most of the significant environmental management issues, provide current statements on knowledge in the particular aspects, and indicate priority actions to address the issues. In addition numerous other documents were used, and these reports, plans, proceedings, papers are all listed in Appendix 1.

Coastal Zone Inquiry

The final report from the Coastal Zone Inquiry carried out by the Resource Assessment Commission (RAC, 1993, p36) made some conclusions which have been confirmed and supplemented by further consultation and reviewing of other reports:

- eighty-six per cent of the nation's population resides in the zone
- almost half of all population growth in Australia in the past 20 years has occurred in coastal zone areas outside capital cities
- a high proportion of Australia's fast-growing tourism and recreational activities, all mariculture activity, and almost all wild fishing activities (both commercial and other) occur in the zone
- a high proportion of all industrial activity takes place in the zone.

Among the most important consequences of increased resources use are:

- continuing degradation and loss of many coastal habitats (especially wetlands and fish-breeding areas)
- increased risks to endangered species
- over-exploitation of many fisheries resources
- introduction of exotic species into marine and terrestrial habitats
- accelerated erosion and loss of coastal soils
- erosion of dune and beach systems.

Of particular concern is the declining water quality in many rivers and streams, estuaries, wetlands and the ocean caused by pollution from urban, agricultural, industrial and marine-based sources.

State of the Marine Environment Report for Australia (SOMER)

Another significant report is the *SOMER*, the first comprehensive description of Australia's marine environment, its uses and values, the issues and threats affecting it and its management. *SOMER* primarily concentrates on the coastal and continental shelf areas around the continent but also covers issues within coastal catchments which affect the marine environment. The report provides a highly relevant context to the objectives of this consultancy project and issues raised have been incorporated into this report.

A conclusion derived from the exhaustive national reviewing which under-pins the *SOMER* is:

"Long-term scientific information on the marine environment, which is essential to accurately assess its environmental condition, is very scattered, or lacking altogether in many areas."

New South Wales State of the Environment 1995

This is a comprehensive analysis of the environment in the State. It identifies a wide range of environmental issues and gives an overview of the government programs which have been initiated to address them. It acknowledges widespread deficiencies in the current level of knowledge of environmental condition and trends and the need for more comprehensive actions to address them.

Ecology and Management of Riparian Zones in Australia
The proceedings of a national workshop on research and management needs for riparian zones in Australia provides a comprehensive view of many of the issues and knowledge base. Whilst there are other significant documents relating to riparian zone studies, this document is a useful collation of current state of knowledge.

Proceedings of National Conference on Acid Sulfate Soils
Acid sulfate soil issues were catapaulted into prominence in the late 1980's by major estuarine fish kills. Over drainage of, and acidification of coastal wetlands and estuaries were soon identified as the major causes. This document is the first major collation of papers describing the significance of, and environmental and management issues to do with acid sulfate soils (referred to from here on as ASS) in Australia. It includes information on how the problem is managed overseas as well as case studies on management options for urban and industrial development and agriculture in Australia.

Fixing Problems Caused by Acid Sulfate Estuarine Soils
Another important paper dealing with ASS is that presented by Ian White and others at the ANZAAS '95 CONGRESS ((White et al 1995). This document describes ASS, their distribution, properties, processes of acidification, environmental impacts, and issues to do with management.

Regulating & Restoring Fish Habitat in Australia
This key report, *Regulating & Restoring Fish Habitat in Australia*, by Michael Hobbs for the Dept. of Primary Industries and Energy, reviews regulation of fish habitat in Australia and proposes options and administrative arrangements for implementing a national fisheries habitat strategy. In doing this, it covers many aspects which are highly relevant to natural resource management generally. Several of his recommendations are pertinent to this report on environmental management of the floodplains and estuaries of NSW.

National Wetlands Review R&D Program - Scoping Report
A major review of issues and R&D needs for wetlands in Australia has been completed by a range of specialists across Australia for the Land & Water Resources R&D Corporation. A very comprehensive report has been compiled, but is in a draft form. The priority issues identified in the wetlands review are noted in this report.

2.2 Consultation With Key Groups

The majority of consultation occurred between January and the end of March, and was carried out by A. Webb. Bob Smith also consulted with several of the Government agency staff from the Department of Land & Water Conservation and the Department of Agriculture in the northern region. In addition, he consulted with a group of dairy farmers in the Lismore area. Discussions with stakeholders were generally in the form of one on one, or small group discussions to allow opportunity for individual perceptions of issues to be raised. This was seen to be important to provide a balance with the often generalised descriptions of issues which are identified in many of the reports. Phone consultation and follow up also

provided valuable information from stakeholders or technical support people not able to be interviewed personally. A. Webb had two trips to Sydney to consult with government agency staff from Head Offices, and the southern region. A special consultation workshop was held with the Wyong Shire Council environment manager and the consultants who ran the Adaptive Environmental Assessment and Management project on the Tuggerah lakes and catchment. Dr. Greg Bowman CSIRO Division of Soils provided detailed comments on issues related to acid sulfate soils, and assisted in development of the recommendations on acid sulfate soils.

The value of running a phase two AEAM project in the Richmond or some other catchment was discussed with many of those consulted, in particular those groups in the north coast from the Richmond, Tweed and Clarence catchments. A special meeting was held with the Richmond Catchment Management Committee executive, with follow up discussions with the Catchment Coordinator Wayne Garrard. Discussions were held with the coordinator and one of the members of the project steering committee of the Tuckean Swamp Land & Water Management project about supporting them with an AEAM approach. The Tuckean catchment is a sub-catchment of the Richmond River. A technical solutions field day was attended to gain a better understanding of the concerns and the scope of support among the stakeholders.

Following consultations, brief reports on the issues identified were provided to those consulted to allow for clarification and correction of their views. The collated issues were given to most of those consulted and occasionally this resulted in another series of phone discussions.

3. STRUCTURE OF REPORT

The report describes:

- the biophysical characteristics of the coastal floodplains, the demography, land use and industries
- perceived current issues related to management of land and water resources of the floodplains and estuaries
- current programs relating to these issues
- conclusions from an analysis of the issues and programs
- recommendations on future actions.

4. OVERVIEW OF COASTAL NEW SOUTH WALES

The coastal zone of New South Wales is an extremely important zone in terms of its social, economic and ecological base. The floodplains and estuaries along the coast remain focal points for commerce, population growth and recreation industries. This has occurred at the expense of many of the ecological values of these coastal landforms.

4.1 PHYSICAL

The coast region of NSW is a long, narrow, coastal plain backed in the west by the Great Dividing Range. The region extends over 1 000 km from Eden to Tweed Heads. There are about 20 easterly flowing river systems with headwaters up to 120km from the coastline (Figure 1). Separating the valleys are extensive areas of native eucalypt forest occupying undulating to steep land of generally poor soil fertility. Limited areas of rainforest occur. The more fertile and accessible upland areas have been cleared for beef cattle production. Figure 1 shows the land capability of coastal catchments of NSW.

The land capability classes reflect the landscape and soil features of the catchments, and highlight the contrast between the catchment and floodplain dimensions of the northern regions and the southern regions. Of particular note are the differences in the amount of good quality agricultural land available. Intensive agriculture is confined mainly to the narrow, alluvial flood plains of the river systems.
The estimated proportions of the various types of agricultural land in the region are:

- low fertility shale and sandstone 80%
- fertile alluvial soils 15%
- rich volcanic soils <5%

This means that less than 20% of the region has good agricultural land and much of this is on the floodplain. e.g. the floodplain of the Tweed river (Figure 2). However, the floodplain also has severe constraints placed on it by flooding and poor drainage. The lush appearance of much of the region, including the areas of poor soil, results mostly from the high rainfall and mild winters which mask major, widespread soil deficiencies.

LAND CAPABILITY OF COASTAL NSW

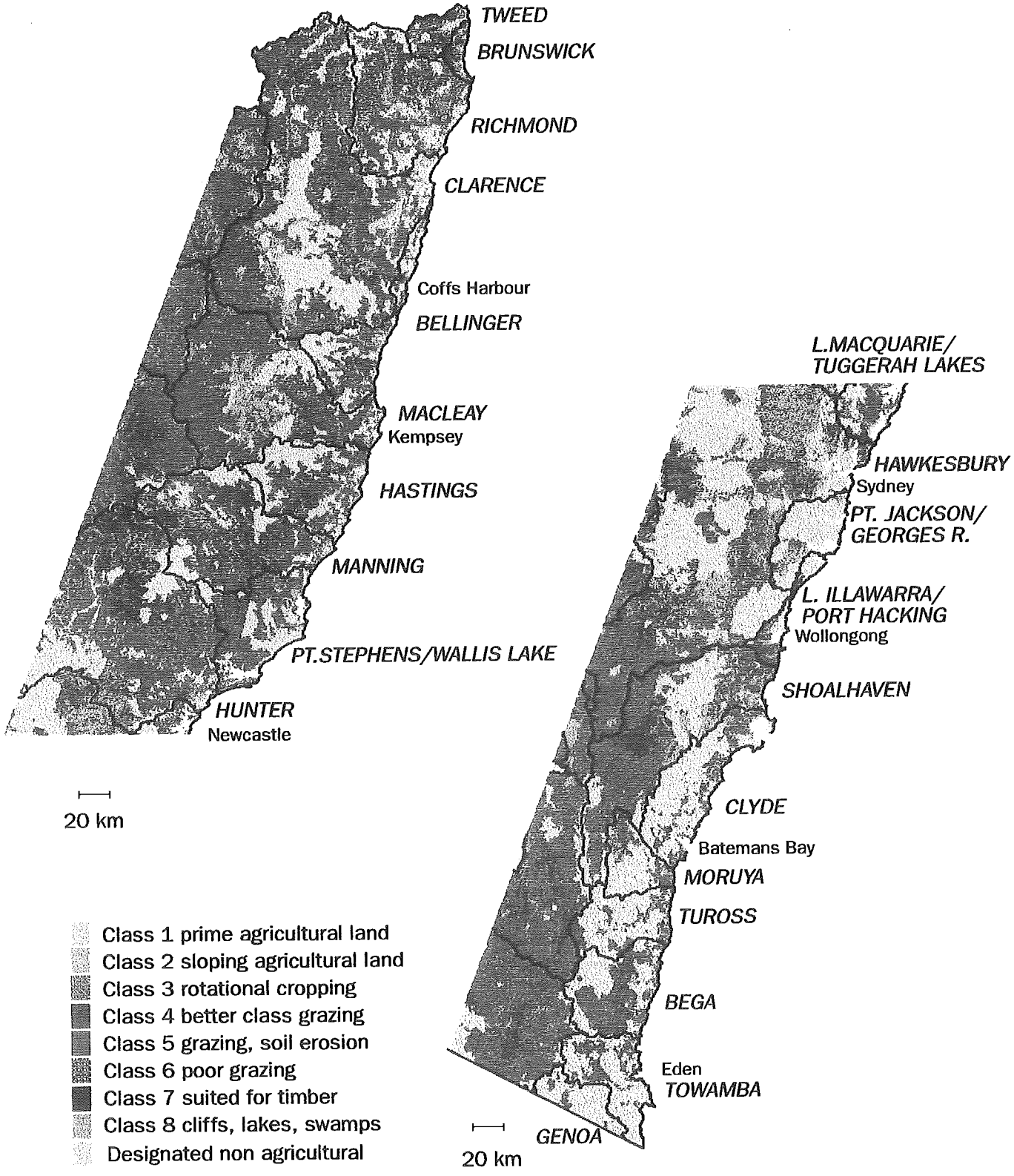

Figure 1. Land Capability of Coastal Catchments (permission of Land & Water Conservation)

Figure 1. Land Capability of Coastal Catchments (permission of Land & Water Conservation)

Figure 2 Floodplain of the Tweed River

The main feature of the climate is the high rainfall varying from 2000mm per year on the northern coastline to about 900mm along the elevated western boundary. The northern coastline receives the highest rainfall of any area in the State. The north coast experiences a winter and spring dry season which extends from July to October and makes irrigation necessary for reliable plant growth during these months. The south coast has a more uniform rainfall and cooler climate. Summer temperatures are moderated by cloud and the cooling effect of sea breezes along the entire coast.

4.2 BIOLOGICAL CHARACTERISTICS

Coastal floodplains and estuaries by their very nature are highly productive and diverse environments. The main contributing features to this productivity and diversity are:

- floodplains and estuaries are nutrient sinks, being the area of deposition for the majority of nutrients (and pollutants) generated by the rest of the catchment
- floodplains and estuaries are moist environments, being liberally supplied with water from fresh water discharges from upstream and tidal water from the ocean
- this combination of abundant nutrients and constant source of water, allow high levels of production of both natural and man made terrestrial and aquatic production systems
- floodplains are diverse in their geomorphology even though the low terrain might suggest otherwise
- this diversity (levee, upper toe, lower toe, semi-permanent swamp and permanent swamp) provides for a wide range of highly productive habitats. These can support rainforest, wet

sclerophyll, dry sclerophyll, melaleuca and casuarina forest associations as well as pasture and crop production

- estuaries have similar diversity ranging from salt marsh, mangrove, sea grass and algal vegetation associations across a range of substrates including mud, clay, silt, sand and rock
- floodplains and estuaries are dynamic under the influence of flooding with fresh and salt water, siltation and erosion
- associated with this diversity of substrates, vegetation and hydrological processes, is a diverse and productive fauna and flora encompassing everything from sea mammals and marsupials to fish and amphibians. A full range of lower order organisms is normally found.

Perhaps the most important feature about the biology of floodplains and estuaries is that the impacts of land and water management on one part of this highly integrated system can extend throughout much of the system, through the common hydrology of the area. Two good examples of this are dredging and drainage. Dredging in one location of an estuary may change the hydrology of the entire estuary by increasing the tidal range, which may lead to widespread lowering of the water table behind floodgates. Installation of new drainage systems, especially if equipped with floodgates, can also lead to widespread changes in hydrology and the associated changes in chemical and biological characteristics.

4.3 DEMOGRAPHY

Coastal areas of NSW are experiencing almost double the population growth as the NSW average (Figure 3). The highest rate of growth is in the north coast region where the population is expected to double to 0.6 million in the next 20 years. Most of the population increase is occurring in a narrow coastal strip, much of which is highly constrained for such development. This is placing considerable pressure on adjacent floodplain and estuarine resources. Additional pressure is coming from the need to upgrade infrastructure, particularly roads, to service the expanding population. In most cases, these improvements are being located on floodplains and estuaries.

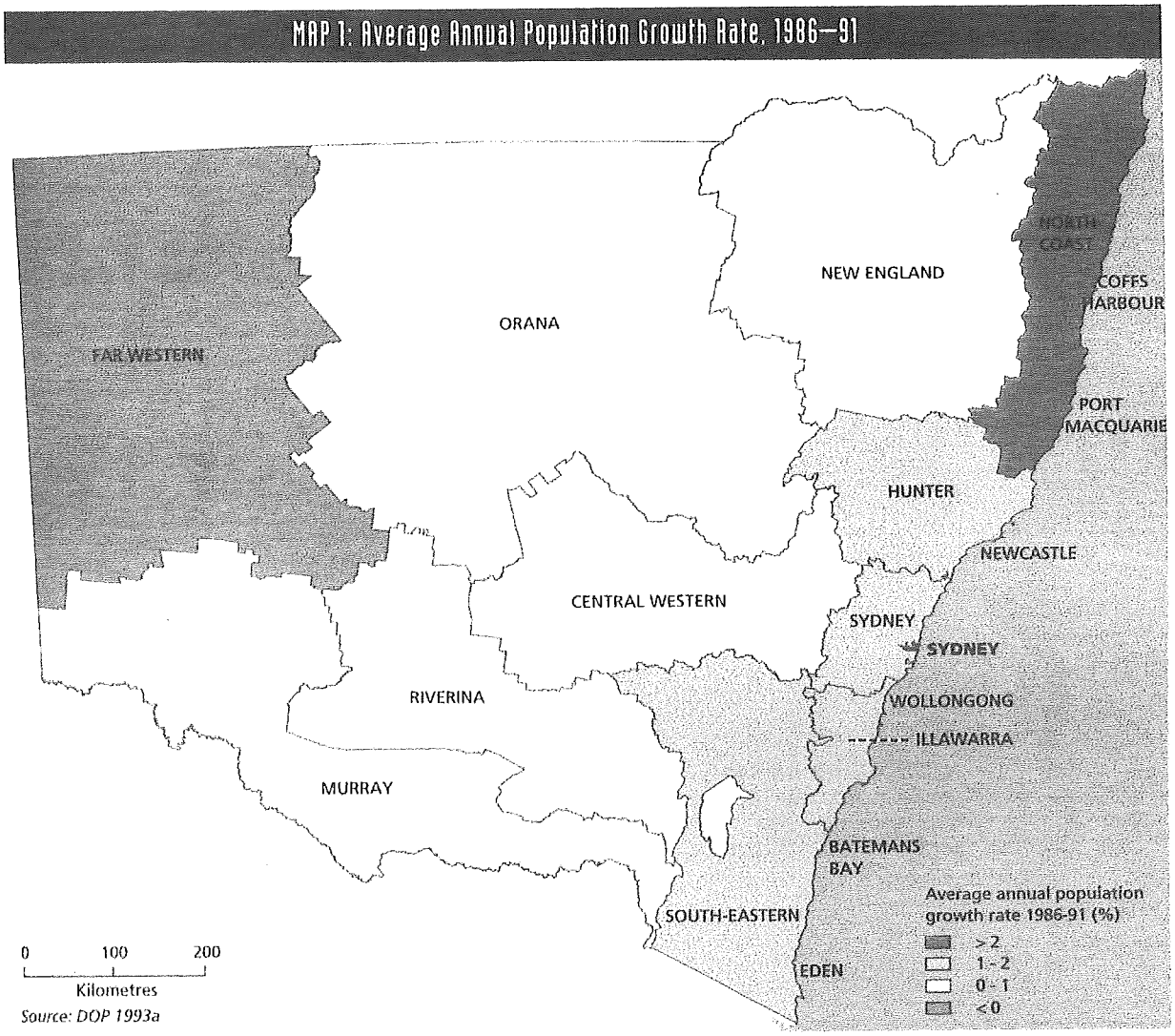

Figure 3. Population Growth in NSW (extracted from EPA 1996)

Most of the population increase is coming from the southern cities. These new residents have very limited knowledge of environmental management issues of coastal floodplains and estuaries.

4.4 LAND USE

Agriculture plays a significant role in the coastal economy outside of the metropolitan areas, and is by far the dominant land use on the floodplain. Other uses include infrastructure (roads, railways, utility services), urban and rural residential development, tourism, aquaculture and areas preserved for environmental values.

Benefits from agricultural industries include employment opportunities. Agriculture provides 20 855 jobs in the north coast region, which is 15% of total jobs (estimated by NSW Agriculture). A similar pattern could be expected in the Hunter and south coast areas.

Unfortunately agricultural industry statistics for the coastal areas are unreliable because small farms are not counted. The Agricultural Census, according to NSW Agriculture, underestimates the value of agriculture for the beef cattle industry by $34m and even more for the horticultural enterprises.

Estimates of the value of the major agriculture and fishing industries of the coastal floodplains and estuaries of NSW are summarised in Table 1.

4.5 Other Industries

Coastal floodplains and estuaries support value adding industries ancillary to the main agricultural industries mentioned in Table 1. These include abattoirs, dairy factories, sugar mills and a refinery, teat tree stills and processing plants, plus seafood factories. In many instances, these processing plants are located on the floodplains adjacent to the estuary, and require measures to ensure that effluent and byproducts from processing do not pose floodplain or estuary management problems.

Table 1

Agriculture and Fishing Industries of the Coastal Floodplains and Estuaries

Beef cattle:
- $200m
- 1 million head
- associated export abattoirs

Bees:
- $3.5m
- 100 commercial beekeepers
- 30 000 beehives
- 2 500t of honey
- half of NSW honey production

Dairy cattle:
- $250m
- 2 000 dairy farms
- 800m litre annual production (80% of the State's milk production)

Sugar:
- $140m
- 600 cane growers
- 25% of domestic sugar market

Tea tree:
- $8m
- 140tonnes tea tree oil (1993)
- current plantings exceed 1800ha

Commercial fishing:
- $120m

Recreational fishing:
- $600m (20% freshwater) - includes associated industries

Oysters:
- $30m

5. CURRENT ISSUES FOR ENVIRONMENTAL MANAGEMENT

The major current issues for environmental management of floodplains and estuaries have been categorised into:

- water
- land
- riparian zone and
- land use planning and management issues.

In categorising issues, arbitrary groupings have been made for expediency of presentation. For example, some have been grouped with land issues because they are associated with land management or production systems, even though they relate also to other categories.

This report does not paint a happy picture. It indicates there are serious problems with natural resource degradation and deficiencies in the way information is communicated and used. Despite good intentions, some of the processes used across the levels of government lack effectiveness. In order to improve the reading of the report the number of references in the text have been limited. The main references used as a basis for the statements made are listed at the beginning of each section.

5.1 WATER ISSUES

A range of important issues related to water quality and management are listed in Table 2, and discussed in the subsequent sections.

5.1.1 Riverine and estuarine water quality is degraded from urban runoff, urban and infrastructure development, waste disposal, and canal developments, and has impacted particularly on seagrasses and fish

(Algal Coordinating Committee 1994, Chambers 1995, DEST 1995, Dept. Water Resources 1994, DUAPP 1995a, b, c, EPA NSW 1995, 1996, Eyre and Morrisey 1994, Hastings Shire Council 1995, Hawkins and Hill 1995, Hawkins 1995, Hawkins and Millar 1995, New South Wales Govt. 1994, NSW Water Resources Council 1994, Simmons and Trengrove 1989, SPCC 1987a,b,c, RAC 1993, Richmond Catchment Committee 1995, Sammut et al 1995, Walker 1992, Wyong Shire Council 1995.)

Regional planning documents, state and local government State of Environment (SOE) reports, the Coastal Zone Inquiry report, and the State of the Marine Environment Report (*SOMER*) all point to continuing general degradation of water quality in the coastal streams and estuaries of NSW. A common element is the degradation caused by existing and continuing urban development pressures. Erosion induced by urban and rural infrastructure and development, inadequate waste disposal systems, untreated urban and industry runoff, and non-point source nutrients and acid drainage from agricultural lands are repeatedly identified as important water degrading activities.

Table 2

Current Issues for Environmental Management of Floodplains and Estuaries
Water
1. Riverine and estuarine water quality is degraded from urban and infrastructure development, waste disposal, and canal developments, and has impacted particularly on seagrasses and fish
2. Threshold conditions which control eutrophication of estuaries are not well understood.
3. Sedimentation of streams has created problems for shipping and changed estuarine and river habitats
4. Impacts of dredging estuaries and lower rivers on the stability of the waterways and the biology are not understood
5. Disruption to habitat gradients is occurring through physical, chemical and nutrient 'barriers'.
6. Sediment and nutrient runoff from agricultural land periodically degrades waters of the rivers
7. Impacts of land use on groundwater processes in coastal dunes and estuaries are not well identified
8. Water monitoring programs lack uniformity in criteria and time frames.
9. Monitoring of water and sediments for pesticides is insufficient to determine impacts from agricultural and urban practices.
10. Adoption of effluent management systems by dairy farmers is disappointing.
11. Community stakeholders (landholders, industry, urban, environmental) have not been effectively involved in the debates and management decisions on water use, environmental flows and mechanisms for achieving them. (top down approaches have prevailed
12. High water demands during low flow conditions affect stream water quality and groundwater levels.

The end result is loss of habitat to estuarine biota, which is vital to the fishing industry as well as ecosystem functions generally, and the loss of recreational and amenity values.

Estuaries are the main interface zone between fresh and salt waters. Because they are naturally rich in nutrients, estuaries are ecologically highly productive, and are important fish and fauna habitats. Estuaries and sheltered bays have also been the focus of urban, industrial, tourism and recreation development. Often the resultant land based activities have degraded water quality. Elevated nutrients can cause eutrophication and the excessive growth of algae which may smother other organisms and deplete oxygen levels.

At least 64% of estuaries in New South Wales are considered to have poor water quality.

The State of Marine Environment Report (*SOMER*) emphasised the importance of seagrasses for marine productivity, their ability to trap and stabilise sediments, their importance as fisheries habitats. Australia has the highest biodiversity of seagrasses in the world, the largest areas of temperate seagrass and one of the largest areas of tropical seagrass. However, the temperate seagrass beds appear to be under particular threat. Increased sedimentation and nutrients from catchments have been linked with massive die-back of seagrasses in many areas. New South Wales has lost half of the Zostera seagrass in its estuaries. Other highly significant losses have occurred in other states. Once lost, seagrasses do not readily recover. The *SOMER* report concluded that the decline in temperate seagrass is one of the most serious issues in Australia's marine environment. Loss of seagrasses has also been linked with acid water discharge and associated iron flocculates. Mangroves on the other hand have in many areas shown a net increase due to their ability to colonise areas of recent sedimentation.

Poor water quality and loss of habitat, combined with high recreational and commercial fishing pressures, have also caused a decline in estuarine fisheries. For example, fisheries are thought to be threatened in 21% of estuaries in New South Wales and 23% in Victoria.

Many rivers and estuaries close to large population centres in NSW show signs of eutrophication. For example, blooms of toxic plankton are increasingly common in areas such as the Hawkesbury River.

Waste disposal from sewage treatment plants, detergents and other nutrients in urban runoff, as well as seepage from septic systems are regarded as prime causes of algal blooms near urban and rural residential areas. Soil erosion and fertiliser runoff are other sources identified in agricultural and non urban areas.

The major industrial discharge to the Tweed river and its major inland community are both located in an area of the river that is not well flushed by tidal water movements. The State Pollution Coordinating Committee (SPCC 1987c) reported that observed changes in water quality in the Terranora, Cobaki area have been attributed to the increases in population beyond the capability of the available sewerage services and/or the poor location of effluent disposal.

In addition to the impact of point source discharges, consideration of the fate of urban drainage is required, particularly in the upper catchment. In addition the Rous River (Tweed catchment) has endemic poor water quality due to high nutrients, high turbidity, high algae, occasional depleted oxygen levels, and periodic high acid content. This impacts on the Tweed river downstream from Tumbulgum. Urban runoff is damaging some habitat areas and in some popular recreation areas of the lower Tweed.

The water quality in the Tweed broadwaters has deteriorated since 1978 with regard to phosphorus and nitrogen concentrations. Nutrients have encouraged the development of extensive floating and attached algal communities. Oxygen depletion has been recorded in some canal developments within the district, and these require investigation to establish the extent and causes. Concerns have been raised about the extra problems likely to be caused by increased population.

In another survey by the SPCC (1987b) of the Richmond river, nutrient concentrations (particularly phosphorus) were high adjacent to Kyogle, Casino, Lismore, Coraki and Woodburn, and have resulted in nuisance aquatic plant growth and occasional fish kills.

A study of the flux of nutrients from runoff and sewerage identified that the first flush of urban storm runoff from Ballina carry significant nitrogen but low phosphorus concentrations.

Water quality deterioration in the many small and sensitive waterways of the south coast is resulting from urban development . Factors which contribute to this are:

- storm water runoff (sediment, pollutants)
- fertilisers, herbicides and insecticides from urban gardens
- sewage disposal and inadequate septic systems.

Water quality decline and eutrophication has occurred in coastal lakes and lagoons, particularly those which are intermittently open or insufficiently flushed by the sea, for example, Tuggerah Lakes and Lake Macquarie (NSW). A significant proportion of the nation's coastal lakes has been degraded by proximity to major urban areas. Much of this degradation is caused by inadequate sewerage or septic waste disposal systems, and nutrient runoff from urban gardens and sporting fields such as golf courses.

Strategic planning for the NSW north coast region by the Department of Urban Affairs and Planning (DUAPP 1995a) has emphasised that there are few suitable alternative garbage tip sites for the disposal of solid non recyclable wastes, and this poses a challenge for local government to find a solution which does not lead to pollution of the waterways. Most existing tips do not conform with EPA requirements.

Although there are some comprehensive water quality studies in a few key streams, e.g. Hawkesbury Nepean (EPA NSW 1995b), knowledge of the water quality, sources of pollutants and the dynamics of the systems is seriously deficient in the coastal streams. Local communities are very concerned about water quality issues, but this is against a background of very limited data. Management decisions related to water quality impact widely on many facets of land use. There is very limited data on sedimentation in the lower parts of the creeks and estuaries. Sources of sediment and rates of movement downstream are not known. In addition the impacts of sediment on nutrient levels is not well understood. Consequently remedial or management decisions lack any objective basis, and long terms impacts are not monitored.

5.1.2 Threshold conditions which control eutrophication of estuaries are not well understood

(Algal Coordinating Committee 1994, Commonwealth Govt. SOMER 1995, DUAP 1994, EPA NSW 1996, State, Wyong Shire Council 1995,)

Whilst tidal flushing is seen to keep eutrophication of most coastal rivers and estuaries to a minimum, periodic eutrophication is reported for parts of several of the north coast and south coast rivers, as well as the Hawkesbury-Nepean system. This is expected to become much more of an issue as urban and industrial development increase along the coastal areas, and nutrient inflows to streams and water bodies increase. The problem of eutrophication has become well recognised, but the management of it is complex. It is known that both point and diffuse sources of nutrients are largely responsible for eutrophication, but the particular processes and predisposing factors are still being researched. Major control programs are in place through the Algal Management Strategy of NSW, aimed at managing and monitoring algal blooms, one of the symptoms of eutrophication. The Wyong Shire Council is currently reviewing the waste management design for a large industrial development site in the vicinity of the Tuggerah lakes, because of better knowledge of the impacts and management needs of waste waters.

Threshold conditions which control eutrophication of estuaries are not well understood. Consequently management decisions for sustaining acceptable water quality within water bodies carry considerable uncertainty. Algal blooms are affected by a number of factors such as nutrient content of water, the water movement dynamics in the water body, and the turbidity. There is poor understanding of the thresholds of these sorts of factors beyond which management of algal blooms is very difficult or impossible. These sorts of thresholds need to be better understood to guide decisions on nutrient inflow management, stream bed morphology and depth management (dredging), and minimum water flows.

5.1.3. Sedimentation of streams has created problems for shipping and changed estuarine and river habitats

(Commonwealth Govt. 1995, Chambers 1995, DUAPP 1995b, Hastings Shire Council 1995, Hawkins and Hill 1995, RAC 1993, Richmond Catchment Committee 1996, TCM Committee 1995).

Sedimentation of estuaries and shipping channels with marine sand causes shoaling and alters currents and is a major problem in ports. In addition, sedimentation from riverine systems is creating adverse impacts on fish habitats through changes in substrates, depth and flow velocities. In most cases the source and processes of the sedimentation is poorly understood. Consequently targeted management options are difficult to justify and implement. It is thought that improved riparian zone management will lead to improvements in bank stability and a reduction in sediment in the rivers. Other sources may be the in-stream sediment, or erosion losses from cropping and grazing lands in the upper catchment, or urban, rural residential and infrastructure development in the catchment.

On the NSW north coast, sedimentation in the river has increased flood risk and contributed to degradation of the river ecosystem. Flood levee banks which are a feature of most floodplains have greatly contributed to sedimentation of the rivers even during minor floods. Prior to levees being built in the 1960's the rivers spilt over the banks and sediment was dropped on the floodplains. The loss of this natural 'top dressing' by the sediments on floodplains has not been calculated. The Public Works Department have acknowledged that with current knowledge, rural levees would not have been built. It was recognised that sand movement along the coast and into the mouths of the rivers has resulted in sedimentation of the lower estuary areas and probably increased the sedimentation from upstream sources such as bank erosion, and erosion from uplands and alluvial plains. This has resulted in sedimentation occurring progressively further upstream.

High sediment levels in the water reduce light penetration which affects rates of photosynthesis of seagrasses. When sediments settle they can also smother seabed organisms.

5.1.4. Impacts of dredging estuaries and lower rivers on the stability of the waterways and the biology are not understood

(DEST 1995)

Dredging has been used regularly in estuaries to construct canal estates, marinas and allow continued use by boats. Dredging re-suspends sediments, creating further environmental problems. Impacts of dredging of estuaries and lower rivers on stability of the waterways and the biology are not well understood and is poorly monitored. Dredging is seen to be unstructured, with little planning on the impacts of the surrounding systems.

5.1.5. Disruption to habitat gradients is occurring through physical, chemical and nutrient 'barriers'

(Ferguson and Eyre 1995, DEST 1995, McDonall and Leadbitter 1996, Middleton et al 1985, New South Wales Govt. 1994, Pollard and Hannan (undated), Sammut and Lines-Kelly 1996, Sammut et al 1995a, Sammut and Melville 1995b, SPCC 1987b, White et al 1995, Williams and Watford 1996).

Disruption to aquatic habitat gradients is occurring through physical, chemical and nutrient 'barriers' in the rivers and tributaries. Fishers and biologists are concerned about the degree of restriction caused to fish movement by structures such as floodgates, barrages, weirs, culverts and the like. An associated issue is the effects that some of these structure might play on processes which affect stream and estuary food sources such as seagrass beds. The barriers are largely physical structures, but can include water body temperature differences, water salinity, turbidity, and in some cases chemical and nutrient levels.

Studies on water quality in the lower Richmond catchment (SPCC 1987b) have identified significant impacts from acid runoff from ASS in agricultural land. Drainage structures and tidal barrages are identified as having a major influence on the volumes and persistence of acid runoff produced from acid sulfate soil areas through the alteration of floodplain hydrology. The flocculation of large amounts of aluminium hydroxides suggests that aluminium concentrations may be very high in sediments which may have implications for the health of benthic communities in these areas. Although dissolved aluminium may be confined to the drains and upper reaches of the creeks during the dry season, it can be expected that extremely toxic levels will be experienced over much greater areas (eg Tuckean Broadwater) during the wet season. Acid flows during the wet season also coincide with large drops in dissolved oxygen thereby compounding the effects of aluminium on fish.

Aluminium toxicity will also directly and indirectly affect phytoplankton and macrophytes mainly through its competitive binding of phosphorous

A study by NSW Fisheries has reported over 4000 physical structures exist in the tidal zone of NSW. These are:

- 1795 culverts
- 1187 bridges
- 1037 floodgates
- 36 fords
- 96 weirs
- 78 causeways

It was concluded that because of the structures 113 of the 125 substantial water bodies in the State's tidal zone were degraded in some way, and that removal of many of the structures may facilitate the rehabilitation of fish habitat.

The consequence of the barriers is that the range of niches from marine through to freshwater are modified, sometimes very seriously, and these impact adversely on fish habitat and production. Management decisions on river and estuarine resources are being made in an absence of knowledge about fish habitat requirements and maintenance of fish resources. Habitat assessment for fish carrying capacity is very poorly understood, and in most cases anecdotal information is the only source of information on how well rivers and estuaries produced prior to and following development of structures. As a result of the lack of information about habitat assessments, there is a thrust by fishers and biologists to apply the precautionary principle after the event, and seek to have as many structures removed as is feasible to restore the various niches from marine / tidal / inter-tidal freshwater / and freshwater zones. There has been considerable negotiation and pressure from the fishing industry to remove as many of the floodgates as possible, or to at least have them open in normal flow periods to allow better fish access to habitats in drains and wetlands.

Whilst there is some sympathy for improving fish access and opportunities for flushing of the drains with tidal waters, there is concern also that mismanagement of floodgates will lead to salinisation of cane land during high tides. Recent experience has shown that farmland can be salinised by incursion of seawater during high tides through floodgate management problems. A project on Roberts creek, upstream from Maclean on the Clarence river, has been set up with the local community and the Dept. of Land & Water Conservation to study the impacts of allowing tidal flows through the floodgates.

Recent adverse publicity has heightened the concern that legislation will be introduced which might remove the authority for management of the drains from farmers.

5.1.6. Sediment and nutrient runoff from agricultural land periodically degrades waters of the rivers and lakes

(DEST 1995, SPCC 1987a,b,c, New South Wales Govt. 1994, Hastings Shire Council 1995, Weaver & Prout 1993, Wyong Shire Council 1995)

Although water quality of the Clarence river valley was found to be generally good by the State Pollution Control Commission (SPCC)in 1987, and compared favourably with other water bodies in the state, major tributaries and some sections of the main stream were found to have poor water quality from time to time. Elevated phosphorus levels were measured in the estuarine section below Grafton and adjacent to Maclean during low flows. The Broadwater and some of the tributaries tended to respond differently to the main channel during high and medium flows. In the Broadwater nutrients entered the system primarily from agricultural runoff. During medium flows the South and North arms and Serpentine channel exhibited elevated nutrient concentrations and poor clarity. Tributaries such as Sportsmans creek, Southgate creek and Coldstream river had poor water quality with extensive macrophyte growth at times during the year. Poor oxygenation and clarity, and elevated nutrient concentrations were measured during low flows. These creeks were influenced by flood mitigation and drainage schemes.

The SPCC (1987a) concluded that the relative influence of point and non-point source pollutants in the Clarence is dependent on freshwater inflows, land use activity and location in the catchment. Diffuse source pollution is a significant contributor of suspended solid loads in the river during medium and high flows. In the upper catchment the principal cause is extensive soil erosion of grazing lands. Intensive agricultural practices in the lower estuary of the river also contribute significant sediment loads under high flow conditions.

The water quality of the Richmond Valley was found to be poor when compared with the other NSW North Coast rivers studied. Although the SPCC (1987b) concluded that the nutrient and sediment loads delivered to the Richmond were probably the result of erosion from agricultural land, there were no data to substantiate this conclusion. It has been pointed out since, that the Richmond drains volcanic land with soils which are naturally high in phosphorus, and the sediment may be coming also from non agricultural lands.

The SPCC also concluded that pollution from diffuse sources contributes significantly to suspended loads in the river between Casino and Wardell and below Lismore on the Wilson river during medium and high flows. Intensive agriculture in the lower estuary also contribute major sediment loads under high flow. As part of the flood mitigation works, floodgates have been constructed at the mouths of most creeks emptying into the Richmond River below Casino. The drainage system is thought to encourage run-off of agricultural chemicals into the river system but there was little evidence during the study to suggest the significance of quantities involved. The overall conclusions of the SPCC in 1987 were,

"There is no doubt from the visual observation of this and the study in the Clarence River catchment that these areas promote poor water quality behind the floodgates."

Inadequate information exists on the relative contributions of effluent and sediments to phosphorus levels in south coast streams. Dairy farmers are not convinced that phosphorus 'flushes' in streams are always due to effluent discharge or nutrient movement from dairy farms. They contend that phosphorus is unlikely to move through the soil to the streams, and that erosion is not a problem in the dairy lands of the south coast. The contribution from stream bank erosion, upland erosion, and wildlife may be significant at times. Similarly on the north coast dairy farmers contend that there is a need to identify the relative contribution of dairying versus other sources of nutrients (rural residential, multiple occupancy, sewage treatment works, roads, forestry etc.) into waterways. There seems to be a need for development of catchment nutrient budgets which have some spatial segregation capabilities, before developing management plans/strategies.

5.1.7 Impacts of land use on groundwater processes in coastal dunes and estuaries are not well identified

(Personal comments from consultations)

The long term impacts of land use on the groundwater processes and the associated ecosystem processes need to be taken into account in resource management decisions in the coastal dunes and estuaries. The role of groundwater processes in estuary habitat functioning, particularly those in the coastal barrier sand dunes in the lower estuaries need to be well understood to avoid degradation or depletion. The freshwater inflows into estuaries from the sand dunes as baseflow may have very significant roles in ecosystem functions such as growth and persistence of seagrasses and fauna diversity. The sand dunes have been used for urban development, and in most cases effluent disposal systems were rudimentary. Septic systems for example did comprise a large proportion of human waste disposal systems. In areas of intensive land use the probability of nutrients and pesticides moving through into groundwater in these landforms is high. In addition pumping for domestic and garden purposes from the groundwater can reduce flows to the extent that baseflows into the estuaries can be severely reduced. The effects on these sorts of systems has not been widely appreciated and studied.

5.1.8. Water monitoring programs lack uniformity in criteria and time frames

(EPA NSW 1996, Riding 1992)

The NSW SOE report indicates that few environmental quality indicators have been monitored in a consistent way which allows a comprehensive overview of the condition of NSW rivers. Many of the current studies often use different sets of indicators. For most coastal waters in NSW, there are no long-term baseline water quality data (EPA 1996), although long term trends have been monitored in key sites since 1992. In addition, much of the water quality information in NSW is fragmented across agencies and inconsistent both in terms of standards and time frames.

National criteria for water quality indicators are provided in the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC 1992) as part of the National Water Quality Management Strategy (NWQMS).

Specific purpose studies have been carried out in various rivers, but no standard procedures exist and no common databases have been developed to allow examination of trends in water quality through time. A major government program is in progress to develop interim water flow and quality objectives for the catchments of NSW. These objectives will form the basis for inquiries into the development of longer terms objectives and indicators in collaboration with catchment groups and local government. The water sampling strategies employed for monitoring quality need to take account of stratification in water bodies, if the information is to have much relevance to habitat needs for fish and other aquatic fauna and flora. A recurring problem which threatens the sustainability of monitoring programs is the need for management of data bases in the long term, and the difficulties which arise in ensuring common standards in methods of measurement.

5.1.9. Monitoring of water and sediments for pesticides is insufficient to determine impacts from agricultural and urban practices

(SPCC 1987, Smith 1995)

There are public concerns about the use of pesticides by many rural sectors, and in the control of nuisance aquatic plant growths in flood mitigation drains. A review of past and current pesticides use in the Clarence, Richmond, Brunswick and Tweed catchments highlights this concern. Pesticide use is one of transition from the original use of heavy metal compounds to the very effective but environmentally damaging organochlorines to the current plethora of pesticides available under the main categories of organophosphates, carbamates and synthetic pyrethroids. Current pesticides use patterns were estimated for each catchment from information available through Peskem and on the advice of experts working with the major user industries. An indication of the major pesticide users in the region is provided in the Table 3 below.

Table 3

Major Pesticide Users in the Clarence and Tweed Study Area

(from R.J. Smith and Associates 1995)

Industry	Total Active Ingredient Used (KG /yr)
banana	3464
beef and dairy (dips)	1080
avocado	25195
boating	164
forestry	1275
housing	16311
macadamia	66701
maize	5059
potato	4738
soy bean	8163
stone fruit	32368
sugar cane	48587
tea tree	2380
timber preservation	170000
weed control	n/a *

**reliable data on quantities of pesticides used for weed control were not obtainable during the study*

Pesticides can enter rivers through aquatic weed control, spraying of stream and drain banks, accidental spray drift, spillage, improper disposal of unwanted pesticide containers or as runoff or seepage.

There is currently no monitoring of pesticides on a routine basis in these northern coastal waterways. However agricultural industries have shown a willingness to promote their industries as 'clean and green' and the opportunity therefore exists to initiate with industries and catchment management committees, waterway sediment monitoring programs to identify current problems at their source. The tea tree industry is already discussing the potential for conducting pesticides audits of growers as a means of quality assurance of their health care products

5.1.10 Adoption of effluent management systems by dairy farmers is disappointing.

(Group and personal discussions)

Discussions with dairy farmers in both the northern and southern coastal regions of NSW indicated that effluent management is providing some concerns. The comments were that dairy farmers are having difficulty obtaining or applying the most appropriate waste management systems, and infrastructure management to eliminate nutrient and sediment runoff into streams.

Considerable improvements have been achieved in reducing effluent discharge into streams, and the EPA has been quite supportive of, and accommodating towards the industry efforts to achieve the necessary standards. The farmers are under considerable pressures to upgrade their effluent management and land management systems to prevent nutrient, chemical and sediment inflows to streams. Some farmers are unsure what is most appropriate for their circumstances. e.g. ponds, irrigation. They feel the technology is not readily implemented and may require further improvements to achieve the desired standards. For example there is little experience in the use of artificial wetlands to treat dairy wastes.

It may well be that costs of implementation are causing difficulties with some farmers, and this is the reason for their reticence or criticisms of available technology. It was not possible in this type of scoping exercise to analyse this issue. A specific concern raised in the southern region is the shortage of advisers in dairy waste management. In addition there are weaknesses in the monitoring systems. There have been requests for a manual for waste disposal which is specific or relevant to the needs of the farmers of the south coast area. In addition the options for preventing sediment and nutrient movement off laneways during high rainfall periods are difficult to assess.

5.1.11. Community stakeholders (landholders, industry, urban, environmental) have not been effectively involved in the debates and management decisions on water use, environmental flows and mechanisms for achieving them. (top down approaches have prevailed)

The recent workshops conducted by the Dept. of Land & Water Conservation on planning for the future for water, highlighted the wide interest in the community for education and awareness programs about water management. This was reflected in the repeated requests for community education programs and strategies for water management to achieve ecological sustainability. There may be a need for more coordinated programs aimed at providing education for adults of water management practices within a whole catchment context.

Whilst the recent workshops referred to above are an example of an attempt to provide opportunities for this type of input, they are still within a framework which is essentially 'top down'. Experiences from the landcare movement and associated rural sociological studies on stakeholder participation in Australia have indicated clearly that sustainable resource management is dependent on stakeholder acceptance, understanding and close involvement in resource management solutions. This then demands that the processes and structures to allow this to occur need to be put in place. Currently government agencies and to some extent local government still take the major role beyond policy development, to strategy development, development of implementation plans, and then attempt to promote/market the outcomes to the wider community who have the ultimate responsibility for implementing the solutions.

The TCM process does not seem to have resulted in a wider and ongoing role by the community in the debate about the development and implementation of the solutions. *One of the deficiencies is the lack of targeted communication programs to allow the stakeholders to become sufficiently aware to be able to contribute confidently and effectively to the debates.* There has been a reliance on regulation of a prescriptive set of management tools. Consequently many groups in the community remain unaware of the range of issues, their significance, the long term constraints and opportunities for addressing them. In addition the motivation and innovativeness often possible from a wide group with common concerns is lost, or at best severely limited. As an example the issue below could well be addressed effectively by more enlightened approaches to stakeholder participation in management .

5.1.12. High water demands during low flow conditions affect stream water quality and groundwater levels

High water demands during low flow conditions affect stream water quality and availability, and groundwater levels. Competition for water for environmental flows is causing restrictions on irrigation by farmers in many areas. Recent dry conditions have focused attention on the need for environmental flows to maintain in-stream processes and to minimise degradation such as blue-green algae outbreaks. As a consequence, there is considerable discussion on the need to ensure that water flows are not fully exploited for urban, rural and industrial purposes to the detriment of environmental systems. As a result there are moves to reduce the irrigation entitlements previously enjoyed by farmers. This has considerable impact on production system viability particularly in the drier periods, and is likely to lead to conflict between the farming community and the urban and other non-farming groups. Community pressures for maintenance or improvement in natural resource values in the region have highlighted the need for objective and equitable guidelines for decisions on water management which are understood by stakeholders. Rural producers feel their rights to the use of water for irrigation may be curtailed to allow for environmental flows without a proper understanding of the requirements. There seems to be a clear need for stakeholders to be involved in addressing this complex issue, and to be part of the solution.

Extracts from New South Wales State Of the Environment 1995

"There has been no comprehensive comparison between current land use and agricultural land capability or suitability for the state. "

"For most coastal water systems in NSW, there is currently no long-term baseline water quality data, though this is changing."

"There are an estimated 1.75 million recreational fishers in NSW. The recreational catch is unknown."

5.2 LAND MANAGEMENT ISSUES

Major land issues are listed in table 4 and discussed in the sections following.

5.2.1. Acid sulfate soils are a natural phenomenon and therefore difficult to assign or get ownership of the impacts (cause/effects) which are mostly off-site

(Dept. Water Resources 1994, EPA NSW 1996, Middleton et al 1985, Sammut et al 1995a, White et al 1995)

Soil acidification from natural causes is common in soils of the coastal floodplains of New South Wales where land and wetlands have been drained or excavated for agriculture, industrial or urban development. Acidification results from oxidation of iron pyrites deposited in the floodplain sediments. Oxidation occurs when watertables are lowered, or when pyritic material is brought to the surface or exposed in canals or trenches. When water moves through the acidified layers of the soil, it acidifies and carries with it aluminium and iron compounds. Acid drainage into waterways can severely affect the aquatic biota not only through the low pH but also through the effects of elevated concentrations of aluminium and iron compounds in the water. Periodic fish kills following runoff events have been graphically reported in the media over recent years, and awareness of the acid drainage problem is very high in the north coast region.

Habitat loss both in-stream and in the drained wetlands is seen as one of the most serious consequences of acidification of water upstream of flood mitigation structures. Other impacts of acidity impacts are the weakening of pier and bridge pylons, corrosion of concrete slabs, fence posts, foundations of buildings, water and sewerage pipes. Used as landfill, ASS severely impede plant growth, and can pose problems for foundations of buildings and roads due to uneven subsidence and low bearing capacities. Precipitates of iron oxides can block perforated pipe drainage systems. Hence the economic impacts from ASS can be extremely high.

Because ASS are a natural phenomenon, it is difficult to get ownership of problems caused by acid drainage, most of which impacts off site. There has been evidence of acid drainage related fish kills back in the days prior to extensive floodplain development. Understandably some farmers feel that since the land was developed under government schemes and regulations, they should not be targeted as the group to take responsibility for the problems which have subsequently been identified.

The majority of information on the distribution, properties and management of ASS has come from research by White, Melville, Sammut, Bowman, Dent and others, and this has been promoted through communication activities associated with the NSW Acid Sulfate Soils Management Program, a whole of government approach to managing ASS.

Table 4

Current Issues for Environmental Management of Floodplains and Estuaries
Land
1. Poor understanding of hydrology, groundwater and water balance processes of floodplains is limiting the development and assessment of land management options for sustainable systems.
2. Terrain elevation data are inadequate for assessing the impacts of floodplain rehabilitation management.
3. Acid sulfate soils (ASS) are a natural phenomenon and therefore difficult to assign or get ownership of the impacts (cause/effects).
4. More detailed distribution of ASS is required for urban, agricultural and industrial development.
5. Techniques for assessing ASS hazard are contentious among resource scientists.
6. Current land management practices are generating acid drainage inadvertently, and attempts to encourage and promote sustainable management practices are still at an early stage.
7. Development of appropriate management practices is constrained by limited knowledge about acid production rates and fluxes for different ASS types groundwater regimes, weather conditions and disturbance situations.
8. Techniques for environmentally sound construction and development on ASS are inadequate
9. Drains designed for wet season flows may be inappropriate for management of ASS (over drained).
10. Long term impacts of the shrinkage and subsidence of ASS following drainage is not understood.
11. Remaining wetlands are still being developed incrementally irrespective of legislation, information on wetland values, ASS drainage and suitability of soils.
12. Reliance on herbicides is posing long term problems for sugar cane production.
13. There is little information on grazing values of wetland pastures.

5.2.2. More detailed distribution of ASS is required for urban and industrial development and for farm management practices

(Bowman pers.com., Naylor et al 1995,Neilsen pers com., EPA 1995)

Mapped information by the Department of Land & Water Conservation, on the likely occurrence of ASS show considerable areas in which they might occur on the floodplains of NSW. The current mapped information was collected to provide information on where ASS might occur, as a basis for more detailed focused assessment and was never seen as appropriate for management at a site or farm level. This has not been fully appreciated by canegrowers who are highly sceptical of the extent of the area being identified as potentially being affected by ASS. There are indications that in the absence of more detailed maps of actual occurrence of ASS, the risk maps will be used for decisions on planning and development proposals. This has important commercial and legal implications. If the risk maps are used to make land use decisions and they are found to be unreliable (as they will be at a local scale), they will be challenged &/or will come into disrepute. It is not practicable to produce ASS maps at a such a large scale and with sufficient reliability that they serve as land use zoning maps, except for limited areas such as recognised 'ASS hot spots'. There is a need for much more detailed mapping of ASS, and definition of current sources of acid drainage for development projects and areas which are likely to be subjected to increased levels of development. The sugar industry has commenced a major project aimed at assessing the ASS risk on all of the cane farms in northern NSW. In addition to the current conventional forms of mapping, there is pressure for the development of other techniques such as the use of remote sensing, surrogate indicators, knowledge based expert systems and rapid field identification techniques.

5.2.3 Techniques for assessing ASS hazard are contentious among resource scientists

(Bowman pers com.)

ASS assessment is a complex field and the choice of technique depends on the purpose, on precedent, on regulations and on experience with ASS. Consequently, it is open to considerable dispute (as is now occurring). A technical sub-committee of the Acid Sulfate Soils Management Advisory Committee (ASSMAC) has released an 'Acid Sulfate Soils Information and Awareness' paper titled '*Acid sulfate soils analytical methods June 1996.*' This is seen as a very useful contribution, but there has been limited peer review outside the group that prepared the paper. For example, it has not come before the Australian Soil and Plant Analysis Council Inc. Some of the methods are variants of the recommended methods of soil analysis included in the *Australian Laboratory Handbook of Soil and Water Chemical Methods* (Rayment and Higginson,1992). Since the legal consequences of actions made on the basis of chemical assessment methods may be very serious, there is value in ensuring that a more inclusive approach be made to evaluation of the proposed methods. One approach is to have an independent review of the ASS assessment protocol in terms of its suitability for all land use planning and management situations, and variations in ASS around Australia.

5.2.4 Development of appropriate management practices is constrained by limited knowledge about acid production rates and fluxes for different ASS types groundwater regimes, weather conditions and disturbance situations

(Melville et al 1995, ASSMAC 1996)

The rate of oxidation of the sulphidic material is the critical issue in management of ASS. It is dependent on the hydrology, the drainage properties, the climatic regime, the permeability of the soil or sediments to air, and the soil temperature.

Detailed information is available for one site on one ASS soil type in northern NSW. Because of major differences in the environmental factors affecting ASS, and ASS characteristics around Australia, it is important that a better understanding of acidification rates and leachate production rates be obtained in order to allow appropriate management. Monitoring and modelling similar to the current NSW study site is required for other ASS types on other estuaries so that a more comprehensive and representative overview can be obtained (preferably Australia-wide).

5.2.5 Current land management practices are generating acid drainage inadvertently, and attempts to encourage and promote sustainable management practices are still at an early stage

(Dept. Water Resources 1994, DEST 1995, EPA NSW 1996, McDonall and Leadbitter 1996, Lines-Kelly ,White et al 1995, Naylor 1996)

The sugar industry is being criticised as one of the main causes of acid water runoff and resultant fish kills, in the cane growing areas of the far north coast floodplains. Cane growers are concerned that they may be forced to adopt practices which will impact on their viability. Guidelines for management of ASS have been promoted widely within the industry with the main emphasis being placed on minimising the depth of drains in canefields, and minimising removal of acid spoil from drains. Recent applied research in the Tweed valley has shown that acid production can be reduced markedly by liming of drain channel sides, wider shallow drains for efficient surface drainage, and careful maintenance of drains to prevent deepening and exposure of the acid sulfate layers. Whilst there is some interest in minimising acid drainage, there has been limited implementation to date of the new guidelines.

Some farmers already recognise the benefits of using lime or dolomite for production purposes and are aware of the impact that liming of spoil and channel sides might have on alleviating acid drainage. However, lime and dolomite are expensive and their usage is governed by the return received for cane. It may be necessary for incentives such as a subsidy on lime for acid sulfate soil management to promote greater usage by farmers.

5.2.6 Poor understanding of hydrology, groundwater and water balance processes of floodplains is limiting the development and assessment of land management options for sustainable systems

(Bunn et al 1996, Middleton et al 1985, Sammut and Lines-Kelly 1996, White et al 1995)

The overall hydrology of floodplain systems is poorly understood. In addition, the hydrological-ecological relationships are not well researched, and conceptual frameworks for making generalisations from one study or region to another are lacking. This is especially true for wetlands. The consequences of many decisions which result in changes to water flows have not been fully appreciated for the floodplains. It is known generally that modifications to hydrology weakens or alters ecological links in wetlands which can lead to a number of forms of degradation including:

- interrupted or failed breeding, loss of vigour or death for individuals
- ageing populations, species shifts, altered community structure
- loss of biodiversity and changes in habitat within a wetland, if modification is sustained
- regional habitat changes and biodiversity effects, if modification is widespread.

One of the most significant findings from recent work in the Tweed valley, is that while artificial drainage is a major cause for oxidation of sulphidic layers, oxidation has occurred under natural conditions in eastern Australia, probably during very dry periods. "Evaporation by plants and soil plays a major role in oxidation of sulphidic sediments" (White et al 1995). Whilst deep drains which extend into the sulphidic layers reduce the water table and promote oxidation, there is evidence from the Tweed river that because of the very low transmissivity of the subsoil, the water table level is controlled more by evapotranspiration of sugarcane, the rainfall and length of dry periods. This contrasts with the situation in the Shoalhaven catchment where the watertable in pasture lands appears to be controlled predominantly by the drain level. Evapotranspiration from the shallow rooted pastures is less than from deeper rooted crops such as sugarcane and tea tree. These findings have particular implications for management of acid drainage from crop and pasture lands. They emphasis the need for a good understanding of the hydrologic / groundwater / water balance processes in the floodplains. Outside the work of White and Melville, there is very limited knowledge of these processes across the major soils and landforms. This is limiting the constructive development and assessment of land and water management options.

In canelands, the concern about effective drainage to minimise crop yield loss from water logging, has driven the development of effective surface water management using well controlled levelling and shallow surface drains. However there appears to be no information on groundwater levels from piezometer measurements from which to assess the impacts (effectiveness) of drainage on groundwater levels through time. Clearly this issue is very important in terms of future management of the floodplains.

Rehabilitation studies on degraded wetlands is also lacking objective basis. Strategies being considered in the Tuckean Swamp (Richmond catchment) rehabilitation project involve raising water tables to promote pasture options and to assist in minimising acid formation and drainage. However, the consequences of modification of the drainage regime on surface and groundwater hydrology both on site and in areas away from the sites to be rehabilitated, and through time, are not known. Those involved in developing management options are currently having considerable difficulty deciding how they might proceed, largely because of the lack of knowledge about hydrologic processes.

The Seven Oaks (Macleay catchment) rehabilitation project on severely degraded wetlands is an attempt to use low cost approaches to developing pasture cover by raising water tables. At this site also, there is little understanding of the surface/groundwater interactions, and consequently it will be difficult to assess the transferability of the results.

5.2.7 Techniques for environmentally sound construction and development on ASS are inadequate

(Bowman pers com)

The environmental implications of ASS for large development projects are being assessed on very poor information about ASS acidification processes, mostly extrapolated from inadequate agricultural observations. Cost-effective and environmentally benign ASS management and remediation techniques are lacking for the construction and development industry. The current assessments are based on laboratory simulations which are inappropriate for this type of activity where disturbances of the natural conditions can be very considerable, and where much more sophisticated techniques can be considered.

5.2.8. Drains designed for wet season flows may be inappropriate for management of ASS (over drained)

(Lines-Kelly , and personal discussions)

A contentious issue is the depth of some farm drains. Currently many drains designed to dispose of water during wet periods cause the water table to be lowered during the dry periods and results in oxidation of ASS. In addition there is anecdotal evidence that cane grown over shallow water tables (1m) stays green longer than cane without shallow water tables, and during dry periods such as those over the last few years may have significant yield benefits by being able to use the shallow groundwater. This issue needs clarification to assist in the design of drains and water management practices for both wet and dry periods.

5.2.9. Long term impacts of the shrinkage and subsidence of ASS following drainage is not understood

ASS of the floodplains shrink as they dry out following drainage. In many areas land surfaces have dropped significantly. Where fires have occurred in the peat soils, this subsidence is more pronounced. As these ASS soils mineralise over time, subsidence is likely to continue requiring further intensification of drainage and further ASS problems.

5.2.10 Remaining wetlands are still being developed incrementally irrespective of information on ASS drainage and suitability of soils.

(Tweed Shire Council 1994, DUAP 1995a)

Despite the information on ASS drainage and suitability of soils, wetlands have been developed for agriculture and urban development until very recently. The sugar industry has indicated it is now taking a more rigorous role in minimising this practice by refusing to grant cane assignments to unsuitable land. However development of wetlands will not be stopped until government and local government take sustainability factors into account as well as the need for habitat preservation for systems which are already severely depleted.

5.2.11. Reliance on herbicides is posing long term problems for sugar cane production

(Personal discussions)

Reliance on herbicides is posing long term problems to cane production. The sugar industry is becoming increasingly reliant on herbicides and unless attention is given to the development of integrated management approaches, residue problems in soil and water and off-site effects will become difficult to manage. Concerns over residues in water and food have led to much increased pesticide monitoring (e.g. in cotton industry and in export foods), and the capability of detection has improved. Consequently the likelihood of residues being found have increased. This highlights the need for much improved or flexible approaches to weed management. There is some support within the industry for more emphasis into integrated management approaches.

5.2.12. There is little information on grazing values of wetland pastures

(Launders 1996, Smith 1993, Tuckean Project Committee)

There is considerable interest among dairy farmers and graziers in better production from wetlands, but experience in some areas seems to be limited. Over-drainage of swamps has brought about changes in vegetation to dryland species and the extent of ASS has grown. Because the vegetation in many areas now relies on drainage, the productivity of the swamps once prized for their forage value in dry times now have little productivity. During the periods of greatest need, the swamps are now less productive than before drainage. Groups such as the Seven Oaks Drainage Union which controls several thousand hectares of previous wetland, are highly critical of the deep drainage systems that were built through their land. They are now seeking to increase productivity of their land by manipulating ground water levels through additional water retention structures behind flood gates. Flexibility in the management systems is now being promoted. During the wet years, drainage is still required. However during dry times the same drainage is damaging to the environment and productivity. Management practices which maintain the water level in the swamps in dry times, and maintain the drains in wet periods are required.

Although a number of pasture species have been identified as suitable for wetland pastures, there is some uncertainty among producers about relative grazing values. This is constraining them in making decisions on what to plant when planning changes to their systems, or when attempting rehabilitation programs. Economic assessment of the options is an important component of the plans, and there appears to be a lack of confidence in the information currently available or being promoted by advisory services. A typical example is the uncertainty among farmers in the Tuckean swamp and the Seven Oaks area where there is a desire to consider the introduction of pastures in the wetlands as part of rehabilitation programs. "Little organised work seems to have been done with pasture species for ASS situations" is how one adviser has summarised the current situation, and much of the practical information is anecdotal. This has considerable significance for farmers/graziers on floodplain wetlands from the Manning valley north to the border.

5.2.14 Terrain elevation data are inadequate for assessing the impacts of floodplain rehabilitation management

(Mainly personal discussions)

Another key requirement for floodplain management including rehabilitation of wetlands either for habitat or production purposes, is elevation data at the appropriate scale to allow for planning and assessment of the impacts of proposed rehabilitation activities. There are significant risks for landholders in implementing activities which might impact adversely on other landholders or protected zones. Accurate elevation data reduces some of the risks, but it is seldom available. Because of the public benefit aspects of much of the wetland rehabilitation, there may be justification in government entering into cost sharing arrangements for provision of adequate data.

5.3 Riparian Zones

The ecology and management of riparian zones in Australia were reviewed extensively at a national workshop on ecology and management of riparian zones in 1993, and provide a comprehensive view of current knowledge and issues for management. Several of the issues in that report are still current and are seen to be important for ongoing management of the zone. The major issues for riparian zones are given in Table 5 below.

5.3.1. Riparian zones of many streams are degraded, but there is little objective information.

(Anderson 1993, Anderson and Raine 1995, Douglas et al 1993, Gardiner and Raine 1993, EPA NSW 1996, Newbury 1993, Riding and Carter 1992, Roberts et al 1993)

Riparian zones of coastal NSW are generally regarded as highly disturbed in agricultural and urban lands, and in many cases highly degraded. However there is evidence of dramatic recovery, not through active rehabilitation, but through natural recovery since the early 1900's.

Many of the catchments have parts of their riparian zones in degraded states, and this is reflected in the issues, and management activities identified in the Total Catchment Management Annual Report for 1993-1994. Studies of the Manning, Hastings and Camden Haven, Macleay, Nambucca, Richmond and Brunswick catchments and the Hawkesbury-Nepean River show that much of the original (pre-European) riverine vegetation has been cleared and the areas have since been colonised by many exotic weed species. However, the extent and condition of riparian vegetarian throughout NSW have not been adequately reported (NSW State of the Environment 1995).

In the south coast region, the lower and middle reaches of the streams are highly degraded in terms of riparian zone condition and stream sedimentation. The degree of clearing and the land use of the catchments has resulted in increased run-off rates and associated damage to stream beds and banks. Rehabilitation of riparian zone degradation and stream characteristics is likely to be very difficult under the current land use.

Table 5

Current Issues for Environmental Management of Floodplains and Estuaries
Riparian Zones
1. Riparian zones of many streams are degraded, but there is little objective information.
2. Insufficient use has been made of existing knowledge in policies, management guidelines, education and rehabilitation
3. Responsibility and authority for riparian zone management is contentious with farmers
4. The values of riparian zones (both market and non-market) have not been promoted, and used to establish roles and responsibilities among the stakeholders

Management of noxious weeds has become an issue with the increased number of 'hobby farms' and rural retreats, particularly along riparian zones. Farmers in particular are concerned at the rapid increase in noxious weeds through what they consider as inappropriate land management on non agricultural blocks. This has consequences not only on the remaining agricultural enterprises, but also on the integrity of the natural vegetation communities.

A pilot study on the state of the rivers in NSW by the Department of Water Resources concluded that the general extent of riparian vegetation is readily assessable for most NSW streams from regularly flown aerial photography, but more detailed assessment of riparian vegetation such as species diversity, health, structure etc. can only be undertaken with field sampling and verification.

Residents and old photographic records indicate that the riparian vegetation in the Orara catchment has largely re-established itself since large scale clearing in the 1920's and 30's, and apart from recently developed horticultural areas, is generally well vegetated. Unfortunately there has been little or no monitoring of regeneration and consequently opportunities for learning have been missed. Rehabilitation of riparian zones has been identified by catchment community groups as a priority, as it is recognised that riparian zones influence stream water quality, river bank stability, fish habitat, fauna corridors, biological diversity, visual and recreational amenity.

5.3.2 Insufficient use has been made of existing knowledge in policies, management guidelines, education and rehabilitation

(Bunn pers.com., Cummins 1993, Campbell 1993, English 1994, Riding and Carter 1992, Roberts et al 1993, Walker 1993)

A great deal is known about the values of riparian zone vegetation and its influences on riparian systems and in-stream geomorphology and biology. However little of this has been transferred to policy and management. Current approaches to riparian zone rehabilitation and management are not achieving substantial support by landholders. Examples of successful rehabilitation have not been promoted effectively, and many farmer groups are uncertain of the most appropriate approaches. Part of the problem appears to be associated with the lack of appropriate guidelines and awareness programs so that landholders can see what the benefits might be, and how they may be readily implemented. More recent programs are attempting to address this issue, but issues of control and responsibility will need to be settled before there is likely to be widespread responses.

The conspicuous gaps in knowledge of the roles of riparian vegetation in influencing stream ecosystems relate to:

- the impacts of replacing native evergreen species with exotic deciduous species
- methods of restoring riparian vegetation
- impacts of rehabilitation
- size and floral composition of vegetation
- management to control vermin and noxious weeds
- impacts of de-snagging of rivers on fish and other fauna.

However these deficiencies are not seen as the main constraints to action in riparian zone rehabilitation. A review in government suggested that the failure of riparian zone management programs was due to three factors:

- sustainable management was not an objective of previous legislation, and there was no clear policy framework in which to apply the legislation
- much of the degradation is a result of cumulative small impacts which are difficult to identify and control
- much of the clearing of riparian zones occurred late last century and early this century, and legislation focussed on further control rather than on active rehabilitation.

Approaches to river system instability are often not achieving the desired outcomes in terms of physical stability of banks and stream beds, and are impacting severely on in-stream biological systems.

Many of the degradation issues such as river bank instability, flooding and continuing stream bed mobility and their associated impacts on riparian zone and river ecosystems are being addressed through inappropriate approaches. This is often due to single disciplinary approaches such as relocation of bridges, building of large rock walls, lining of river banks etc. without considering the associated impacts on other systems. Bio-physical approaches which take a more integrated view can often be more appropriate and sustainable. These approaches take account of geomorphic, hydrologic and hydraulic processes and look for solutions which recognise the inter-dependence of physical and biological systems. Many of these approaches can be far simpler and cheaper than current engineering solutions being attempted, and can be delivered through group communication and awareness raising methods.

5.3.3 Responsibility and authority for riparian zone management is contentious with farmers

(English 1994)

A study of landholder attitudes to a number of issues including stream bank erosion in the Richmond catchment concluded that there is little support for a landcare program to undertake restoration of a particular creek. This was despite a local example where fencing of a creek had demonstrated benefits in stability and regeneration of native species after 5 years. Landholders often feel they are the only ones bearing the costs, which might include extra management of weeds, pests and fire. Consequently many farmers are resisting contributing to the development of wildlife corridors, and riparian zone rehabilitation. They are under pressure to release land for riparian zone rehabilitation, but are not being recompensed either for the land or the extra fencing and management that ensues. Farmers in the Richmond have indicated they are happy for government to take responsibility for stream bank stabilisation. They would consider taking some part provided they were subsidised. In a survey in the Kiama area, only one farmer agreed to the voluntarily fencing of stream banks to allow revegetation.

North coast dairy farmers indicated that the riparian zone was considered a valuable special 'long paddock', with advantages of permanent water and special values at different times of the year. They would not be in favour of a complete exclusion of the zone to stock. More appropriate management options, incentives and more targeted training opportunities and technical support were identified as being essential before farmers would support any wide ranging program which restricted current use of the riparian zone.

The need for alternative management practices for the riparian zone has been recognised by the NSW government, and major revisions to the government policy are in progress. It is recognised that landholder attitudes are crucial to riparian zone management, and successful management will be dependent on their actions. Cooperation of landholders is likely to require recognition by government that a centrally controlled program is unlikely to succeed. Prescriptive management practices will not be accepted. Performance criteria which are negotiated for the particular catchments and surrounding land use are more likely to be accepted, particularly if funds or incentives are tied to achieving them.

5.3.4 The values of riparian zones (both market and non-market) have not been marketed, and used for promoting roles and responsibilities among the stakeholders

(Ardill 1995, English 1994, Hill 1995, Outhet et al 1994)

A glaring lack in the whole debate on riparian zones is the lack of economic analysis of the benefits and costs associated with healthy riparian zones. Inclusion of non-market benefits and costs is a necessity. In a recent set of studies on the Nepean river, the Wollondilly Council and the Dept. of Water Resources (now Land & Water Conservation) defined riparian land widths for a number of purposes, assessed the suitability of development on the land, and assessed the benefit costs of a number of riparian management options. The results will be used to provide a basis for promotion of similar studies in other catchments in NSW. Despite some of the difficulties in assigning values to perceived benefits from some options, it was concluded that the exercise is a worthwhile adjunct to other factors in decisions on riparian zone management.

Research in North Queensland in canelands shows there are significant economic benefits from establishment of, or maintenance of riparian zones (Bunn pers comm). An outcome from full economic analysis will be clearer identification of the beneficiaries of well managed riparian zones, and this is likely to lead to a better understanding of the roles and responsibilities of landholders and government. Economic analysis is also likely to lead to a better focus of the deficiencies in biophysical information about the roles and values of riparian zones.

5.4 Land Use Planning and Management

Issues related to land use planning and management are listed in Table 6 and discussed in the subsequent section.

5.4.1 Implementation of strategies for sustainable use of natural resources is constrained by inadequacies in whole catchment management approaches. (Structures/authority, information systems, monitoring systems, decision support systems.)

(Nobbs & Rush 1995, RAC 1993, TCM Committee 1995, Hawkins 1995))

One of the main conclusions from the coastal management inquiry was that there is very little coordination of all of the roles and responsibilities for management in the coastal zone, and this leads to difficulties in achieving integrated resource management. Many of the issues raised in this report cannot be addressed effectively outside an integrated catchment management approach.

The objectives of the Total Catchment Management (TCM) program in NSW are to ensure that natural resources are managed by:

- coordinating policies, programs and activities as they relate to catchment management
- achieving active community participation in natural resources management
- identifying and rectifying natural resource degradation
- promoting the sustainable use of natural resources
- providing stable and productive soil, high quality water and protective and productive vegetation cover within each of the state's catchments

The TCM program has provided an opportunity for community stakeholders to contribute to the identification of natural resource management issues and develop strategies for managing them. However the catchment management committees (CMC's) set up under the TCM program do not have the structures nor authority to implement strategies which they develop to address at least two of these points.

They may be able to coordinate policies and programs within government, although some members of CMC's would argue that they have great difficulty in having much influence. There coordinating influence with some Local Government bodies and other outside bodies can be very difficult because they lack any real authority.

In addition they have very limited ability to achieve the last point. They are not able to have a strong influence on the implementation of strategies because they do not have implementing authority, nor the resources. They do not have authority to raise resources as a Catchment Management Trust can, and they receive inconsistent support from State agencies. They also find difficulties in accessing information.

Priorities derived by the catchment management committees (CMC's) do not always coincide with those of agencies in the regions, and resources for implementation of projects are difficult to acquire. On the other hand, local government is a major player in resource management decisions, and account for an estimated 80% or more of resource management decisions along the coast. In addition they have existing structures and responsibilities which allow them to carry out many of the functions which are required to achieve sustainable resource use. They regularly play an integrating and implementing role for the community. Unfortunately local government area boundaries are not generally based on catchment boundaries.

Whilst local government are represented on catchment committees, there is very limited indication that this has led to improved resource management through the planning of catchment management committees.

An example of where local government has taken a very positive role with a catchment focus is the Wyong Shire, which has embarked on a comprehensive program of planning and resource management which incorporates environmental considerations. In the Tuggerah Lakes and catchment project, they used the Adaptive Environmental Assessment and Management (AEAM) approach, which facilitates the integration of social, economic and environmental aspects into decision making. It relies heavily on stakeholder input into the process.

In a recent review of practices in local government which take into account ESD in their planning decisions, it was concluded that there is a need to provide advice to local government planners on how to incorporate ESD principles into planning decisions and how to implement performance standards. Of particular significance was the conclusion that although the importance of widespread community support is known to be essential for successful planning initiatives, ***only a small percentage have adequate community participation processes in land use planning.*** Stakeholder participation was a strong element of the Tuggerah Lakes and catchment project.

Table 6

Current Issues for Environmental Management of Floodplains and Estuaries
Land Use Planning & Management
1. Implementation of strategies for sustainable use of natural resources is constrained by inadequacies in whole catchment management approaches. (Structures/authority, information systems, monitoring systems, decision support systems.)
2. There is a general realisation that maintenance of habitat diversity has been severely compromised through floodplain development.
3. Planning and management decisions by government and local government could be improved by more use of full economic analysis including market and non-market aspects of natural systems.
4. Communication of information on programs and legislation across stakeholders is large, not coordinated, and complex (numerous bodies responsible, uncoordinated activities usually not on a catchment basis)
5. Rural -urban conflicts are increasing through urban encroachment into traditional farming lands.
6. Rural-urban conflicts are increasing through urban encroachment into traditional farming lands.
7. The cane industry requires full time staff to represent industry interests in regional planning and catchment management activities

One of the constraints to the incorporation of relevant information into planning decisions is 'information overload', at a time when local government is under enormous change pressures in environmental management. The forms and ways in which information is presented and promoted are often inappropriate for easy incorporation or adoption by local government councillors and staff. Few groups, whether they be catchment groups or local government or Trusts, have adequate information systems, monitoring systems or decision support systems to effectively implement an integrated resource management program. One of the outcomes of the Tuggerah lakes project was a decision support system and a monitoring plan. Information databases were developed as part of the decision support system (model).

A major deficiency of the catchment management programs under TCM seems to be the lack of a framework or decision support process to assist in selection of management options for natural resource management. Many of the committees have developed strategies, but have no objective basis for decisions on priorities for investment. Without this sort of capability, it is difficult often to get agreement among stakeholders of priorities, and to convince landholders and government to commit funds to specific projects.

5.4.2 There is a general realisation that maintenance of habitat diversity has been severely compromised through floodplain development

(DEST 1995, DUAP 1995a, b, Hawkins 1995, Middleton et al 1985, Mobbs 1996, Nuttall 1987, Pressey and Griffith 1992, Dept. Water Resources 1994, RAC 1993, Tweed Shire Council 1994)

Maintenance of habitat diversity including water quality has been severely compromised through floodplain development. Whilst there is considerable support throughout the community for maintenance of biological diversity to maintain ecosystem functions and to conserve the natural biota, there has been poor use of existing policies and knowledge of ecosystem component functions in management decisions, and poor monitoring of development impacts. In some cases deficiencies in existing regulations have resulted in damage to natural systems. Whilst special reserves and parks have been set aside and are protected, the larger areas under private control have been largely left unprotected from development proposals. State Environment Planning Policies (SEPP's) have often been ineffective against specific developments (e.g. road maintenance and construction activities).

If population growth is not properly managed, the special environmental resources and attributes of the coastal regions will be de6graded. The south coast region has limited areas where population expansion can occur without destroying the features which attract people. "*It is the cumulative effect of fragmentation of the coastal lands by a large number of small developments and inappropriate management of the various natural resources that pose the greatest threat to the region's assets.*" (DUAPP 1995b). Clearing for housing and infrastructure, introduction of exotic plant and animal species, intensive recreational use, all create degradation of the environment. In addition, sewage, waste disposal and water supplies are insufficient to cope with the extra population pressures, and pollution of the waterways is occurring.

In the north coast alienation of agricultural lands will reduce options for agricultural development and may lead to an unviable sugar industry. In common with many other coastal areas, competition for land brought about by population increase, is leading to loss of good quality agricultural land to urban, tourist and industrial development. This may lead to reduced capacity to supply mills and ultimately affect efficiencies and viability of mills.

These issues exist against a background in which there has been and largely still is a lack of overall vision for the regions. Consequently Government, Local Government and the community do not have guiding objectives against which planning and development decisions can be measured. For example, there are no specific objectives about estuarine habitat which will ensure that some minimum areas are retained in areas which are known to be functionally effective. Until there are common objectives, local government and the various government agencies cannot be efficiently coordinated.

Environmental impact assessments are required before approval is given for developments which are likely to affect the environment. It is claimed there is very little follow up to ascertain whether predictions or guarantees made about environmental impacts made at the approval stage, are borne out. In addition to this the lack of strategic overview or broad vision and environmental objectives means that developments are considered in isolation to one another. As a result, cumulative impacts of proposals are often missed.

5.4.3 Planning and management decisions by government and local government could be improved by more use of full economic analysis including market and non-market aspects of natural systems

(Middleton et al 1985)

There is a paucity of full economic analysis including market and non-market aspects of natural systems in planning and management decisions by government and local government. Consequently environmental aspects such as habitat diversity and water quality have been seriously under emphasised when aspects such as public benefits have been considered in decisions on development proposals and regional planning generally. The values of riparian zone vegetation, wetlands, water flows, fauna habitat (including aquatic fauna) have seldom been taken into account. Consequently long term costs and benefits of proposals have often been down played in favour of immediate market benefits and political expediency. Whilst there are limited studies and data on non-market values of natural resource components, this situation will continue to exist. Community attitudes are clearly in favour of taking into account values of natural systems.

A specific example relates to the management of drains and floodgates. The lack of information on the benefits and costs of floodplain mitigation structures across the various stakeholders, including the environment, is limiting objective discussion and decisions on management options to address issues such as floodgate barriers to fish and water movement, water flow to wetlands, acid sulfate drainage, riparian zone rehabilitation, water use allocations etc. Development of options and government policies to support options is limited by the lack of objective information on the costs and benefits and who bears / shares them. Non-market values need to be incorporated into these analyses. Middleton et al

indicated that although there had been attempts to value attributes of wetlands, there are conflicts about the methods.

5.4.4 Communication of information on programs and legislation across stakeholders is large, not coordinated, and complex (numerous bodies responsible, uncoordinated activities usually not on a catchment basis)

There is a large amount of information on resource management for the coastal catchments and estuaries of NSW. Information on issues has been identified and collated in numerous planning activities across government agencies and programs. In several cases these activities have been part of the development of strategic plans to address increased population growth, water use planning for the future, or development of estuary management plans to address specific issues.

Much of the planning has occurred through programs of a range of government agencies, and to some extent Local Government, often with limited coordination or integration across programs. Many of the industry, community and Local Government stakeholders in the coastal catchments are not aware of the range of information, or do not understand how it relates, and have limited understanding of the implications for their activities. Those stakeholders that do have an understanding are generally representatives of groups involved with Government programs such as Total Catchment Management, or Estuary Management. However, even these representatives have difficulty dealing with the amount of information. Some of the difficulty is due to the form in which the information is presented, or the lack of context for the users. It became apparent during the consultations that some technical people within Government and Local Government also had limited knowledge of much of the information. These problems are due in part to the sheer volume of information, but also to the type and format, the lack of targeting of 'clients', and the poor promotion of much of the information. In some programs it is obvious that there has been planning associated with the communication, at least in terms of community groups who are involved in the program. The current 'Water for the Future' program coordinated through the Department of Land and Water Conservation is an example. However, in their case, many of the technical groups in Government (State and Commonwealth), appear not to be well informed. A good example of a focused communication program is that associated with the NSW Acid Sulfate Soil Management Program. This program has a communication officer who acts as a key link for those involved in or interested in the ASSM program.

5.4.5 Rural-urban conflicts are increasing through urban encroachment into traditional farming lands

(DUAP1995a,b, consultations)

In parts of the coast where urban encroachment has occurred into agricultural areas, conflicts have arisen because of impacts on the urban community as well as on the farming community. It is recognised that intensive agriculture such as sugar cane production generates noise, dust, odours, and perceived safety hazards which impact adversely on urban community if it is too close. In addition urban communities can create problems for farmers through uncontrolled run off, vandalism, theft or interference with machinery, crop damage, fire etc.

In some areas, there is concern that rural urban conflict is leading to significant restrictions on rural enterprises. e.g. restrictions on the use of tractors and stock management practices to reduce noise and dust nuisance to urban dwellers. Farmers see urban encroachment and changed community values creating unreasonable disruption and constraints to their rights to carry on normal rural enterprise operations. Some councils are placing restrictions on farming operations in response to this conflict.

The social division in the population of some coastal areas is making it very difficult for programs reliant on group processes for delivery of natural resource management outcomes. e.g. (landcare programs). The changed community values resulting from new residents with different backgrounds moving into the region has resulted in conflict between them and the existing rural communities. The social division can be quite severe. e.g. forestry workers and conservation minded groups. The traditional rural groups see their lifestyle and livelihood threatened, and their values criticised and sometimes attacked. Natural resource management programs such as those delivered through landcare programs, and Total Catchment Management programs are extremely difficult to develop under these circumstances, and considerable efforts are required in conflict resolution.

The level of conflict and the national focus on some of the issues has enhanced concerns in the rural/agricultural community that government interference will result in loss of local control of decisions on land use practices. Rural groups are conscious of recent government policies and constraints on land use without sufficient (any) community consultation. The decisions have impacted in some cases on the agricultural enterprises.

5.4.6. The cane industry requires full time staff to represent industry interests in regional planning and catchment management activities

The sugar industry, one of the largest industries in the north coast, has made valuable contributions to regional planning activities through their executives attending the large number of planning meetings and workshops held to address issues to do with catchment land and water quality, regional development, estuary management, conservation planning, water supplies and environmental standards. It is very difficult for the industry to participate fully in all of the meetings since executives and representatives are generally full time farmers and become over committed. There appears to be a need for full time positions to

provide a first point of contact for external agencies and for industry input to regional and industry planning. The complexity of environmental management issues, and the need for constant demands for industry involvement in the range of issues require that representatives are fully informed in the matters being dealt with on a regional and catchment basis, as well as on matters to do with new regulations.

6. PROGRAMS AND PROJECTS

A number of programs and projects relevant to floodplain and estuary management were identified through searches of databases, program reports and contact with agency staff. These are listed in Appendix 3. Another source of information on projects was the technical report 'Environmental research related to Total Catchment Management – Universities and CSIRO', commissioned by the Hawkesbury-Nepean Catchment Management Trust . Many of the projects identified in the Hawkesbury-Nepean report are current or very recent. In addition the NSW SOE report provides brief details of government programs which are addressing many of the issues identified in the report.

The projects in Appendix 3 are either current or have been completed within the last 3 years. They were sorted into categories which reflect those identified in the section on current issues for environmental management, to ascertain whether there are any significant gaps in the issues being addressed. There are projects addressing some of the issues in one way or another. Some projects being carried out in other states or regions, have direct implications for management in NSW coastal areas.

6.1 WATER QUALITY PROJECTS

The eutrophication studies being undertaken within CSIRO and the National program coordinated by LWRRDC are likely to have reasonably direct relevance to the NSW floodplains and estuaries. However other studies such as those on nutrient movement out of the Johnstone river catchment (NQ) under various forms of land use, have indirect relevance. Certainly the approach and methods are likely to be of relevance elsewhere. The information on processes may have some relevance, but differences in climate, soils and land use are likely to mean that only general principles are directly relevant.

There is no statewide program for water quality monitoring in streams and estuaries, however there is a current statewide program for developing water quality and environmental objectives for the main catchments. Projects in water quality standards for fish and aquatic flora are lacking. There are several projects looking at environmental flow requirements and research into environmental indicators for river health, and in pesticide impacts on riverine biota.

There are several projects aimed at restoring estuarine and wetland habitats. There are few communication / education / awareness projects. The water for the future program has an associated communication activities, and the ASSM program has a good communication thrust.

Dairy effluent management has ongoing projects and in fact a specific project for advisory service. There are several projects on nutrient management on agricultural land and dairy effluent management on the Hawkesbury - Nepean catchment.

Hydrogeomorphic impacts or biological impacts of extractive industries are being assessed on the Nepean river, Double Swamp Creek (Grafton), and the Bellingen, Boyd, Macleay and Gwydir rivers. However, impacts of dredging on biological systems do not appear to be being looked at, although there are dredging activities associated with some of the estuary management projects.

There is one project looking at sediment sources in Newcastle harbour. Wetland and floodplains sedimentation rates have been surveyed for the Hawkesbury-Nepean, Macdonald and Colo rivers. Sedimentology studies have been carried out as part of the north coast estuary management program. However these have not covered the sediment dynamics in terms of processes and sediment sources and sink from the fluvial reaches to the lower estuaries.

Studies on groundwater processes have been carried out in a few projects such as the Lake Ainsworth Management Plan and the Belongil Estuary Management Plan.

6.2 Land Management

There is a number of projects in the management of ASS, but few are looking directly at the issues identified. The ASSMAC strategic plan has proposed some which do address the issues.

There are no projects looking at integrated weed management control to reduce the reliance of cane farmers on herbicides, nor on grazing value of pastures for wetlands.

There are projects looking at land use impacts on a catchment scale, but there are few activities where the management is being implemented on an integrated basis. The AEAM study on the Tuggerah lakes is one such project. Broad activities of the water authorities in several catchments and regions are attempting to implement an integrated approach. There are few case studies being promoted widely to local government, although there have been studies funded through Commonwealth programs in this general aspect. There appear to be no specific studies on structures and processes to achieve integrated management. The outcomes from the AACM / UNE project on effectiveness of ICM, carried out for the DPIE have still not been released. A review is underway on the TCM program in NSW.

There are some projects listed on economic analysis in natural resource management, apart from those underway in the National Dryland Salinity Program. The Wollondilly study was developed as a case study for riparian zone management decisions.

In summary whilst some of the issues are being addressed, most of the issues listed are not being directly or wholly addressed in current projects or programs.

7. CONCLUSIONS

Since the floodplains and estuaries along the New South Wales coast remain focal points for commerce, population growth and recreation industries, the natural resources have come under much increased pressure from urban, tourist, industrial and agricultural development in recent years. The result has been degradation and sometimes the loss of these resources. Improved management of the natural resources of the floodplains is essential if development is to be sustained. In this regard a number of the technical, social and economic issues identified in this report need to be addressed. The following aspects are not an exhaustive list, but are those which should be recognised, and in some cases considered by the R&D Corporations for further action. Recommendations are provided where it seems appropriate with respect to the Corporations.

7.1 DEGRADATION OF WATER, RIPARIAN ZONE AND FISH HABITAT

There is ample evidence of degradation of water quality through sediments nutrients and other chemicals in urban and rural runoff. The pollution from urban and industrial storm runoff is not getting the same attention as the water and sewage waste from urban areas, and in the long run could be just as significant as degrading agents for the rivers and estuaries. Riparian zone degradation is thought to contribute sediment and nutrients to streams. Sediment, nutrients and chemicals from agricultural areas also contribute to water degradation and pose management challenges for rural industries. The other highly significant source of degradation is acid drainage from the cane, grazing, and teatree industries located on ASS. There are concerns also about loss of biological diversity and habitat corridors. The major impacts of water degradation are on the riverine and estuarine ecosystems, and loss of fish habitat is seen as one of the most serious issues.

In general there are very poor data on:

- water quality of streams and estuaries,
- urban and agricultural runoff water quality,
- changes to hydrology through urban and rural development,
- riparian zone condition
- impacts of degraded water on fish and seagrass

Whilst there are important knowledge gaps, causes of these degradation issues are sufficiently well understood to achieve better water quality and riparian zone condition with application of current best practices. *However, there is still uncertainty about whether or not the application of current best management practices are long term solutions to the problems.*

7.2 Eutrophication Processes

Eutrophication of coastal streams and estuaries is not a widespread issue in coastal NSW, but could become very important with increased development. Management is difficult because of poor understanding of processes controlling it. Since population pressures are expected to increase substantially, this is an extremely important area requiring research. There is considerable focus on the identification of eutrophication processes nationally, particularly through the CSIRO Division of Fisheries and the Division of Water Resources and the LWRRDC national program. On the assumption that these programs will continue to be supported, no recommendation is made. The education and awareness of factors which are seen to contribute to eutrophication are being addressed already through other programs such as the Algal Management Strategy and the Estuary Management Program. The effectiveness of these programs in reducing eutrophication was not assessed.

7.3 Sedimentation of Rivers and Estuaries

Sedimentation has impacted on fish habitat and navigation. Dredging can be used to remove sediment, but there are impacts on seagrass through re-suspension of fine sediments. It is contended that insufficient monitoring has occurred following dredging to gain better knowledge on the impacts in NSW rivers and estuaries. This concern was identified through consultation with industry and agency staff rather than through review of documents

There seems to be a considerable lack of knowledge about the sources and dynamics of sediment in the streams and estuaries. In many cases there is uncertainty that resources put into managing or preventing sedimentation are justified. Sedimentation itself is a major concern in some areas because of its biological impacts , but the erosion which may be leading to the sedimentation may also be of concern. There is a need to understand more clearly what the sedimentation dynamics are in the floodplains in order to make decisions about remedial options.

Recommendations:
That geomorphic studies using techniques which will assist in the identification of sediment sources and movement in the floodplain estuaries be implemented to provide a basis for decisions on management options.

That the LWRRDC and FRDC hold discussions with the Dept. of Land and Water Conservation and NSW Fisheries to ascertain the potential benefits from monitoring biological impacts after dredging, using some of the current dredging projects in the estuary management program.

7.4 WATER QUALITY

Knowledge of water quality in the streams is grossly inadequate for management of this common resource. State programs to develop water flow and quality objectives will take some time. Once objectives have been agreed to for each of the catchments, monitoring programs will be required. Opportunities will occur to develop a collaborative government-local government industry-community approach to monitoring. One of the deficiencies seems to be water quality standards for fish and other aquatic biota. There will need to be some cognisance of this fact when objectives are being developed.

7.5 FISH HABITATS

Floodgate management impacts on water quality, and fish habitat availability. These are a major source of conflict between fishers, biologist and farmers. Some progress is being made through several pilot projects to attain some experience in increasing (or re-introducing) tidal flows to streams and drains. Some of the comments about the Roberts creek project indicates that there is a lack of coordination among the various groups involved. The solutions to achieving improved fish habitat are as much social as technical. As a result of recent experience in restoration methods, and investigations into the number of physical barriers and water quality barriers to fish movement, there are several fish habitat restoration projects underway and planned for parts of major estuaries on the coast. Some of the conclusions and recommendations on issues raised below have a bearing on these projects.

Recommendation:
That current and proposed projects assessing the impacts of altered floodgate management, and the removal of physical barriers be reviewed with the objective of identifying opportunities for gaining better understanding of the hydrologic processes affected and their significance for fish habitat.

7.6 HYDROLOGIC/GROUNDWATER/ WATER BALANCE PROCESSES

Knowledge of hydrology, groundwater and water balance processes in the major landscape units of the floodplains is required for assessment of management options in agriculture. This knowledge is essential for assessing factors such as acid production risk, drainage and surface water management practices, impacts of rehabilitation practices, management decisions on groundwater usage, and negotiation of environmental flows in streams. Water balance information under forests, pastures and crops such as sugar cane is required. At the very least, the interactions of surface hydrology, groundwater and land use are needed at the paddock type scale. Ideally knowledge of the processes at a catchment scale would allow assessment of activities in one part of a catchment on another.

Lack of this information is limiting the assessment of development proposals as well as inhibiting the development and extension of practices to limit acid drainage.

Recommendation:
That a core group of scientists and engineers with experience in hydrologic/groundwater /water balance studies, be commissioned to develop projects which will allow objective assessment of the hydrologic impacts of land management options for agriculture. This may involve key sites across major landscape units in conjunction with demonstration sites for best management practices.

7.7 Groundwater Processes in Sand Dunes

Apart from a couple of studies on the north coast in the Estuary Management Program, there is little work on groundwater processes and management for the dunes. Management of groundwater has not been identified as a specific issue to date in the main estuaries, but this may be due to the general focus of the Estuary Management Plans. Since the groundwater of sand dunes is likely to be extremely important in ecosystem function of the estuaries, it seems important that the current knowledge of these systems be collated and assessed, and that the planning authorities be made aware of constraints to water use and land use practices to avoid degradation of the resource.

Recommendation:
That the knowledge of groundwater systems in the barrier and other dunes of the major estuaries be reviewed to identify:

- ***knowledge gaps in the dynamics and role of groundwater for ecosystem functions***
- ***the condition of the resource (quality and quantity)***
- ***constraints to land and water use to avoid degradation of the groundwater resource and dependent ecosystems.***

7.8 Effluent Management

The feedback from a few dairy farmers is that effluent management systems are not being implemented at the rate desired, and that in some areas, farmers are concerned that the technology is not appropriate, or is not understood. Since there is a program in place to address effluent management systems for dairy farmers, some review of its effectiveness may be warranted.

Recommendation:
That the DRDC review the effectiveness of the advisory services to dairy farmers on effluent management systems.

7.9 ASS Mapping

There is a clear need for more detailed mapping of ASS for farm management and for assessment of development proposals. The latter are generally required as part of the EIA process. However there is no such requirement on agricultural land, where practices can lead to acid drainage. A current project is assessing the distribution of ASS on sugarcane farms in the NSW sugar belt. More detailed investigation is in progress for other areas along the coast.

Conventional resource mapping techniques are costly, and there is a need to identify alternative methods for identification of ASS distribution. Remote sensing, use of surrogate indicators, rapid field identification techniques and knowledge based systems are being pursued as possible alternatives. However any such techniques will require considerable development and a clear statement of the levels of confidence (reliability) on the identification. The demand for better mapping and the need for other techniques needs to be debated with client groups to ascertain a clearer picture of the demand. The ASSMAC strategic plan has identified more detailed identification of ASS as a priority.

Recommendation:
That the Corporations liaise with the ASSMAC Technical Committee to review techniques and priorities for future research.

7.10 TECHNIQUES FOR ASSESSING ASS HAZARD ARE INADEQUATE

Since there is considerable dispute on the appropriateness of ASS assessment techniques, an independent review is needed to review the ASS assessment protocol in terms of its suitability for all land use planning and management situations, and variations in ASS around Australia. The thrust of the review should be to ensure that appropriate techniques are available to assess management approaches for ASS. It is anticipated that the forthcoming conference on ASS in September will provide some direction on this issue, and this should be taken into account in any review.

Recommendation:
That the SCARM National Acid Sulfate Soils Working Party be requested to undertake an independent technical review of ASS hazard assessment and to formulate appropriate national standards.

7.11 MANAGEMENT TECHNIQUES IN THE DEVELOPMENT AND CONSTRUCTION INDUSTRIES

Financially, this seems to be the most significant current ASS issue, with at least several billion dollars of potential development projects currently constrained by regulators &/or substantial cost impositions. The environmental implications of ASS for large development projects are being assessed on information about ASS acidification processes, mostly extrapolated from agricultural observations which may not be appropriate for this purpose. Research is needed to develop and test appropriate, cost-efficient and environmentally benign ASS management and remediation techniques. This work should be driven by industry and resource management stakeholders to ensure that commercially feasible and realistic (not solely based on laboratory simulations) techniques are assessed. Since this topic is also likely to be a focus of part of the ASS conference in September, the options for R&D should be re-assessed following the conference.

Recommendation:
That following the ASS conference in September, the Land & Water Resources R&D Corporation review the need for further research on ASS management techniques with the SCARM Working Party.

7.12 Subsidence of ASS

There are some long term concerns about the sustainability of farming the ASS where shrinkage and subsidence are occurring. Risks of continuing subsidence and resultant environmental impacts need to be assessed, and taken into account in long term planning.

Recommendation:
That a risk analysis be commissioned by the Corporations to assess the likely environmental consequences of continuing to farm ASS where subsidence is occurring.

7.13 Riparian Zones

The values of riparian zones need to be promoted. This might be strengthened by economic analysis of the benefits using some case studies. Methods for assessing riparian zone condition are available, and information such as guidelines on riparian zone rehabilitation and management should be promoted strongly.

Recommendation:
That case studies on the benefit/costs of rehabilitation of riparian zone be initiated by the Land and Water Resources R&D Corporation.

7.14 Floodplain Systems

Several of the reviews and reports emphasise that knowledge of processes and dependencies in floodplain systems as a whole is very limited. Insufficient knowledge of the geomorphic and hydrologic processes in large floodplain river systems is inhibiting the development of sustainable land use management decisions. The inter-dependencies of geomorphic processes and ecosystem processes and the relative impacts of activities in the various parts of catchments of large floodplain catchments such as those in coastal NSW is not well understood. There are three differing paradigms on how they operate:

- outcomes in the floodplains and estuaries are highly dependent on activities in the upper parts of the catchment
- outcomes in the floodplain areas are largely determined by the interaction of the various systems operating in the floodplain and immediate areas.
- outcomes in the floodplains are determined more by the immediate riparian zone and river management activities.

Since there is no clear understanding of which of these paradigms is dominant in the river systems, the decisions on land and water management are not well based, and tend to ignore the fundamental processes which might be determining the long term results of natural forces.

Some research scientists question management objectives on the basis that there is no confidence that outcomes really make any difference to the long term effect. I.e. reducing sediment in rivers by say 50% may have little real impact on the habitat. There is no objective information on what the threshold levels are. This challenge is not being met by any of the programs at this stage.

This topic needs further discussion across discipline groups and industry. I do not feel there is sufficient definition of the critical floodplain processes which need to be understood to have confidence in the natural resource management objectives and management practices which are currently being promoted. There is still no common model or integrating framework which allows stakeholders to confidently assess impacts of current or alternative land use.

Recommendation:
That a working party drawn from discipline groups involved in natural resource management and research, be commissioned to identify where the uncertainties lie in understanding of coastal floodplain ecosystems as a whole, and what significance this has on ESD in these geomorphic units. Such a working party might be asked as part of this task to review the utility of current models and integrating frameworks.

7.15 COMMUNICATION

General
Perhaps the most important conclusion from this project is that there is a large amount of information about environmental management of the floodplains and estuaries of NSW. Information covers the full range of aspects (technical, social, political/regulation, limited economic), and is in the form of comprehensive planning and technical reports, research journals, workshop reports, policy statements and program guidelines, newsletters, fact sheets. There is no shortage of information upon which better natural resource management decisions could be made. A major issue is that many of the people who need to be aware (and have ownership) of this information are not. Another issue is they are not able to access it readily or make use of it in its present form. Information overload is part of the story. As was pointed out by one clear thinker "unless people know firstly that there is a problem, they are unlikely to realise that certain information should be important to them".

There is a major need to improve the communication of information needed by stakeholders for natural resource management. This is likely to require:

- analysis of existing programs and processes.
- better definition of target groups and their needs.
- identification of preferred ways of receiving and giving information.
- assessment of communication channels across the groups.
- identification of appropriate products or systems with each group (keep it simple).
- identification of ways to influence those who supply information.
- training for specific communication systems.
- development of easily used information systems.

One of the outcomes of such an analysis should be identification of the sorts of information required by particular stakeholders, and an indication of the appropriateness of existing information 'products'. This should help address the often raised issue that information is not in the form where it can be used or appreciated. It should also identify where more use needs to be made of group communication methods and promotion or training. For example, hard copy guidelines for surface drainage or piezometer installation may need to be supported by demonstrations, video presentations, or group discussions at key locations.

There is widespread evidence of degradation of water quality, aquatic and land habitats through resource use associated with urban, infrastructure and agricultural development of the floodplains and estuaries of NSW. These issues are unlikely to dissipate since the development pressures on coastal resources are considerable. Nutrients, sediments and chemicals in urban and industrial runoff are causing particular concern near population centres, and monitoring programs are inadequate to identify where the problems exist and their rates of change. Whilst some community groups may be aware of some of these issues, few have a good understanding of the full range of degradation issues and their significance.

Part of the solution to degradation is education of the community, and this needs to be incorporated into any communication program.

ASS

There was clear indication that some farmers do not believe that the acid drainage from farm land is a major issue for them. It has very little impact on them directly, and many (most) are not fully appreciative of the environmental damage done. All would be aware of the periodic fish kills, but some (many?) are not aware of the less obvious effects on water quality and its resultant effects, such as the precipitates which coat river flora, and the chronic impacts on fish and other fauna. It will be very difficult to get farmers to change water and land management practices until they believe that a problem exists, that they have a role in managing it, or they see production benefits from changing water management.

Acid drainage into estuaries is a chronic problem which is unlikely to be addressed in the short term. It requires collaborative development of solutions across stakeholders, with government and industry ensuring that the appropriate technical information is available. During this project, It became evident that farmers do not have a wide knowledge of the research and development outcomes and current conclusions from work on ASS management. The promotion of guidelines for surface leveling and drainage design by the sugar industry and the communication activities of the ASSMAC needs to be strengthened to ensure that all farmers are exposed to the latest conclusions and recommended practices. Implications for acid drainage need to be more widely discussed in this activity.

There is highly credible information available on the effects of acid drainage, the conditions under which it occurs, and some of the practices which can be taken to alleviate the impacts. Any program aimed at promoting a much better awareness of ASS management problems will require careful attention to process and should be initiated by the sugar industry in the north, and the dairy industry in the south. Skills in conflict resolution would probably be useful, particularly as those with expert information on acid sulfate soil processes and impacts in the environment, may be seen to be antagonistic to farmers.

It was suggested that many farmers with ASS are not receiving the ASSAY newsletter, a major vehicle for communication of acid sulfate management information. Government and Industry support personnel could assist by ensuring that farmers who should be, are on the distribution list for ASSAY.

Recommendations:
That the Corporations consider negotiating with stakeholders in one of the regions such as the north coast region, a thorough analysis of the communication requirements for integrated natural resource management, and the development of appropriate strategies to meet the needs identified. Stakeholders would include Catchment Management Committees, Local Government, industries and government agencies.

That the sugar industry enhance its current communication activities with a focus on informing cane farmers about the factors involved in producing acid drainage, the current knowledge about the off site impacts of the acid waters, the management options which have been proposed and the basis for them, and where technical assistance can be sought. Such activities should involve R&D personnel who have expert knowledge in the various aspects of ASS and their management.

That the sugar industry consider funding low cost 'best practice' demonstration studies where outcomes such as yield, acid drainage, groundwater levels and costs are monitored and reported to cane farmers.

7.16 Structures and Processes

There are deficiencies in the current programs and structures which are attempting to address the specific natural resource management issues in the regions. There are a large number of groups with responsibilities in this area, and each has its own set of objectives and processes. The TCM program which is the forum provided by government for coordinating activities to address these natural resource management issues appears to lack authority, skills and processes to handle the contentious and complex issues involved. There appear to be deficiencies in the linkages between CMC's and Local Government. Whilst in some cases there are good working relations, in general the Councils do not seem to be reflecting the natural resource management priorities or strategies in their planning and management. Much closer ties should be made with local government who already have the structures and processes, and in many cases authority for implementation of management plans. Local Government councils are already closely involved in estuary management programs which should be more closely linked to whole catchment planning. The community participation processes which are inherent in whole catchment management (TCM) and the estuary management programs would make a useful contribution to the local government processes in which, community participation is generally weak. The current SOE reporting by local government could provide a key linking point between CMC's and local government.

There are also deficiencies in the way government agencies support the CMC's in developing their catchment plans, and take account of the priorities identified by the CMC's. Again, this is a generalisation and there are examples where CMC's and some agencies work very well together. Identification of common visions and objectives are required at the very least, if the major players are to achieve integrated natural resource management outcomes.

One of the advantages that The Catchment Management Trusts have is a structure and authority to allow them to ensure that integrated approaches to resource management are implemented.

Whilst many catchment groups may have some skills in strategic planning, the underlying processes which make strategic planning a powerful tool do not seem to be commonly used. Strategies are being developed with little rigour put into assessing the opportunities and constraints associated with achieving them. In addition there is little real attempt made to assess the spatial impacts of strategies, an essential requirement if credible benefit/costs are to be evaluated. CMC's need to be supported better to allow them to achieve better planning and assessment of strategies.

Government, including local government has a major role in facilitating (not running) stakeholder participation processes and providing technical support in aspects such as those outlined above.

7.17 Full Economic Analyses

A major thrust in achieving natural resource management objectives has been through regulation, and there is a raft of policies and regulations in NSW which relate to river, estuary, fish habitat, wetlands and riparian zone management. However it seems that in resource management as in other aspects of social behaviour, 'laws are a blunt instrument', and seldom achieve desired behavioural outcomes on their own. Recent analyses of the constraints to achieving 'on-ground implementation' of preferred management options have promoted the principle of offering incentives and cost sharing arrangements to resource managers such as farmers and fishers. This can take a number of forms, and stakeholders should be involved in negotiations to identify those which are most appropriate to their situations.

Practices such as liming of ASS, accurate surface drainage designs, the capture of surface elevation data for rehabilitation of riparian zones and wetlands all lend themselves to incentives and cost sharing arrangements.

However a major deficiency in assessing the merit of resource management options is the lack of comprehensive economic analysis. Objectivity in decisions on priorities and who should bear the costs has suffered. The level of rigour associated with full economic analysis ensures that ***all*** of the benefits and costs, and those who bear and share them are identified. The degree of public benefit from improved resource management is probably being under-rated, and consequently opportunities for encouraging individuals and groups to address issues are being overlooked. Comprehensive economic analysis of management options is a key requirement in decision making and should be looked upon as being every bit as important as the natural resource information. Unfortunately, natural resource economists are few and far between in Australian government agencies and probably even scarcer in local government. However there are skills and approaches available and being used in various programs in natural resource management programs in Australia, although in some areas such as valuation of wetlands and conservation areas, the methods and experience are still at an early stage of development.

Application of these approaches needs to be driven by stakeholders. TCM groups in particular should be demanding the services of natural resource economists to assess many of the management options they have developed or are considering to develop. There has been a tendency among many involved in natural resource management to want to 'fix' the problems, rather than manage it. Thorough economic analysis of some issues can lead to the decision that the benefits of fixing some issue are far outweighed by the costs, and that strategies which allow us to live with the issue are far more sensible. The use by the Wollondilly Shire of economic analysis to assist in decisions on riparian zone widths in their planning could be used as a case study for promotion and discussion of economic analyses in natural resource management by local government and catchment groups.

There are several projects under way and proposed for rehabilitation of wetlands which involve modification to structures to manipulate water flows or watertable heights. One of the constraints identified at some sites is the difficulty in acquiring elevation data at a fine enough detail to confidently predict the outcomes of some of the proposed actions. Another

constraint is the cost of design of the overall plan which may involve detailed hydrologic modelling by consultants. Where these activities are occurring on private land, there could be justification of subsidisation by government or industry, or some other incentive to reduce the costs to the private landholder. A constraint to the negotiation of cost sharing arrangements or incentives is the lack of information on likely benefits. Where public benefit can be identified cost sharing arrangements or other incentives may be able to be negotiated. A condition of any arrangements might be the monitoring of appropriate indicators to assess the objectives of the rehabilitation activities.

Recommendation:
That economic analyses be carried out on a number of rehabilitation projects as case studies to ascertain the degree of public and private benefits associated with the outcomes, and to assess the degree of public input which can be justified for the projects.

7.18 Integrating Framework or Decision Support Systems

An associated deficiency to lack of economic evaluation is the lack of an integrating framework for assessing the impacts of management options. Community stakeholders are highly unlikely to have the capabilities to develop such frameworks and decision support systems. There are a number of examples of support systems being used in Australia, and one mentioned previously is that developed out of the AEAM project of the Tuggerah Lakes and catchment. Promotion of these sorts of developments seems to be needed to expose other local government and TCM groups to their capabilities and utility in resource management decisions. The level of integration and analysis involved through the use of some of these tools is far beyond that which councilors and committee representatives would be able to reach using the tools and time currently available to most of them.

Recommendation:
That the Wyong Shire Council AEAM study on the Tuggerah lakes and catchment be promoted as a case study among other local governments and catchment management committees with the view of indicating the role and benefits from using a decision support tool based on an integrated catchment management approach .

7.19 Coordination

It was not possible in the time frame of this project to objectively evaluate issues related to coordination of activities related to natural resource management in the floodplains. Nevertheless some useful observations were made.

The TCM program through the catchment and research program coordinators is providing some level of coordination across the various programs and groups involved in natural resource management. Certainly a network exists across the government agencies and catchment management committees. There is some evidence that the TCM program and catchment committee activities are not well understood by groups of farmers and probably some urban community groups. A good example of regional coordination was the identification by the combined group of catchment management chairpersons and coordinators of priority projects for the north coast region. This list was promoted as a guide for selection of projects for NLP and TCM funding.

There were indications that coordination across government agencies is still lacking in terms of efficiencies and integration of efforts and outcomes. Recent amalgamation of Public Works, Water Resources and CALM provides some better opportunities for coordination among their programs, but it appears there is no common set of objectives for catchments or regions at this stage. There appear to be weak linkages between the catchment management program and the estuary management program.

The current development of water flow and quality objectives for the major streams of NSW is the first real attempt at achieving coordination across agencies. The program is being lead by the EPA, with a large input from Land & Water Conservation. The Dept. of Urban Affairs and Planning has a major role in regional planning, and interacts closely with local government. However there is little evidence of real coordination between these groups and the other departments in terms of common programs.

The acid sulfate soil management (ASSM) program has not really functioned as a program yet. It has been a coordinating mechanism for government in assessing the management issues associated with ASS, and in assisting in communication across R&D agencies, technical support ,and regulatory agencies, local government and rural industry. The technical advisory committee has identified R&D priorities, and helped in the identification of management practices for agriculture and land development. The strategic plan recently submitted to government (Appendix 4) recommends a number of strategies for addressing the management of ASS. Some of these strategies are similar to those recommended in this report.

The recent Commonwealth initiative, Coastcare, a program similar to the national landcare program with a coastal focus, has not begun functioning properly yet. Facilitators employed for this program are to be supervised through the Dept. of Urban Affairs and Planning. It will be a challenge to get coordination between activities generated under this program with the current state estuary management and coastal management programs, the current TCM and landcare programs, the ASSM program, and the Commonwealth regional development and local government support programs. It would seem difficult for these programs to contribute efficiently to integrated natural resource management without some rationalisation of roles, structures or some other coordinating processes at the regional level.

In addition, coordination of programs across government and industry will remain difficult without some common agreed vision and objectives in the regions or catchments. Centrally developed and managed programs will not be effective in addressing the major issues without some well understood objectives against which activities can be judged. The proliferation of Commonwealth government programs has been a mixed blessing to local government and community groups. Each program has its own set of objectives and principles or guidelines to be met before funding submissions can be considered. At times this creates difficulties for local groups who have other specific objectives for their catchment or estuary or other natural resource issue. There seems to be a need for regional groups to be assisted substantially in seeking funds for their objectives, rather than modifying their objectives to meet those of particular programs. The current situation does not encourage catchment or regional groups to develop very clear strategic plans and business plans aimed specifically at their own objectives.

Effective coordination across natural resource management programs and component R&D programs is not a trivial matter, and it is likely to remain difficult as government agencies continue to restructure under ever changing political priorities. Identification of common visions and objectives is likely to do more for improving coordination than is restructuring. If the recommendation on development of a communication project is accepted (7.15), this aspect of defining visions and objectives will need to be incorporated.

7.20 General Comment

It is recognised that R&D Corporations have a number of criteria and principles against which project proposals are evaluated. At the risk of being trite, there are a number of aspects which the Corporations might consider giving some emphasis to, in decisions about funding proposals related to natural resource management of the floodplains.

- the extent to which objectives of the proposal align with priority issues identified by catchment management groups, Local Government or other regional structures. (Do these groups have a well defined set of objectives which are aimed at an integrated approach to natural resource management?)
- the explanation of how the outcomes of the proposal will be used, or integrated with other information, to address priority resource management issues. (Is there a model, decision support system or integrating framework into which the results can feed?)
- the degree of management by clients/stakeholders (Who drove the development of the proposal?)
- the extent to which communication of the outcomes is addressed. (Is there a rigorous communication strategy? How will it be assessed? Will it lead to a wider base of stakeholders or R&D groups having access to information or skills?)

This last point is particularly important in the current environment where Government provided technical support groups are shrinking, and a series of specialist centres (often with self interest as part of their culture) are competing with other smaller groups.

8. PHASE TWO OF THE PROJECT

8.1 AEAM PROJECT

In the project submission it was agreed that, as part of the first phase, the level of commitment to running a focus catchment project aimed at the development of management solutions to the priority resource management issues, would be gauged. The project was to be carried out using the Adaptive Environmental Assessment and Management (AEAM) approach.

Tuggerah Lakes AEAM project

In order to get a first hand appreciation of the benefits and experiences from running an AEAM study, the team responsible for implementing the AEAM study of the Tuggerah Lake and catchment were consulted for a day at Wyong. Dr. Rob Argent , one of our project team accompanied me, as did Alex Wells from FRDC, and Richard Price from LWRRDC. Points out of the discussions which are highly relevant to any decision on a second phase are:

- it is essential that the principal client(s) must be fully supportive of the project
- there must be sufficient time spent with stakeholder groups to allow them to become familiar with the detail of issues, and appropriate technical expertise must be on hand for the various types of dimensions (environmental/technical, social, economic, planning)
- up to a point, the quality of the outcomes are determined by the amount of funds allocated. The Tuggerah Lakes exercise cost around $240 000 over a 12 month period. The level of data available was probably as good as that for the Richmond River
- the decision support models developed are well focussed and can be used to answer policy and planning / management queries.

The Wyong Shire staff are very pleased with their investment, and are using the models and experience to make some very important decisions related to development proposals and long term environmental requirements.

Richmond catchment

The value of the AEAM project was discussed with many of those consulted, in particular those groups in the north coast from the Richmond, Tweed and Clarence catchments. A special meeting was held with the Richmond Catchment Management Committee executive, with follow up discussions with the Catchment Coordinator Wayne Garrard.

There was scepticism among some of the cane farmers about the value of such a project, partly because they felt there were still too many gaps in knowledge to develop management solutions to some issues, and partly because they felt that there was too large a time commitment required. The fishing industry people were interested in being involved in a project, particularly on the Richmond catchment. However the Richmond catchment executive were not willing to accept the offer of the AEAM project. They indicated they had already identified all of the issues and developed strategies for addressing them. They felt they would not benefit from a new approach, even though it was offered as a way of helping them develop their strategies further and as a means of identifying the relative impacts and importance of the strategies. From my questioning it became clear they did not have any way of assessing the probable outcomes of the strategies and had no objective way of assessing priorities.

Tuckean Swamp catchment

Discussions were held with the coordinator and one of the members of the project steering committee of the Tuckean Swamp Land & Water Management project about supporting them with an AEAM approach. The Tuckean catchment is a sub- catchment of the Richmond River.

The Tuckean Project involves the development of a land and water management plan for a degraded wetland of 8 500ha which is significant for its agriculture and its former wildlife and fisheries values. This area is one of two biggest contributors of acid drainage to the Richmond river. The issues to be addressed in the Tuckean are a microcosm of those identified in the review of coastal floodplain issues. The body responsible for the project is a steering committee answering to the Richmond River County Council. Significant progress has been made in identification of the condition of the natural resources, and considerable consultation has occurred with the farmer stakeholders in the catchment. An economic study of various aspects of the area ha been carried out. The project team is currently attempting to develop with the farmers, details of land and water management options. The government agency staff on the committee are hoping to be able to take some of the management options developed for Tuckean to other similar situations in the north coast. There is considerable uncertainty at the moment about the types of options which should be developed and recommended. There is no integrating framework within which the various options can be assessed. Following a field day in which a range of technical experts were exposed to the environmental issues of the Tuckean catchment, to discuss management options, it became apparent that several of the project team were hesitant about entering into an AEAM approach. As a result it was decided not to pursue the matter further.

8.2 WHERE TO FROM HERE?

The three options discussed with the Steering Committee were:

1. Pursue the discussions with other catchment committees to ascertain if there is any interest in implementing an AEAM approach to catchment planning and management. If it is clear that some worthwhile outcomes are achievable, then more details of the project can be developed as a second phase. A concern I have following the discussions with the Tuggerah project team, is that the costs to achieve a worthwhile outcome as per the original objectives, would exceed the funds budgeted to date for this project.
2. Take a case study approach and identify the best bet management options developed out of a number of current projects, and attempt to get some appreciation of the level of confidence in the effectiveness of them when implemented. This approach could identify some well focussed R&D needs. The projects which might lend themselves to this option are the Tuckean project, a low input wetlands rehabilitation project in the Seven Oaks (Macleay) area, a rehabilitation project about to commence on the Cudgen lake catchment near Kingscliffe, and one of the habitat rehabilitation projects such as Kooragang island or Rocky Mouth creek.
3. Develop a dialogue with one or more of the catchment committees and major stakeholders to ascertain what their interests and needs are to achieve improved environmental management in their catchments, and to use this as a basis for negotiating/developing support and projects which will enhance environmental management of the floodplains.

The project steering committee recommended developing the third option. Preliminary discussions have been held to give some guidance in the strategies which might be included in developing this third option. The catchment which has been recommended by the local government managers responsible for the catchment management committees is the Clarence. This fits the original criteria outlined in the project. It is less advanced in planning than the Richmond catchment, and this may turn out to be an advantage in terms of developing a working relationship.

Recommendation:
That the Corporations develop a second phase to this project which involves:

- ***negotiating the implementation of priority projects out of the above recommendations with the Clarence Catchment Management Committee (CMC)***
- ***facilitating implementation of priority actions identified by the CMC planning.***

Appendix 1

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Appendix 2

Individuals and Groups Consulted

Who?	When?	Where/how?
Acid Sulfate Soils Management Advisory Committee	14-12 -95	Wollongbar
Richard Hagley, DLWC	14-12-95	Lismore
Steve Jensen, DLWC	9-1-96 plus phone calls	Byron Bay
Assorted Sugar, ASSMAC and Government Group Alan Munro, SRDC John Williams, NSW Agric Tony Hayes, NSW Sugar Coop Peter Neilsen, NSW Sugar Coop Don Parsons, NSW Sugar Coop Des Schroder, DLWC Ian White, CSIRO Ted Gardner, QDNR George Rayment, QDNR	14-12-95	Broadwater Mill
Phil March, CFAC	several	phone
Bob Smith Consultant	4-1-96	phone
Tweed Sugar Industry Group Robert Hawken Graham Martin Tony Hayes Robert Quirk	8-1-95	Condong
Clarence Sugar Industry Representatives Vince Castle Neil Gregor Alan Munro Andrew Baker Alistair McFarlane	9-1-96	Maclean
Steve Jensen, DLWC	9-1-96	Byron Bay

Who?	When?	Where/how?
Richmond Sugar Group Jim Sneesby Russell Bailey Bert Plenkovitch Jim Simmons	10-1-96	Wardell
David Pensini Hastings Council Environment Officer	17-1-96	phone
Mal Imrie, DUAPP Ballina	17-1-96	phone
Ken Markwell, Fishing retailer		Chinderah
William Hawkins, DLWC	31-1-96	Parramatta
Lois Gray, DUAPP Sydney	31-1-96	Sydney
Garrett Barry, DUAPP Bega	31-1-96	Sydney
Jim Bodicott, DLWC Sydney	31-1-96	Sydney
Fishing Industry Workshop Phil March, CFAC Duncan Leadbitter, Ocean Watch Bruce Coates, DLWC Kathy Ridge, DLWC Tony Battaglene, ABARE Grant Johnson, DPIE Stephen Tapsall, QCFO Michael Mobbs, Consultant John Gallagher, Fisher Rob Williams, NSW Fisheries Craig Copeland, NSW Fisheries Peter Helman, Consultant Peter Schaeffer, RAC 2 Jerry Sansom, USA Barrie Heyen, Ocean Watch David Anderton, DLWC Joe McLeod , QCFO	2-2-96	Ballina
Kevin Roberts, DLWC Sydney	6-2-96	phone
Col Griffith, NSW Agric	6-2-96	phone

Who?	When?	Where/how?
Grant Johnson, DPIE	7-2-96	Canberra
Margaret Tailby, DEST	7-2-96	Canberra
Mike Blacklock, NSW Agric Nowra	21-2-96	phone
Lawrie Kirk, DLWC Sydney	21-2-96	phone
Fiona Conroy, DIRDC	21-2-96	phone
John Wilson, farmer Kiama	21-2-96	phone
Gold Coast City Council Richard Whitlow Peter Joy Zoe Murrell Haydn Betts	22-2-96	Nerang
Jane Lofthouse,Tweed Shire		phone
Richmond Catchment Committee Executive David Lovell Wayne Garrard Jeff Spash Bob Jarman Russell Bailey Craig Copeland Richard Hagley	23-2-96	Lismore
Craig Copeland, NSW Fisheries	7-3-96	Alstonville
Don McPhee, DLWC Bega		phone
Stuart Bunn, Griffith Uni	11-3-96	Brisbane
Coastal Management Issues Rob Williams, NSW Fisheries Bruce Coates ,DLWC Klaus Koop, EPA	13-3-96	Sydney

Who?	When?	Where/how?
Tuggerah Lakes Study Brian Bell, Wyong Shire Alistair Gilmour, Macquarie Uni Greg Walkerden, Macquarie Uni Alex Wells, FRDC Richard Price, LWRRDC	20-3-96	Wyong
Wayne Garrard, DLWC	22-03-96	Wollongbar
Dairy Discussion Group with Bob Smith	28-3-96	Lismore
Ian Poiner, CSIRO	29-3-96	phone
Mike Hughes, NSW Agric	9-4-96	phone
Michael Pitt, DLWC Grafton		phone
Bob Bannens, MDBC		phone
Daylan Cameron, Hawkesbury -Nepean Trust		phone

Appendix 3

LAND & WATER RESOURCES RESEARCH & DEVELOPMENT CORPORATION (LWRRDC)

Project No.	Title	Organisation	Start	Finish
QP126	Nutrient control in irrigation drainage systems using artificial wetlands	Queensland Department of Primary Industries	Jan 1994	Jun 1996
QP116	A generic hydrological design model for the irrigation management of effluent disposal	Queensland Department of Primary Industries	Jul 1992	Jul 1995
ANU3	Scale effects in land, water and vegetation assessment	Australian National University	Jan 1992	Dec 1994
UNE14	Assessment of the economic benefits of land management programs on a national, regional and catchment basis	University of New England	Apr 1993	Apr 1996
USH1	Innovative approaches to environmental valuation in integrated catchment management	University of Western Sydney	Nov 1993	Jun 1996
ANU4	Valuation of non-market environmental attributes and resources	Australian National University	Feb 1992	Feb 1995
GRU17	Rehabilitation and management of riparian lands: ecological issues (Program B)	Griffith University	Jun 1994	Jun 1999
BCW1	Demonstration/evaluation of riparian restoration in the Blackwood catchment	Blackwood Catchment Coordinating Group	Jan 1995	Dec 1998
DAT3	Management of stock access to riparian zones	Tasmanian Department of Primary Industries and Fisheries	Jan 1995	Dec 1997
ANU6	The role of corridors and retained vegetation in biodiversity conservation	Australian National University	Jul 1995	Jun 2000

Project No.	Title	Organisation	Start	Finish
OHW1	Rehabilitation of saline riparian lands	Oyster Harbour Catchment Group	Jan 1995	Dec 1998
DAV69A	Assessment of the effects of shelterbelts on pasture and crop production in Victoria	Victorian Department of Agriculture	Jul 1993	Jun 1998
DAW49A	The impact of trees in the physical environment and productivity of farmlands	Western Australian Department of Agriculture	Jan 1994	Dec 1998
UA25A	Effect of windbreaks on crop and pasture productivity in South Australia	University of Adelaide	Jul 1993	Jun 1998
UMO23	The impacts of hydrological disturbance on stream communities	Monash University	Sep 1994	Dec 1997
AWT3	Application of IFIM to environmental flow requirements of stream macroinvertebrates	Australian Water Technologies	Jan 1995	May 1997
GRU10	Ecological basis for river habitat and in-stream flow management	Griffith University	Jul 1993	Aug 1998
CWN11	Water requirements for plants of floodplain wetlands	CSIRO Division of Water Resources	Sep 1994	Aug 1997
AWT2	Evaluation of attached diatoms for assessment of river health	Australian Water Technologies	Sep 1994	Dec 1996
CWN8	Macrophytes as indicators of ecosystem health	CSIRO Division of Water Resources	Apr 1995	Jul 1998
GRU19	River bioassessment using fish community structure	Griffith University	May 1995	Dec 1997
NDW8	Development and evaluation of automatic water quality monitoring in Australian rivers	New South Wales Department of Land and Water Conservation	Jul 1995	Jul 1997

Project No.	Title	Organisation	Start	Finish
MQU2	River response to catchment clearance on the South Coast of New South Wales	Macquarie University	Feb 1995	Feb 1998
UNS12	Relationship between the products of oxidation of pyritic coastal soils, predisposition of fish to red spot disease and reduction of fish habitat area	University of New South Wales	Feb 1992	Dec 1994
UTA2	The impact of willow management practices on instream biota	University of Tasmania	Jan 1994	Jan 1997
EPN1	Monitoring River Health Initiative: New South Wales Program	New South Wales Environment Protection Authority	Feb 1994	Jun 1997
UWR3	Allocation for urban sub-program	Urban Water Research Association of Australia	Jan 1994	Dec 1996
CWA13	An expert system to help catchment managers estimate nutrient exports	CSIRO Division of Water Resources	Jul 1994	Jul 1995
CWA9	Developing a generic catchment management support system	CSIRO Division of Water Resources	Jan 1992	Dec 1994
SRC1	Nutrient balances and transport from pasture lands in the Johnstone River Catchment, Atherton Tableland area	Queensland Department of Primary Industries	Jul 1992	Jan 1996
UAD7	Movement of phosphorus through soils	University of Adelaide	Oct 1994	Oct 1997
NDW6	The impact of pesticides on riverine environments - subcatchment biomonitoring study	New South Wales Department of Land and Water Conservation	Oct 1993	Sep 1995
UTS3	Ecotoxicology of endosulfan on suspended and bottom sediments	University of Technology, Sydney	Oct 1993	Dec 1996

Project No.	Title	Organisation	Start	Finish
UTS4	Ecotoxicology of pyrethroids and profenofos to Australian riverine biota	University of Technology, Sydney	Nov 1993	Oct 1995
DEP1	Ecological processes for management of wetlands and floodplains: practical management systems	South Australian Department of Environment and Planning	Nov 1992	Nov 1995
UNC6	Newcastle Harbour sediment sources	University of Newcastle	Jul 1993	Dec 1995
49/91	Banana irrigation using treated sewage effluent	University of Western Sydney		
2/91	Prediction of catchment scale water erosion, deposition and sedimentation	Australian Centre for Catchment Hydrology		
40/91	The effects of landuse on the water resource: an annotated bibliography	CSIRO Division of Water Resources		
CWA4	Development of a distributed catchment hydrological model to predict the effects of land use change	Australian Centre for Catchment Hydrology		
MQU5	Vegetative interactions within Australian rivers: geomorphic implications.	Macquarie University	Feb 1995	Feb 1998

SUGAR RESEARCH & DEVELOPMENT CORPORATION

Project No.	Title	Organisation	Start	Finish
NSWA1S	Increasing sugar cane yields by improvements in soil structure	New South Wales Department of Agriculture	Jul 1992	Jun 1997
UNSW1S	Drainage-induced soil acidification: its impact on cane growth and methods for its amelioration in pyritic soils	University of New South Wales	Jul 1992	Jun 1995
CSC12S	Evaluating the potential for improved sugar yields by assessing the climatic and soil constraints to production in southern cane-growing districts	CSIRO Division of Tropical Crops and Pastures	Jul 1993	Dec 1998
DAQ3S	Nutrient balances and transport from agricultural and rainforest lands: a case study in the Johnstone River Catchment	Queensland Department of Primary Industries	Jul 1992	Dec 1995
CSC13S	Spatial analysis of the impact of land use on nutrient loads within the Herbert River catchment	CSIRO Division of Tropical Crops and Pastures	Jul 1993	Jun 1997
CSS3S	Environmentally sound phosphorus management for sugarcane soils	CSIRO Division of Soils	Jul 1994	Jun 1998
BS122S	Nutrients and pesticides in surface drainage water and soil under irrigated sugarcane	Bureau of Sugar Experiment Stations	Jul 1994	Jun 1998
BS63S	Farming systems for green cane trash blankets in cool wet conditions	Bureau of Sugar Experiment Stations	Jul 1991	Jun 1996
SR146S	Sugar mill effluent treatments in ponds	Sugar Research Institute	Jan 1995	Jun 1995
SR136S	Options for bagasse storage and reclamation	Sugar Research Institute	Dec 1992	Jun 1995

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Project No.	Title	Organisation	Start	Finish
92/007	Small prawn habitat and recruitment study	Queensland Department of Primary Industries		
92/045	The role of coastal nursery habitats in determining the long-term productivity of prawn populations of the NPF	CSIRO Division of Fisheries		
94/041	Restoration of estuarine fisheries habitat	New South Wales Fisheries		

DAIRY RESEARCH & DEVELOPMENT CORPORATION

Project No.	Title	Organisation	Start	Finish
DAN56	Project 21: a statewide extension program	New South Wales Department of Agriculture	Jul 1992	Jun 1996
DAQ106	Nutrient balances and transport from pasture lands in the Johnstone River Catchment, Atherton Tableland	Queensland Department of Primary Industries	Jul 1992	Jan 1997
UNC1	Reducing nutrients in dairy wastes using artificial wetlands	University of Newcastle	Aug 1994	Aug 1997
VCAH12	Dairy farm waste management advisory service	Victorian College of Agriculture and Horticulture	Jul 1993	Jun 1996

TCM ENHANCEMENT - NSW DEPARTMENT OF LAND & WATER CONSERVATION

Project No.	Title	Organisation	Start	Finish
CW0177.94	Ponto weed and pasture management, revegetation and agroforestry project	Geurie Macquarie Landcare Group	Jul 1994	Jun 1997
AA0635.95	TCM 1995/96 Small Projects Fund	New South Wales Catchment Management Committee	Jul 1995	Jun 1996
BE0068.95	Tuckers Rocks coastal vegetation protection and rehabilitation project	Tuckers Rocks Dunecare	Oct 1995	Feb 1996
BE0144.95	Erosion control platform construction and blowout remediation	Mylestom Landcare Group	Jul 1995	Jun 1996
BG0338.95	Borambola wetland to protect fragile drought sensitive catchment	Kyeamba Valley Landcare Group	May 1995	Oct 1995
BG0361.95	Minimise drought effects on sensitive Borambola riparian environments	Kyeamba Valley Landcare - Borambola sub-group	Apr 1995	Jun 1996
BW0536.95	Ettymalong Creek rehabilitation and management project	Umina Landcare Group	Jul 1995	Jun 1996
CH0485.95	Coffs Creek Reserves enhancement program (Brodie Drive section)	Friends of Coffs Creek Landcare Group	Jul 1995	Sep 1996
CW0611.95	Restoration of Windburndale rivulet	Upper Windburndale Landcare Group	Jul 1995	Jul 1998
DD0566.95	Revegetation of Sydney Harbour foreshore and ocean frontage	Manly Bushland Volunteers	Jan 1996	Jun 1998

	Title	Organisation	Start	Finish
HN0078.95	Nile Valley Creek bank erosion control stabilisation trial	Capertee Valley Landcare Group	Jan 1996	Jan 1997
HN0339.95	Riverbank stabilisation and revegetation proposal Crown Creek stabilisation and reclamation	Capertee Valley Landcare Group	Jan 1996	Jan 1997
KL0605.95	Tilligerry Habitat: restoration of foreshore at Tanilba Bay	Tilligerry Habitat	Jan 1996	Jan 1997
LA0253.95	Native pasture re-establishment and management	Euabalong West Landcare Group	Jan 1996	Jun 1998
LS0111.95	Feral cat trapping	'The Improvers' The intellectual Persons of Shoalhaven	Aug 1995	Aug 1998
LS0191.95	Fencing and revegetation of swamps	Tapitallee Creek Revegetation Landcare Group	Jul 1995	Jun 1996
LW0013.95	Revegetation of Tomakin Spit	Tomakin Residents and Ratepayers Dunecare Group	Jan 1996	Jun 1996
MN0542.95	Saltwater Reserve vegetation protection and re-establishment and community information	Greater Taree City Council Saltwater Reserve Working Committee	Jan 1996	Jan 1997
MN0543.95	Littoral and lowland rainforest rehabilitation and community information	Greater Taree City Council	Jan 1996	Jan 1997
MN0581.95	Tiri Bridge river alignment clearing improvement and stabilisation	Mount George Landcare group	Jan 1996	Jan 1998
MY0477.95	Wiradjuri Cultural Interpretative Walkabout	Albury Wodonga Development Corporation	Jul 1995	Jun 1996
MY0613.95	Investigations for Koraleigh Management Plan	Koraleigh Land and Water Improvement Group	Jul 1995	Jun 1996

Project No.	Title	Organisation	Start	Finish
NW0079.95	Sustainable grazing through improved techniques of revegetation	Manilla Landcare Inc - Bubbogullion 100 Landcare Group	Jan 1996	Jul 1998
NW1066.95	Ground truthing electromagnetic induction survey	Blackville Landcare Group	Apr 1996	Apr 1997
RM0048.95	Regeneration of seafront leading to Lennox Headland	Lennox Head Residents Association Inc	Oct 1995	Oct 1996
RM0416.95	Coastal reafforestation public awareness and education project	Angles Beach Dunecare and Reafforestation	Jan 1996	Jan 1997
RM0436.95	Wanganui riparian network	Upper Coopers Creek Revegetation Society Inc	Jan 1996	Jan 1997
US0101.95	Ballalaba Krawarree erosion control and remnant vegetation survey	Ballalaba Krawarree Landcare Group Inc	Jan 1995	Dec 1998

CO-OPERATIVE RESEARCH CENTRE (CRC)

Project No.	Title	Organisation	Start	Finish
1.3	Interactive farm scale survey of acid-sulfate soils in NSW canelands	NSW Sugar, Broadwater & QDPI	1996	1998

OVERVIEW OF COMMONWEALTH PROGRAMS RELEVANT TO COASTAL FLOODPLAINS

Title	Organisation	Description
Better Cities Program	Dept of Housing & Regional Development	Commencing in 1991, this program has a budget of $816m over five years to reform urban management processes
Coastal Strategic Planning Program	Dept of Housing & Regional Development	This program provides a planning framework for the Coastcare Program. It has different committees to those supporting the Coastcare Program. Budget: $12m in 1995/6; operates within the Better Cities Program
Endangered Species Program	Australian Nature Conservation Agency	Recovery plans for endangered species includes restoration of wetlands eg Kooragang Island, NSW
Local Government Development Program	Dept of Housing & Regional Development	This program has $13m each year until 1998 and environmental management is a priority of the program
Migratory Species Program	Australian Nature Conservation Agency	Administers the Bonn Convention, Japan Australia Migratory Birds Agreement, China Australia Migratory Birds Agreement to help preserve migratory species, and focuses on wetlands

Title	Organisation	Description
National Landcare Program	Dept of Primary Industries & Energy	The following five programs are sub-programs of the NLP program:
• Integrated Catchment Management	• Murray-Darling Basin Commission	• supports catchment management strategies and plans that address Murray-Darling Basin priorities. Budget for the preceding five NLP sub-programs: around $83m per annum, with Land and Water taking up about $76m.
• Land and Water Ekements	• Dept of Housing & Regional Development	Funded 1849 projects. In 1995, the Land and Water Program contained 57 flood mitigation projects with a total budget of $11.45m and of these, 26 worth of total of $9m, were in NSW. State and Local Governments contribute funds, which are initiated by councils wishing to overcome flooding problems; • Supports planning, promotion and use of sustainable land, water and vegetation management practices (needs performance measures to indicate whether the practices are sustainable);
• One Billion Trees	• Australian Nature Conservation Agency	• Supports the re-establishment and maintenance of native trees and vegetation;
• Waterwatch	• Australian Nature Conservation Agency	• Supports water quality monitoring in, and education about, Australia's waterways.
National Reserves Systems Co-operative Program	Australian Nature Conservation Agency	Complemnts the National Representative System of Marine Protected Areas and may include assistance for acquiring land identified as having outstanding national nature conservation significance

Title	Organisation	Description
.National Wetlands Program	Australian Nature Conservation Agency	Implements the Commonwealth Government's national and international wetlands commitments. Budget: around $1m
Ocean Rescue 2000 • National Representative System of Marine Protected Areas • Australian Marine Conservation Strategy • National Marine Education Program • Marine and Coastal Community Network • National Marine Information System	Dept of Environment, Sport & Territories • Under review • State of the Marine Environment Reporting (outcomes) • Great Barrier Reef Marine Parks Authority • Marine and Coastal Community Network • Environmental Resources Information Network	• This is a decade-long marine conservation program with three elements: a baseline study or 'state of the environment report'; development of a national marine conservation strategy; and the Marine Protected Areas program. Funds are being allocated to ANCA and GBRMPA to support a co-operative arrangement with the States and Territories in establishing the marine parks system.
Register of the National Estate	Australian Heritage Commission	Alerts governments and the community to the heritage value of listed sites, which include fish habitat in the form of wetlands, rivers, etc. There were 295 sites listed as of June 1994. The Register only binds Commonwealth bodies to consider 'feasible alternatives' to damaging an item in the Register.

Title	Organisation	Description
Rural Partnership Program	Dept of Primary Industries & Energy	Co-ordinates DPIE's rural adjustment, Landcare and agribusiness programs by providing access through one submission to the programs.

FISH HABITAT RESTORATION PROJECTS

Title	Organisation	Date	Location
Tweed Estuary Management Plan: Fingal Peninsula Enhancement	Dept of Land & Water Conservation	Early 1996	Tweed River mouth
Tuckean Land & Water Management Plan	Dept of Land & Water Conservation	1994/1996	Richmond River, near Broadwater
Rock Mouth Creek Habitat Improvement Project	Dept of Land & Water Conservation	Completed 1995	Richmond River, near Woodburn
Everlasting Swamp Wetland Rehabilitation Project	Dept of Land & Water Conservation	Proposed	Clarence River
Roberts Creek Habitat Improvement Project	Dept of Land & Water Conservation	On hold	Clarence River, near Maclean
Yarrahapinni Wetland Rehabilitation Project	Dept of Land & Water Conservation	1991/1996	Macleay River, near South West Rocks
Ironbark Creek Wetland Rehabilitation Project	Hunter Catchment Management Trust	Late 1995	Hunter River, near Newcastle

Title	Organisation	Date	Location
Kooragang Island Rehabilitation Project	Newcastle City Council	Commenced 1992	Hunter River, near Newcastle

DEPARTMENT OF LAND & WATER CONSERVATION
NORTH COAST REGION
COASTAL PROGRAM PROJECTS

Title	Date
Hastings Point Dune & Lagoon Rehabilitation	1995/1996
Murwillumbah Voluntary Purchase	1995/1996
Tweed Flood Warning	1995/1996
Murwillumbah Floodplain Management Invest. (East)	1995/1996
Tumbulgum Canefields Drains	1995/1996
Tweed Flood Maintenance	1995/1996
Lower Tweed Estuary Management Plan	1995/1996
Upper Tweed Estuary Management Plan	1995/1996
Tweed Entrance	1995/1996
Tweed Coastal Estuary Management Plan	1995/1996
Cavanbah Beach Improvement	1995/1996
Cosy Corner/Tallow Beach Improvement	1995/1996
Marshalls Creek Floodplain Management Plan	1995/1996

Mullumbimby Floodplain Management Plan	1995/1996
Brunswick Floodwarning	1995/1996
Belongil Estuary Mnagement	1995/1996
Byron Bay Alternative Boat Launching	1995/1996
River Street Restoration, Ballina	1995/1996
Angels Beach/Black Head Access	1995/1996
Ballina Floodplain Management Study	1995/1996
Tuckean Swamp Management Plan	1995/1996
Lower Richmond Estuary Management Plan	1995/1996
Lake Ainsworth Management Plan	1995/1996
Evan Head Reserve Upgrade	1995/1996
Shark Bay/Razorback Lookout Improvements	1995/1996
Goanna Headland Improvements	1995/1996
Mid Richmond Flood Investigation	1995/1996
Rocky Mouth Creek Investigation	1995/1996
Richmond River Bridges Replacement	1995/1996
McDonalds Hill Levee	1995/1996

Monti's Floodgate Replacement	1995/1996
RRCC Asset Management	1995/1996
RRCC Flood Maintenance	1995/1996
Woodburn Riverbank Protection	1995/1996
Evans River Midden Protection	1995/1996
Evans River Estuary Management Plan	1995/1996
Evans Head Boat Launching Facility	1995/1996
Lismore Floodplain Management Plan	1995/1996
Lismore Voluntary Purchase	1995/1996
Maclean Dune Care	1995/1996
Yamba Beach Improvement	1995/1996
Palmers Island Voluntary Purchase	1995/1996
Lower Clarence Floodplain Management Plan	1995/1996
Roberts Creek Investigation	1995/1996
Lawrence Flood Study	1995/1996
Ferry Park Jetty	1995/1996
Grafton Overtopping Investigation	1995/1996

South Grafton Levee Construction	1995/1996
Grafton Levee Easements	1995/1996
Grafton Levee Sheetpiling Replacement	1995/1996
Ulmarra Riverbank Management Plan	1995/1996
Swan Creek Floodgate Modification	1995/1996
Access Bridges Replacement	1995/1996
Floodgates Lifting Program	1995/1996
Ulmarra Levee Easements	1995/1996
CRCC Asset Management	1995/1996
CRCC Flood Maintenance	1995/1996
Lower Clarence Estuary Management Plan	1995/1996
Coffs Harbour Dune Care Stage 2	1995/1996
Coffs Creek North Arm Flood Study	1995/1996
Bonville Creek Flood Study	1995/1996
Bonville Creek Floodplain Management Study	1995/1996
Moonee Creek Flood Study	1995/1996
Coffs Creek Waterway Improvements	1995/1996

Coffs Harbour Port Boat Ramp	1995/1996
Bellingen Floodplain Management	1995/1996
Nambucca Main & Shelley Beach	1995/1996
Nambucca Flood Gauge Telementry	1995/1996
Nambucca Flloodplain Management	1995/1996
Nambucca Foreshore Improvement	1995/1996
McKay Street Boat Ramp	1995/1996
Lower Macleay Floodplain Management Study	1995/1996
Kempsey Voluntary Purchase	1995/1996
Kinchela Creek EIS	1995/1996
Macleay Acid Sulphate Soils	1995/1996
Hat Head Levee Investigation	1995/1996
Macleay River Bank Protection	1995/1996
Macleay Flood Telementry	1995/1996
Macleay Floodgate Replacement	1995/1996
Belmore Floodway Structure Replacement	1995/1996
Macleay Bridges Replacement	1995/1996

Kempsey Flood Maintenance	1995/1996
Killick Creek Study	1995/1996
Yarrahappini Estuary Restoration	1995/1996
Queens Grant Voluntary Purchase	195/1996
Flynns Beach Revetment Repairs	1995/1996
Port Macquarie Flood Mitigation	1995/1996
Camden Haven Floodplain Management	1995/1996
Hastings Flood Maintenance	1995/1996
Kooloonbung Creek Estuary Management Plan	1995/1996
Lake Cathie/Lake Innes Estuary Management Plan	1995/1996
Maria River Acid Sulphate Soil Study	1995/1996
Kooloonbung Creek Boardwalk	1995/1996
Lakewood Jetty Repairs	1995/1996
Dunbogan Boat Ramp	1995/1996