



# Cooperative Research Centre for Coastal Zone, Estuary & Waterway Management

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## Integrated indicator framework for monitoring and reporting on biophysical health and social wellbeing in the coastal zone

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Central Queensland  
UNIVERSITY  
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## Executive summary

Indicators are used to monitor and report, in a timely and cost-effective manner, on those aspects of a system that provide the most reliable insight into its overall wellbeing.

Using indicators to monitor the effects of resource-use activities on environmental and social health is critical to effective, adaptive and sustainable natural resource management. This report presents an integrated indicator framework and related social indicators developed through research by the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management (Coastal CRC).

This model is based on an elaboration of the Pressure-State-Response (PSR) framework used extensively in Australia and around the world for State of the Environment reporting. This framework seeks to identify environmental indicators that provide a reliable guide to the overall state of ecosystems (state indicators), the human activities responsible for changes in these indicators (pressure indicators), and appropriate management responses (response indicators).

As shown in Figure 1, the elaborated model suggests consideration of:

- The role of human values in determining the pressures that are placed on ecosystems and on the development of management responses to environmental change;
- The impact of changes in key environmental indicators on human welfare (impact indicators);
- The features of ecosystems and communities that make them more or less likely to suffer negative consequences as a result of internal or external stresses and hazards (vulnerability indicators);
- The level of risk posed to environments as a function of human pressures and innate system vulnerabilities;
- The level of risk posed to human communities as a function of environmental change and social vulnerability; and
- The features of social and ecological systems that influence their ability to respond to disturbances and adapt to change while retaining critical integrity and functioning (adaptive capacity indicators).

With an almost infinite number of management responses available to resource managers on the basis of information generated using these indicators, management priorities are seen to arise as a function of the state of natural resources, the current and future risks faced by those resources and the

communities that depend on them, and the values placed on those resources for conservation, social and/or economic purposes.

A Pressure-State-*Impact*-Response model was tested for its ability to integrate biophysical and social information related to estuarine and waterway health in the Port Curtis and Lower Fitzroy catchments of Central Queensland. A summary of results is presented in this report for the Lower Fitzroy.

Eleven biophysical estuarine stressors are identified including sediment, toxicants, pH, pest species, nutrients, organic matter, litter, changed hydrodynamics, habitat removal or disturbance, biota removal or disturbance, and bacteria/pathogens.

Looking specifically at the potential impact of changed water flow regimes, a range of social issues were identified in relation to changes in these stressors that warrant monitoring. These include:

- Increased costs of water access and decreased regularity of supply;
- Threats to the continuity of Indigenous cultural and spiritual practices;
- Deterioration of community identity, bonds and cohesion;
- Availability of fish and seafood resources to sustain commercial fishing;
- Recreational opportunities along foreshore, waterways and in-shore coastal areas;
- Attractiveness of the area and resources for tourism activities; and
- Public exposure to contaminated recreational waters and fish and seafood.

While some of these issues are less amenable to quantitative monitoring through indicator development than others, the PSIR model presents a promising framework for the conceptualisation of natural resource monitoring and management programs that are sensitive to the relationships between natural resources and human communities.

Integrated indicator framework for monitoring and reporting in the coastal zone

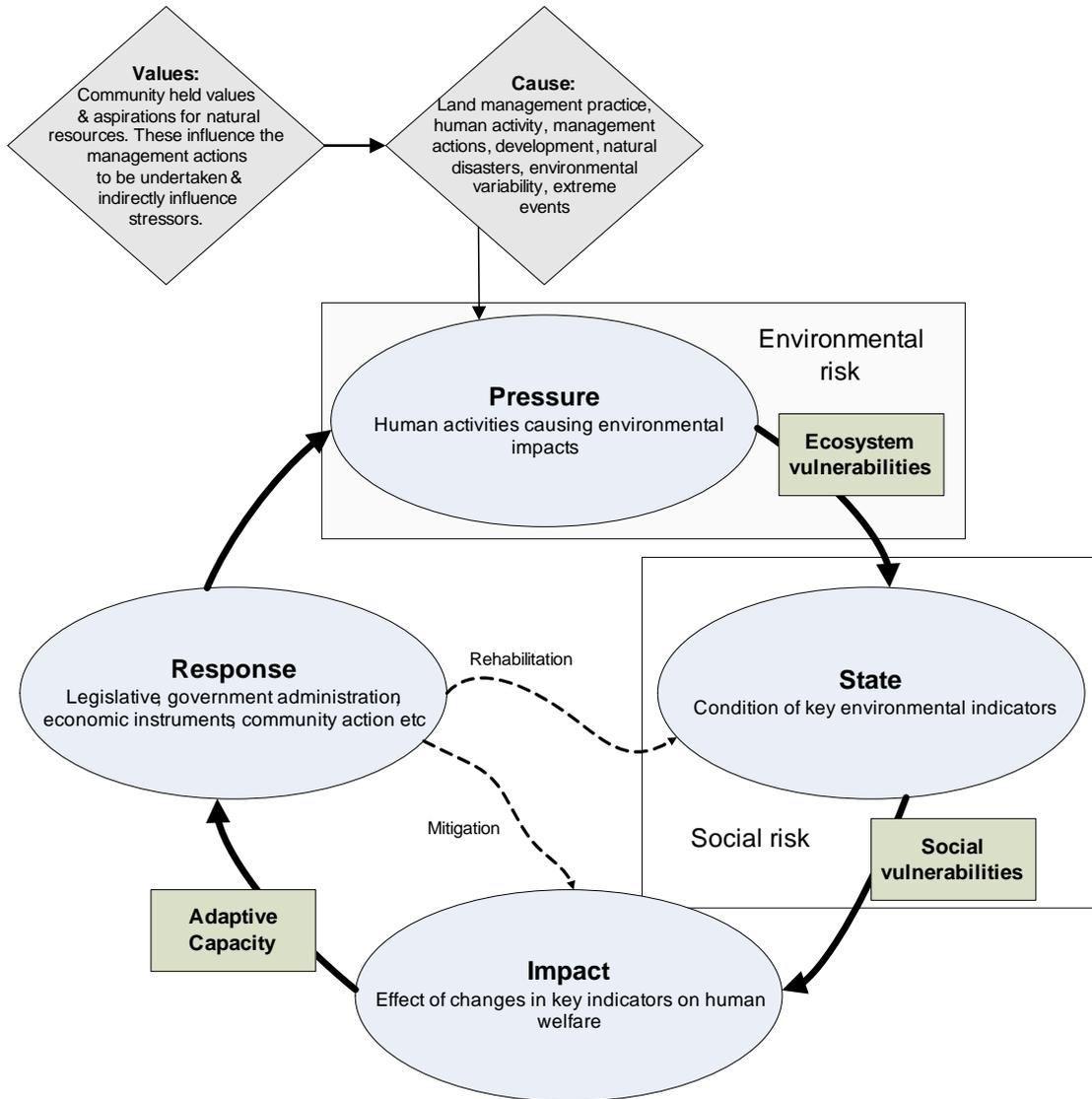


Figure 1. The Pressure-State-Impact-Assessment model and associated concepts (adapted from Turner *et al.* 1998a; Moss 2005; Lockie *et al.* 2004)



# 1 Introduction

For coastal ecosystems, any change in resource condition will have consequences for water quality, marine health, public health and community wellbeing (Cox *et al.* 2003). Changes in the functioning of coastal ecosystems affect the goods and services provided to society and impact on human wellbeing. Current approaches to managing ecosystems often fail to account for, or adequately assess, the impacts of changes in ecosystem health on human wellbeing (Cox *et al.* 2003).

This report outlines an integrated indicator framework and related social indicators developed through research by the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management (Coastal CRC). Development and implementation of integrated indicator monitoring and reporting programs addressing the health of estuarine and coastal environments offer benefits to a range of stakeholders including government agencies and regional natural resource management (NRM) groups. Integrated indicator programs will assist such groups both to monitor progress in addressing key resource management issues specific to each region and to meet monitoring needs specified under current national NRM programs.

The report is structured into five sections:

- Section 1 outlines the NRM framework currently used by government along with the rationale for researching an integrated (social, biophysical) approach to coastal zone management.
- Section 2 discusses integration and then summarises some of the challenges confronting adoption of an integrated approach to achieve sustainable NRM.
- Section 3 covers the social impacts associated with individual biophysical stressors in the Fitzroy River estuary of Central Queensland in order to illustrate the linkages between changes in resource condition and social outcomes.
- Section 4 describes the Vulnerability-Pressure-State-Impact-Risk-Response (VPSIRR) software used to determine the condition of estuaries and to assess where management responses are required (Moss *et al.* 2005) in relation to future inclusion of a social component.
- Section 5 contains concluding comments and recommendations for the conceptual framework and integrated social and biophysical indicators.

A detailed set of appendices provides additional information articulating the relationships between changes in resource condition and social impacts.

## 1.1 Current NRM monitoring and reporting in Australia

The investment of increasing sums of money to address natural resource management issues in Australia is occurring through major government programs such as the Natural Heritage Trust (NHT) and the National Action Plan for Salinity and Water Quality (NAP). Investment at a number of spatial scales to ameliorate landscape-wide problems involves Local, State, Territory and Commonwealth Governments, community groups, regional organisations, industry and landholders. Monitoring and evaluation of these investments to ensure the delivery of desirable outcomes is a priority for government. To assist in this area, two national level documents – the National Framework for Natural Resource Management Standards and Targets and the National Natural Resource Management Monitoring and Evaluation Framework – have been developed. These frameworks are aimed at assessing progress related to:

- Health of the nation's natural assets (e.g. land, water, vegetation and biological resources); and
- Performance of programs, strategies and policies that provide national approaches to the conservation, sustainable use and management of these natural assets (otherwise called resources)(Australian Government 2003; for details on NRM monitoring and evaluation see [www.nrm.gov.au/monitoring/](http://www.nrm.gov.au/monitoring/)).

Such monitoring and reporting frameworks are intended to be usable, cost-effective, accurate, comprehensive and transparent. They are seen as particularly important in ensuring effective monitoring and evaluation arrangements exist at the regional level as part of the accreditation of regional NRM plans. To ensure regional planning processes and regional NRM plans support the achievement of national outcomes, a number of 'matters for targets' have been established. It is in the monitoring of each of these 'matters for targets' that indicators are used as measures to determine the performance of investments made under the various programs and plans, and to contribute to the overall assessment of resource condition.

However, largely absent from these monitoring and reporting frameworks for NRM is consideration of the social, cultural and economic aspects that either influence, or are influenced by, changes in the management or condition of a

resource asset or 'matter for target'. The lack of an integrated approach to monitoring and reporting on the health of ecosystems was consistently identified as a limitation on the effectiveness of monitoring programs by representatives of over 60 stakeholder groups interviewed through the Coastal CRC's Phase 1 Citizen Science project *Stakeholder analysis of coastal zone and waterway stakeholders in the Port Curtis and Fitzroy catchments of Central Queensland* (Lockie & Rockloff 2005). Key questions to emerge in response to the relative lack of attention to the relationships between biophysical and social aspects of NRM included:

- What local and regional indicators of ecological, social and economic status (health) can be integrated into a sustainability indicator framework to benchmark and monitor the health of the Port Curtis and Fitzroy coastal zones, and the impact of natural resource use change?
- What institutional changes and mechanisms are required by environmental planners, resource managers and organisations, to institutionalise a sustainability indicator framework for planning, monitoring and reporting?
- What are the social and cultural impacts of changes in resource use, management and condition in coastal environments?

Consideration of the relationships between communities and natural resources is not only a matter of peoples' democratic and human rights. The information gained through integrated indicator frameworks is necessary to ensure that decisions regarding the use of natural ecosystems are well-informed and, therefore, appropriate (Lockie *et al.* 2004; Moss 2005). Although this is no simple task, this report demonstrates that progress can be made towards achieving this integration.

While considerable knowledge exists on the cause and effect relationships between human activities and changes in the biophysical environment, this level of knowledge and data is not available for the social environment. The variable impact of change within communities, the numerous intervening variables between management actions, ecological change and social outcomes, and the cumulative impacts of multiple management actions all conspire to make the identification and interpretation of appropriate indicators a complicated and challenging undertaking (Lockie *et al.* 2002). Furthermore, in a social climate that is complex and dynamic, there is the added challenge of finding meaningful primary and secondary data for understanding the social context. Social data that is linked in demonstrable ways to the management of water resources is needed to support environmental management in a manner that is consistent with calls for

the elimination of redundancy in reporting requirements and a shift to the delivery of priority information. A streamlining and refinement of assessment methods is essential if natural resource institutions are to maintain the health of waterways and future water resources, satisfy community expectations, and inform State of the Region reporting (Rockloff *et al.* 2005).

## 1.2 Development and implementation of multi-disciplinary research on integration in the coastal zone

To address these issues this project focused on those aspects of social, economic and estuarine health that either influenced or were influenced by, changes in the management or status of specific natural resources. These were water quality and estuarine ecosystems in Port Curtis and water flow regimes in the Fitzroy. Both are major issues for the respective catchments and the Queensland State Government due to economic growth in a number of production sectors (e.g. minerals processing, extractive industry and primary production) and urban expansion. Furthermore, this project has combined basic scientific research (i.e. into social and ecological indicators) with the development of practical tools (i.e. the institutionalisation of indicator monitoring, reporting and evaluation). This was achieved through devising an *integrated* indicator framework.

Indicators are routinely used to monitor and report on those aspects of a system that provide the most reliable clues as to its overall wellbeing over time (Slobodkin 1994). They are used to simplify complex information and provide early warning about changes. Information on what is valued by society guides decision-makers and the community to define social goals, to link these goals to set targets, and to assess progress towards meeting those targets through the use of indicators.

Furthermore, use of indicator sets may provide:

- An empirical and numerical basis for monitoring, evaluating and reporting on performance;
- A mechanism for calculating the impact of human activities on the estuarine environment and coastal communities;
- A mechanism for connecting past and future activities to achieve future goals and targets, and the basis for testing scenarios; and
- A basis for social and environmental goals and targets to be incorporated into mainstream political and economic discourse.

Such monitoring is essential to support the adaptive management of natural resources. Adaptive management frameworks are intended to assist decision-makers with evaluating the performance of management interventions and to respond through increased knowledge and learning, which is achieved by linking scientific knowledge, decision tools, participatory processes and planning. Adaptive management also stresses the importance of integrating social, economic and biophysical monitoring programs and incorporating this information into decision-making (Lockie *et al.* 2004). This project dealt with monitoring and reporting in a systematic way, by developing and validating social and ecological indicators of estuarine status, together with indicator reporting and social assessment frameworks. It was not within the scope of the current research to identify economic impacts and associated suitable indicators.

### 1.3 Overview of the research process

In this research, we were concerned with integrating biophysical information on estuarine and waterway health with information on community and social health and wellbeing. The biophysical part of the research was focused on eleven estuarine stressors that were examined for their impacts on social and human values from changes in the condition of the biophysical environment (Moss, 2005; Scheltinga *et al.*, 2004). The eleven biophysical estuarine stressors included sediment, toxicants, pH, pest species, nutrients, organic matter, litter, changed hydrodynamics, habitat removal or disturbance, biota removal or disturbance, and bacteria/pathogens. In order to achieve integration, the research involved several steps.

Group and individual activities were used early in the research process to gather and verify information on the eleven estuarine stressors. Focus groups allowed direct stakeholder input into the research, while structured interviews administered on a one-to-one basis were later used to inform scenarios and identify social impacts for various changes associated with water quality and water flows (see Lockie *et al.* 2004 and Rockloff *et al.* 2005 for full details). Populating the selected conceptual framework (described later) with relevant social indicators involved three main activities:

- *Identifying resource-use pressure scenarios and scoping potential social indicators* – scoping existing and future resource use pressures impacting on water quality in the Calliope and Boyne Rivers and estuarine areas of Port Curtis, and environmental flows in the Fitzroy River. Next, in collaboration with regional stakeholders, potential

ecological and social indicators of ecosystem status and important values were identified.

- *Validating social and ecological linkages* – strategies were devised to incorporate the assessment and management of social and cultural change associated with changes in resource use, management and condition within a strategic assessment framework sensitive to the temporal and spatial extension of impacts in the two regions. This involved identifying the social and cultural impacts of change in resource use, management and condition associated with river water flows and estuarine status and water quality.
- *Identifying relevant social indicators* – this involved identifying and validating the relationship between biophysical stressors and their social impacts. Verification was conducted through interviews with stakeholders and other experts in the field and through desktop review of similar studies.

The majority of indicators selected for monitoring the effects of the natural resource change were impact and response indicators, suggesting that there are many social issue impacts warranting management attention. These indicators included direct measures of pressures (or drivers), indirect measures and subjective measures of attitudes to understand impacts on health, quality of public access experience, Indigenous wellbeing, and quality of life. Each indicator related to a physical, chemical or biological stressor, which are major components of the environment that, when changed by natural or human-induced factors, can result in the degradation of natural resources.

## 2 Integrated monitoring and reporting frameworks for the coastal zone

*Socioeconomic systems and 'natural' systems are, to a variable extent, now locked into a co-evolutionary path, characterised by joint determinism and complex feedback effects (Turner et al. 1998b, p. 5).*

Integration and integrated approaches can be viewed as the new, superior way of considering the environment in decision- and policy-making, or they can be judged to create as many challenges as they seek to resolve in pursuit of more sustainable NRM. Integrating information on the natural and social environments has the potential to provide: an understanding of the pressures and effects of socioeconomic change (e.g. population pressure, urbanisation); the ability to assess the human welfare impacts of changes in coastal resource systems; and an insight into the social and institutional aspects of natural resource management responses (Turner *et al.* 1998b). The fundamental purpose of integrated approaches to NRM is to maintain, restore and improve desired or valued qualities of the ecosystem and the health and wellbeing of human societies. Nevertheless, there are several challenges to the development and application of integrated monitoring and reporting. These include:

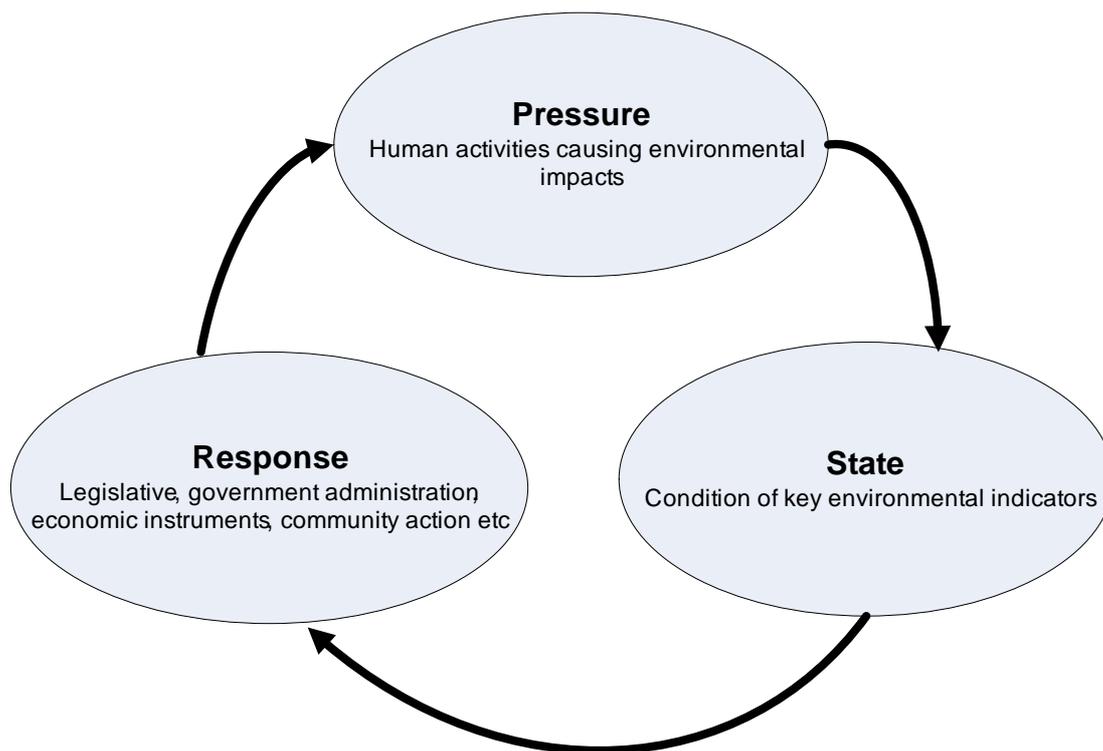
- Current identification of social indicators for natural resource monitoring and reporting is frequently not linked to, or integrated with, biophysical stressors and changes;
- Lack of development and use of an integrated indicator framework, especially by regional NRM groups and other resource managers;
- Absence of decision support systems (e.g. web-based) to guide the identification and use of an integrated set of indicators for monitoring and reporting; and
- Lack of understanding about the vulnerability and adaptive capacity of groups and communities, and the use of indicators to monitor and report on these concepts (including variables of risk, exposure and sensitivity) (Rockloff *et al.* 2005).

The rest of this section outlines the framework that was developed through this research to support integrated monitoring and reporting (also see Turner *et al.* 1998b; Lockie *et al.* 2004; Rockloff *et al.* 2005). This framework is based on the Pressure-State-Response (PSR) model that is widely used already in Australia and elsewhere. Beginning with the PSR model, the framework articulated here

adds progressive layers of complexity that may be utilised, as appropriate, by natural resource managers while retaining the integrity of the basic PSR model.

## 2.1 The PSR framework for environmental performance monitoring and reporting

In Australia, governments use State of the Environment (SoE) reports to provide information about environmental and heritage conditions, trends and pressures for the country, surrounding seas and Australia's external territories. The reports are based on data and information gathered and interpreted against environmental indicators that have been grouped into environmental themes. The Pressure-State-Response Framework used by the Organisation for Economic Cooperation and Development (OECD) and other national and international organisations for environmental performance monitoring has been widely adopted as the common framework (see Figure 2.1).



**Figure 2.1 The Pressure-State-Response framework**

This framework links pressures on the environment as a result of human activities, with changes in the state (condition) of the environment (land, air, water, etc.). Society then responds to these changes by instituting environmental and economic programs and policies, which feed back to reduce or mitigate the pressures or repair the natural resource (OECD 1993). This model has served to

help organise the large quantities of data involved in environmental monitoring, facilitate the development of indicators, and increase the use of this information for the development and modification of NRM policies and programs.

## 2.2 Monitoring social impacts: the PSIR model

The Pressure-State-*Impact*-Response (PSIR) model is another reporting framework derived from the PSR framework (see Figure 2.2). It is used by many OECD countries and the World Bank. This framework links changes in the state of the environment with biophysical and social *impacts*. By including the impacts of changes in environmental state indicators on social environments it is possible to begin understanding and managing the coastal zone and other ecosystems as one co-evolving ecosocial system while focusing the attention of natural resource managers on those social and economic issues of most direct relevance to NRM and avoiding those issues with little connection to NRM practice or outcomes.

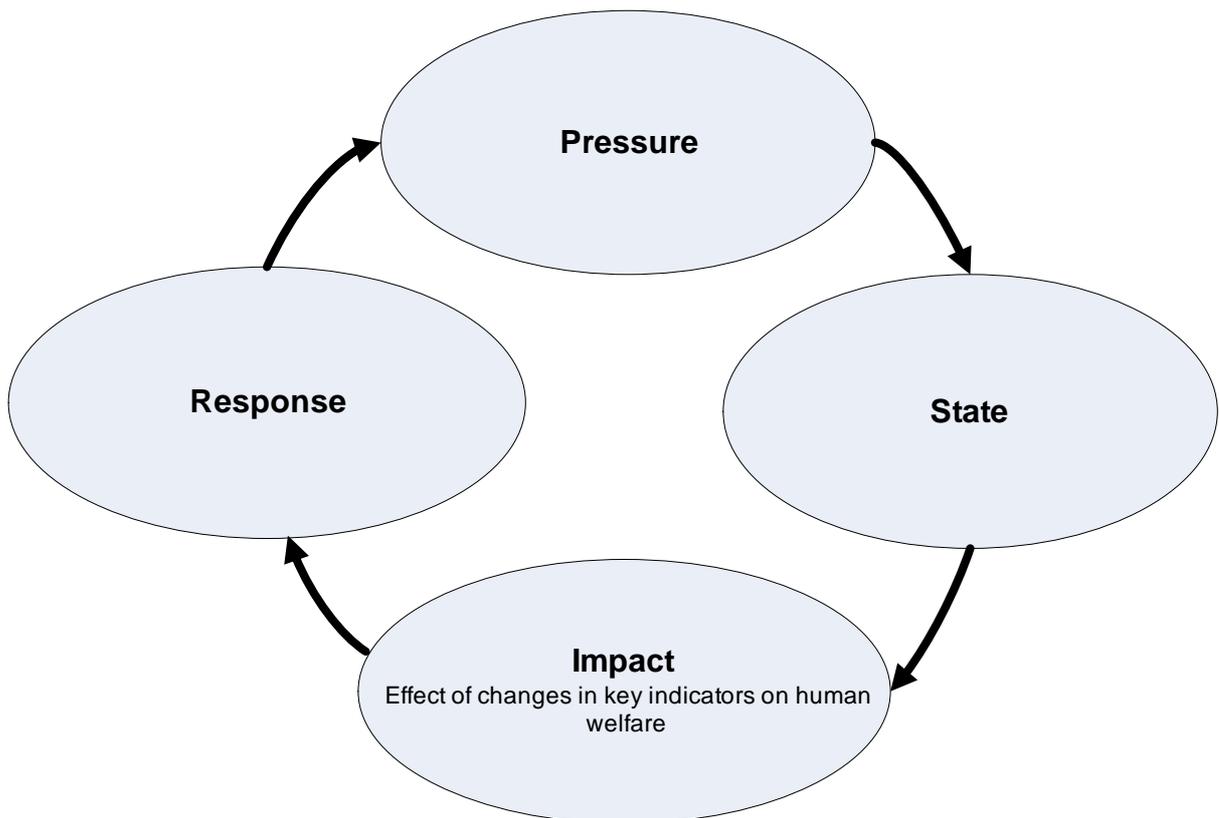


Figure 2.2 The Pressure-State-Impact-Response framework

The PSIR framework is readily understandable, able to adequately reflect ecosystem patterns and processes, and can highlight environmental issues of importance to governments. Most importantly it links the pressures of human activity to the 'state' dimension of the PSR approach and the responses of society. On application, the PSIR framework structures and classifies information and supports the identification of indicators that best describe current development and management actions and the resultant impacts.

### 2.3 The DPSIR integrated monitoring and reporting model

The DPSIR framework offers a further modification to the basic PSR model that differentiates between higher-order processes of social change and their manifestation as local processes of resource-use pressure (see Figure 2.3). That is, socioeconomic drivers lead to environmental pressures. Such drivers may include population change, policy shifts, natural resource regulation, land-use change and economic decline. In the model, stakeholder gains or losses from impacts lead to policy responses.

In this research, a set of indicators based on the Driver-Pressure-State-Impact-Response (DPSIR) conceptual framework was adopted for the purpose of integrating monitoring and reporting (Rockloff *et al.* 2005). Integration is possible within the PSIR and DPSIR frameworks because of the organisation of indicators into categories based on their relationship with those 'stressors' that have been identified for their particular importance to ecosystem health. Stressors are defined as the physical, chemical, biological, social or economic components of the system that cause degradation of natural resources and community health and wellbeing due to change. As system components that alter the condition of natural resources, stressors are the linking factors between causes and symptoms. Determination of the stressors to local systems leads to the identification of pressure, state, impact and response indicators (Cox *et al.* 2004).

Identification of stressors is itself based on an issues- and values-driven approach informed by stakeholders and the community. The issues and values determine which system components are prioritised for monitoring over other system components.

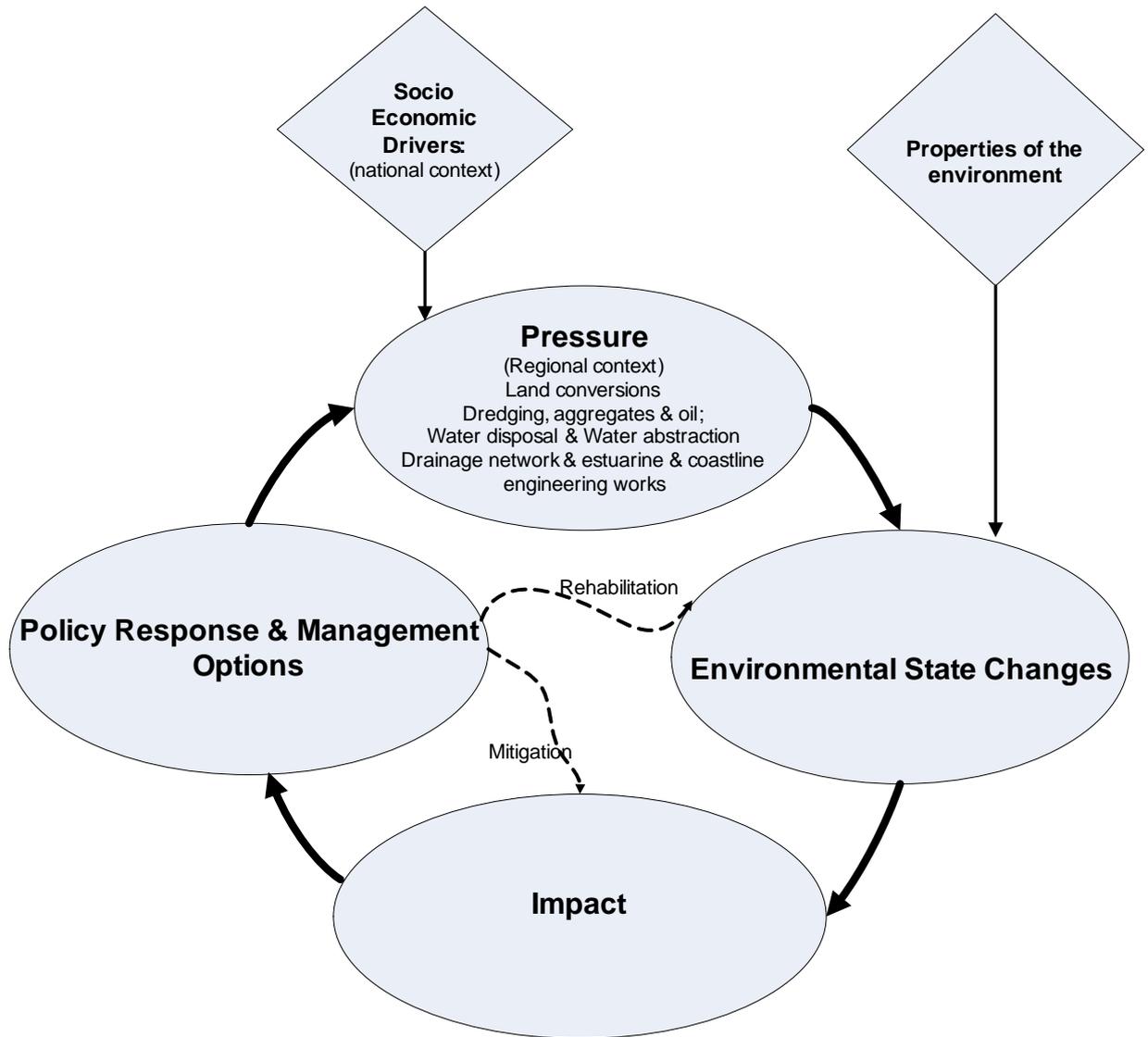


Figure 2.3 The Driver-Pressure-State-Impact-Response framework

## 2.4 Vulnerability and adaptive capacity in the DPSIR model

Because there are no simple linear relationships between changes in the pressures affecting natural resources, environmental stressors and social outcomes, some understanding of both the vulnerability and adaptive capacity of ecosystems and communities is useful in identifying and interpreting environmental and social indicators.

According to the United Nations Development Program, social vulnerability refers to the likelihood that communities, or groups within them, will be affected negatively by internally and externally induced stresses and hazards (UNDP 2002, p. 5). These negative impacts may include disruption to livelihoods, forced

adaptation, reduced social cohesion, and so on (Adger 1996). However, the definition of any social change as negative is dependent on how that change is subjectively assessed by those affected, and some disruptions may be regarded positively. While there is no substitute for consulting with those affected by change, the concept of vulnerability adds some clarity to the development and interpretation of indicators by drawing attention to the characteristics that might make it difficult for individuals, groups or communities to cope with, adapt to, bounce back from or, importantly, direct change. Possible measures may include level of economic diversity, poverty, education, and demographic diversity.

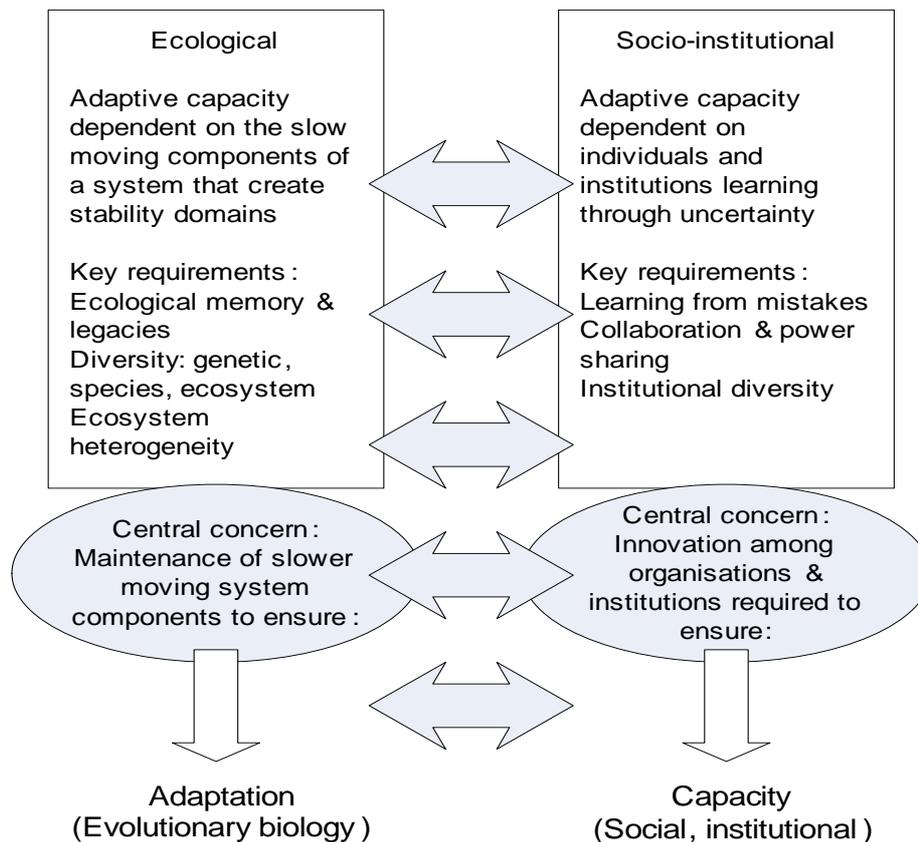
The converse of vulnerability is resilience, or adaptive capacity. Adaptive capacity refers to the ability of a system, either social or ecological, to adapt to change and respond to disturbances while retaining critical integrity and functioning (Armitage 2005; Olsson *et al.* 2004; Folke *et al.* 2003; Walker *et al.* 2002) (see Table 3.1). It is how people and other organisms alter or structurally reorganise their activities to minimise present threats to livelihoods, while enhancing their ability to address new risks (Eakin 2005). This reflects learning, flexibility and the capacity to experiment with novel solutions (Walker *et al.* 2002) in ways that expand the 'range of variability' with which a system can cope (Adger 2003, p. 32).

**Table 2.1 Dimensions of adaptive capacity**

| Component   | Subcomponent  |
|---|---|
| Learning to live with uncertainty, change         | Learn from crises<br>Expect the unexpected<br>Evoke disturbance   |
| Nurture diversity for reorganisation and renewal  | Nurture ecological memory<br>Sustain social memory<br>Enhance socio-ecological memory   |
| Combine different types of knowledge for learning | Combine experiential and experimental knowledge<br>Integrate knowledge of structure and function<br>Incorporate process knowledge into institutions<br>Encourage complementarity of knowledge systems |
| Create opportunities for self-organisation        | Recognise relationship between diversity and disturbance<br>Deal with cross-scale dynamics<br>Match scales of ecosystems and governance<br>Account for external drivers                               |

Source: Folke *et al.* (2003, p. 355).

Despite the similarities, there are important differences in the characteristics of social and ecological systems that support their adaptive capacity. As Figure 2.4 illustrates, the adaptive capacity of ecosystems is derived from slowly changing ecosystem components that foster 'domains of stability' (Armitage 2005, p. 706). In other words, while rapidly changing system components such as insect population cycles, bushfires, floods and droughts promote variability and change, more slowly changing components such as species diversity and spatial connectivity provide a context for these processes that operates at more expansive scales to foster stability and long-term adaptation and evolution (Armitage 2005). The adaptive capacity of social systems, by contrast, relies more heavily on peoples' willingness and ability to anticipate, learn, admit mistakes, collaborate and experiment. The resilience of social groups may, therefore, be defined less by their stability than by their capacity for innovation (Armitage 2005).



**Figure 2.4 Social and ecological dimensions of adaptive capacity**  
(adapted from Armitage 2005, p. 707)

Reflecting these differences, the points at which vulnerability and adaptive capacity can be considered in relation to social and ecological indicators in the PSIR framework are illustrated in Figures 2.5 and 2.6. In both models, adaptive capacity is treated as an intervening variable that helps to determine the appropriate management responses to changes in the physical and social environments. Vulnerability, by contrast, is considered as a mediating variable between pressure and state categories in the case of environmental vulnerabilities (Figure 2.5) and as a mediating variable between state and impact categories in relation to social vulnerabilities (Figure 2.6).

As before, the intention here is to draw resource managers' attention to those issues and features of the social and natural environments that are of most importance to NRM. The ability of the PSIR model, and its derivatives, to inform management in this way can be illustrated by relating the concept of vulnerability to that of risk. After all, it is one thing to know that an ecosystem or community features a number of potential vulnerabilities, but it is quite another to assess how likely particular negative outcomes are to eventuate. By identifying indicators of pressure, state and vulnerability, a simple metric can be developed to calculate risk (see Figure 2.7 and Table 2.2). Environmental systems that experience low pressure and low vulnerability are at low risk, while systems facing high pressure and high vulnerability are at high risk. Equally, communities that experience low rates of environmental change and have low vulnerability are at low risk, while communities that experience significant changes in resource condition and high vulnerability are at high risk.

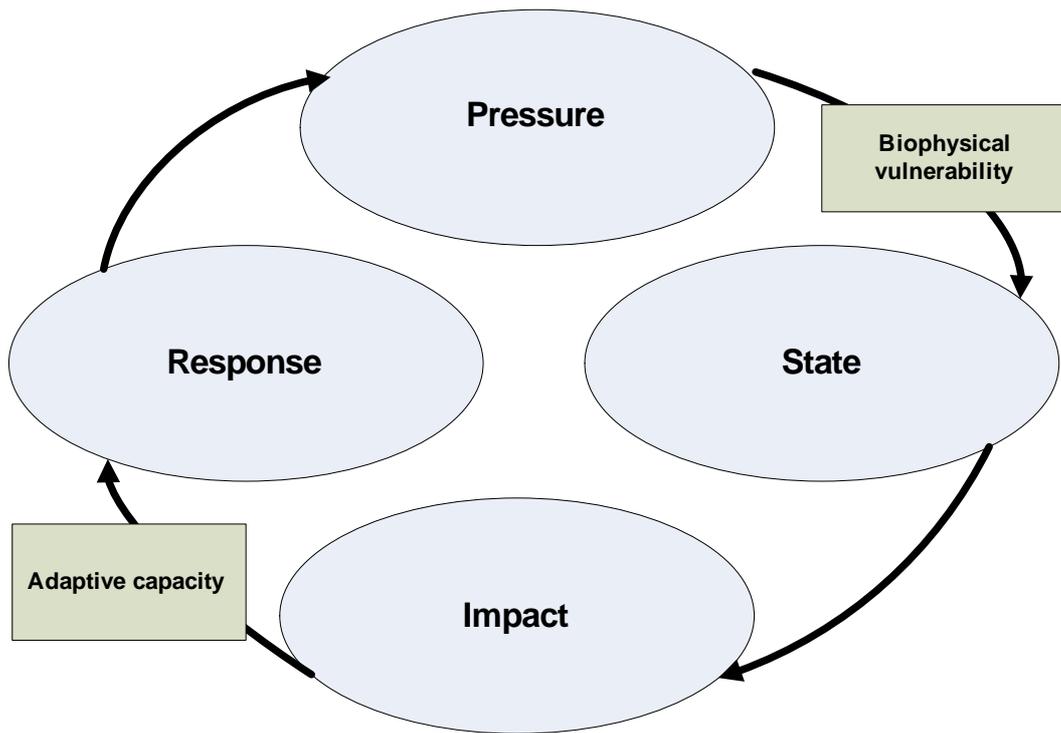


Figure 2.5 Environmental vulnerabilities and adaptive capacity in relation to the PSIR framework

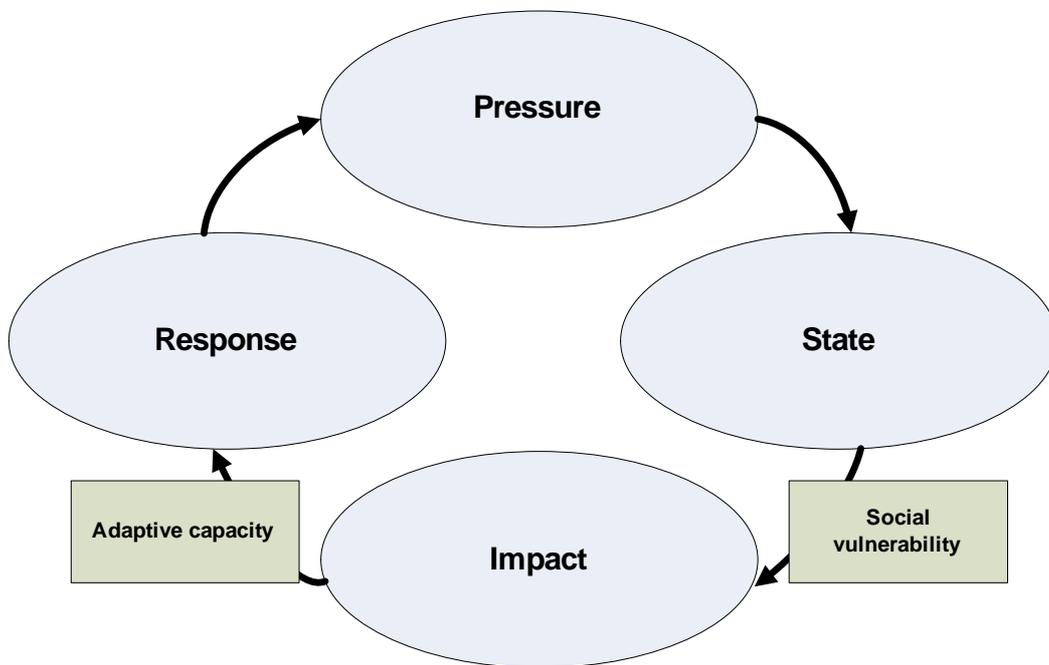


Figure 2.6 Social vulnerabilities and adaptive capacity in relation to the PSIR framework

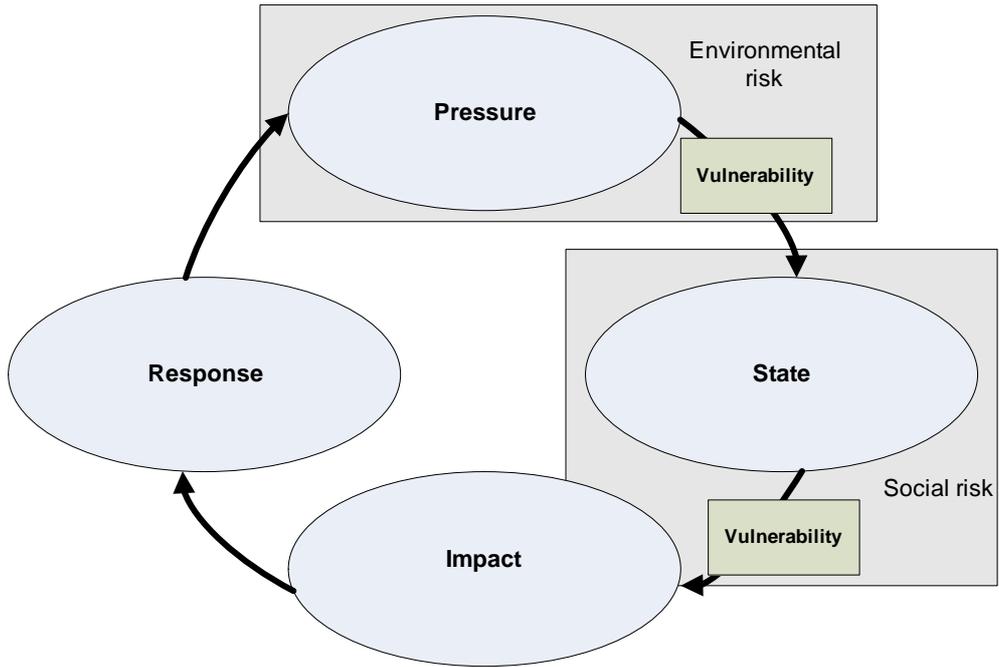


Figure 2.7 Risk within the PSIR framework

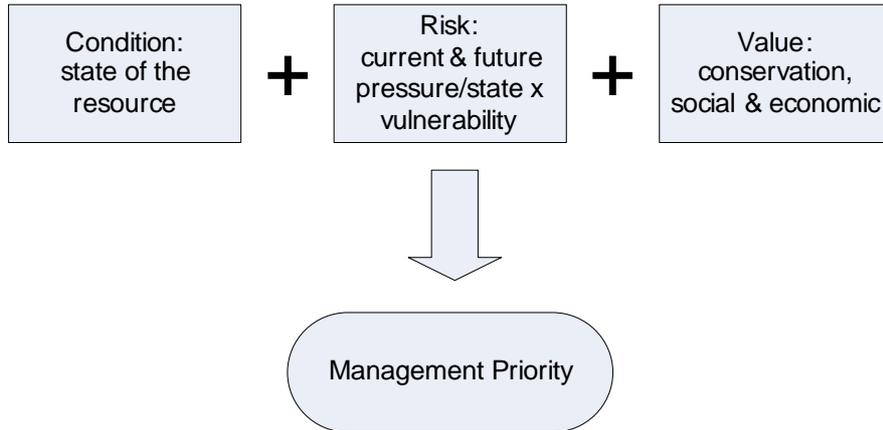
Table 2.2 Categorising environmental risk as a function of pressure and vulnerability

| Risk          |   | Pressure |   |   |   |   |
|---------------|---|----------|---|---|---|---|
|               |   | 1        | 2 | 3 | 4 | 5 |
| Vulnerability | 1 | 1        | 1 | 1 | 2 | 3 |
|               | 2 | 1        | 1 | 2 | 3 | 4 |
|               | 3 | 1        | 2 | 3 | 4 | 5 |
|               | 4 | 2        | 3 | 4 | 5 | 5 |
|               | 5 | 3        | 4 | 5 | 5 | 5 |

Note: 1 = low pressure, vulnerability and risk; 5 = high pressure, vulnerability and risk.

## 2.5 Prioritising management and monitoring strategies

As stated above, the identification of stressors within this framework is informed by community values and issues. Management responses within the PSIR framework are thus seen as a function of the condition or state of the system, the level and type of risks faced by that system, and the values that are placed on the system by various communities of interest (see Figure 2.8).



**Figure 2.8 Setting management priorities**

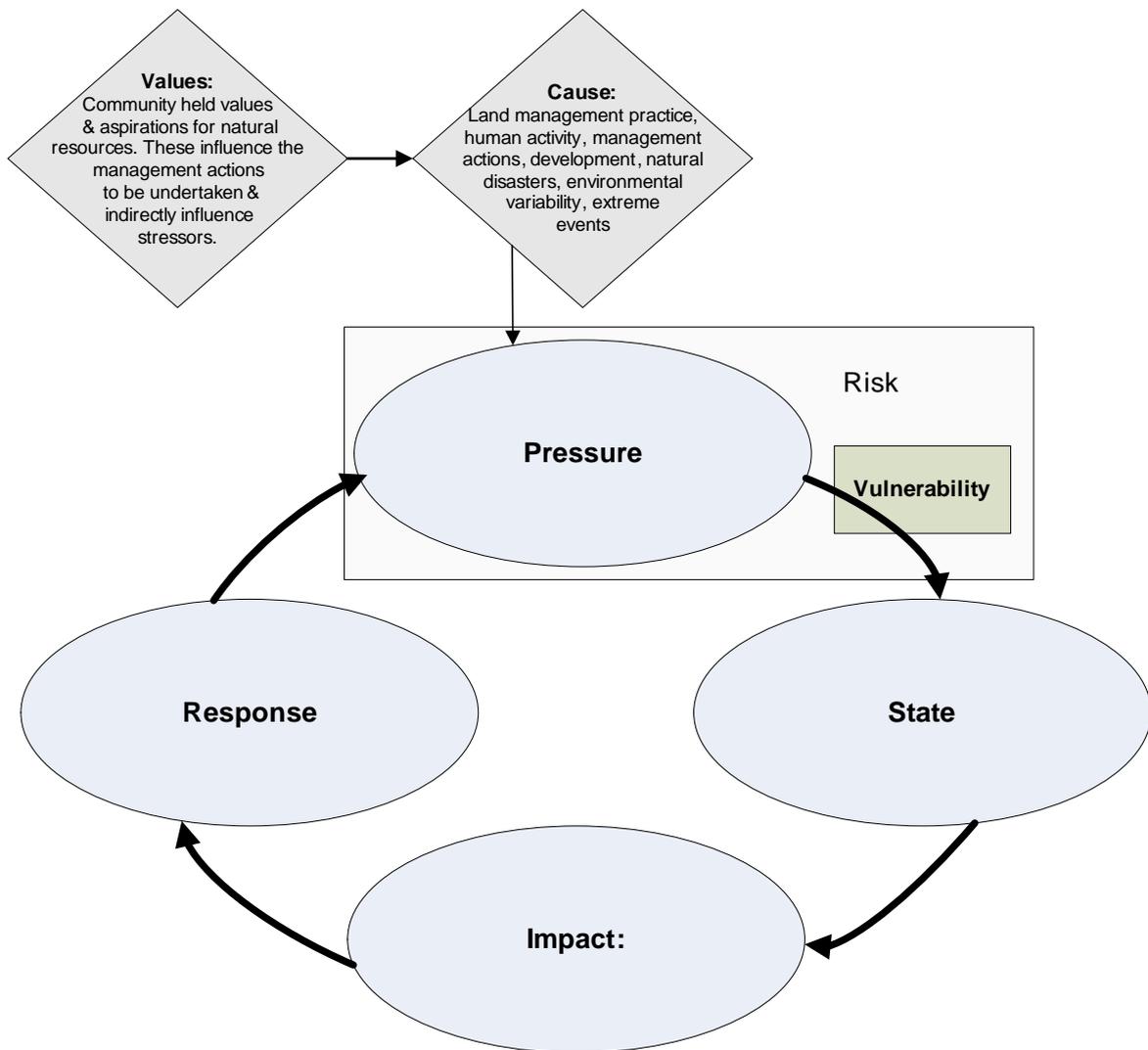
### 3 Environmental change and social impacts in the Fitzroy River estuary, Central Queensland

To illustrate the application and efficacy of the PSIR framework, a brief case study is presented here of social impacts associated with changes in natural resource use and condition in the Fitzroy River estuary of Central Queensland. Reflecting the emphasis of the Coastal CRC on citizen science and adaptive management, this case study was undertaken in an exploratory and participatory manner (see Section 1.3). The information and perspectives provided by stakeholders were integrated with scientific knowledge to develop a better understanding of who is most affected by changes in the natural resource base and how the impacts of those changes might best be monitored by natural resource managers.

Following the PSIR framework, research focused on: (1) identifying those resource use pressures most likely to influence future water quality in the Lower Fitzroy River and adjacent coastal zone; (2) identifying the major environmental changes likely to result from those pressures; and (3) exploring the implications of those environmental changes for human communities.

To simplify the complex array of cause and effects that may be associated with each of the eleven estuarine stressors (see Section 1.3), flow diagrams were compiled to illustrate the relationships between biophysical stressors, biophysical symptoms, social impacts and social indicators (see Figure 3.1). Human values drive the biophysical change which then acts to impact on ecosystem values and human-use values (e.g. recreational values, cultural values, economic values etc. see Moss 2005).

The inclusion of values is important in this approach due to the identification of environmental values in the National Water Quality Management Strategy. Specifying values allows risk and condition to be linked and a better understanding of the dimensions of the impacts from changes to the system. A summary table outlining social indicators for all eleven biophysical stressors is given in Appendices E, I and J. By using the flow diagrams to show the interconnection between the biophysical symptoms and social impacts a number of suitable social indicators are identified for use.



**Figure 3.1 Structure of flow diagrams illustrating relationships between estuarine stressors, resource use pressures, values, and social outcomes**

### 3.1 The social impacts of changed water flow regimes in the Fitzroy

Stakeholders consulted through this research believed the most important NRM issues to assess were a reduction in the volume of water available for consumptive uses, increased sediment and pollution loads due to altered river dynamics, and a reduction in the fishery resource. We will focus here on those social impacts associated with changes in water flow regimes.

In interpreting this data it is important to keep in mind that the purpose of this study was to identify those *potential* impacts for which natural resource managers should consider the implementation of monitoring and/or mitigation strategies. Some impacts may not yet have eventuated and, with appropriate management, may never eventuate. The task of managers is, as articulated above, to assess the risk of impacts and to respond accordingly. These risks will vary for different

ecosystems and communities based on their particular characteristics and vulnerabilities.

Figure 3.2 illustrates the relationship between values, causes, stressors and symptoms to highlight how human values potentially influence biophysical and social change. For example, the biophysical and anthropogenic stressors such as drought, over-extraction, water course changes, and so on, drive change and place stress on water flows (Figure 3.2). Reduced water flows are associated with reduced flushing of the river system, such that sediments and pollutants are more likely to build up, thereby placing pressure on water quality. Sedimentation and pollution of the river and estuary were identified as symptoms of the condition of various resources including river appearance, the marine habitat and fish and seafood stock. The main social issues identified by stakeholders included:

- Increased costs to agriculture, industry and domestic water consumers to access water, along with increased irregularity of supply;
- Health and availability of fish and seafood resources for traditional hunting and fishing by Indigenous people, along with the continuation of cultural and spiritual practices;
- Development of higher rates of social pathologies from deterioration of community identity, bonds and social cohesion within Indigenous communities;
- Health and availability of fish and seafood resources to sustain commercial fishing activity;
- Recreational opportunities along foreshore, waterways and in-shore coastal areas;
- Attractiveness of the area and resources for tourism activities;
- Public health burden and human health decline from exposure to contaminated recreational waters and fish and seafood;
- Breakdown in social cohesion with conflict over access and the future viability of the resource;
- Participation in the fishery resource changed through regulation and the resultant structure of the resource sector favours larger operators and export markets; and
- Negative perceptions of the resource create human health risk, environmental health and resource supply security concerns within the Indigenous community and broader community.

These impacts are summarised in more detail in Table 3.1.

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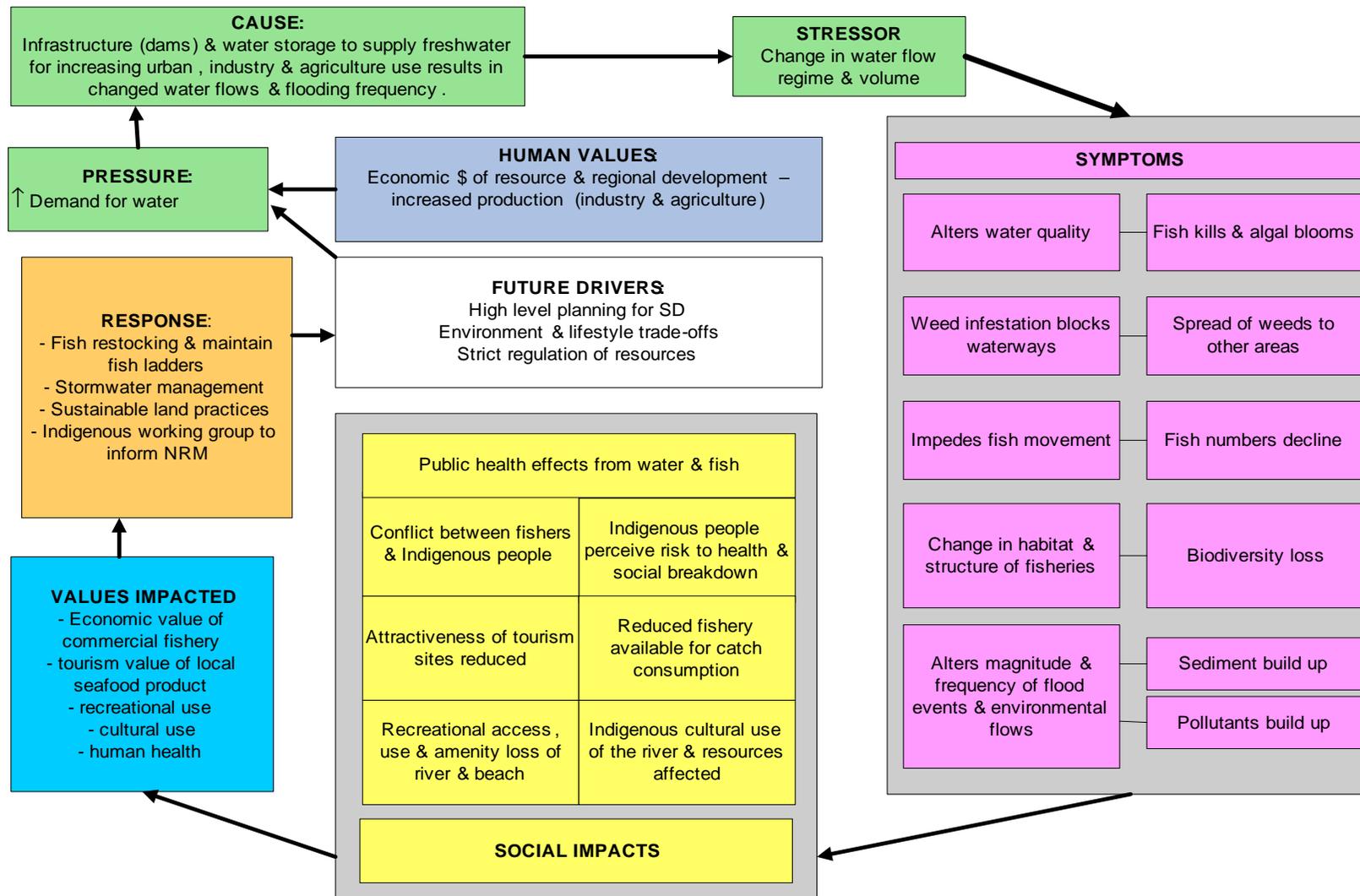


Figure 3.2 Social impacts associated with changed water flow regimes in the Fitzroy

Groups and communities that experience a variety of risks in relation to changed water flows include local communities, commercial and recreational fishers, recreational users of the river and coastal waterways, irrigators, Indigenous communities, tourists, tourism operators and other small businesses (see Appendix H, Part 1). Indigenous communities were one of the most at-risk groups (as displayed in Appendix H, Part 2). The retention of traditional fishing and cultural practices associated with seasonally swollen waterways are integral to the maintenance of Indigenous culture, knowledge and social cohesion. The Woorabinda Aboriginal community in particular have limited recreational access and use of Mimosa creek and lagoon and the loss of gathering places due to the reduced flows and water quality changes. These waterways were perceived to be a public health issue, especially as the birdlife had gone, and children were reported to get sore eyes and ears from swimming.

Indigenous communities reported that their health relies on healthy fish and marine food as a staple diet, and they have concerns about eating locally caught fish. As a substitute local Indigenous people are eating a diet comprising less healthy food options with high proportions of processed foods, placing them at high risk of health complications such as diabetes.

Various data sources exist to measure these impacts including data available from health and hospital databases, reports and enquiries, water quality testing, fish and marine kills databases and community complaints databases (see Appendix H, Part 2), although there are some limitations associated with these data. Difficulty in monitoring Indigenous cultural heritage, amenity and activity was evident by its low usage as a social indicator measure. Problems associated with monitoring and reporting on cultural heritage and practices and aspects of Indigenous health and wellbeing continue to present a challenge and require a collaborative approach with Indigenous communities to identify opportunities and methods to collect data on cultural aspects and build a foundation for longitudinal studies for better understanding of the nature and extent of impacts on community health and social wellbeing.

Mitigation strategies that are an attempt to respond to social impacts and concerns include the construction of bores to supplement water supplies to the Woorabinda community, the development of legal agreements (TUMRAs) on traditional use of marine resources to secure Indigenous interests, and the establishment of working groups to assist with protecting Indigenous interests in decision-making.

**Table 3.1 Summary of social impacts associated with changes in water flows and quality**

| Secondary environmental impacts | Social issues   | Stakeholders affected   | Social impacts  |
|---------------------------------|---|---|---|
| Reduced fish and seafood stocks | Reduced opportunity for recreational and commercial fishing of estuarine fish species → Shift in fishing activity to coast and offshore | Local community<br>Fishers<br>Indigenous community  | <ul style="list-style-type: none"> <li>• Altered system favours less desirable fish species above the barrage</li> <li>• Reduced fishing opportunities for communities above the barrage</li> <li>• Declining recreational fish catches</li> <li>• Significant change to amount of commercial fishing in Great Barrier Reef Marine Park</li> <li>• Changed river structure – no separate waterholes now for recreational use</li> <li>• Infrastructure affects traditional use of the river by Indigenous people (e.g. social gatherings, swimming and fishing)</li> </ul>  |
|                                 | Conflict between commercial and recreational fishers over access to limited fishery resource and the sustainability of the resource     | Fishers   | <ul style="list-style-type: none"> <li>• Negative public perceptions of commercial fishers (even though not all commercial fishers are large-scale operators).</li> </ul>   |
|                                 | Changed access to fisheries resource in Great Barrier Reef Marine Park due to reduced fishery stock                                     | All fishers but commercial fishers more affected<br>Small commercial fishers and family owned businesses<br>Local community<br>Local fish/seafood retailers | <ul style="list-style-type: none"> <li>• Controlled access to fishing areas and gear used</li> <li>• Bag and size limits reduce the recreational fish catch</li> <li>• Fishermen’s Cooperative retail and wholesale stores sold to private businessperson and local buyers affected</li> <li>• Larger commercial fishery operators at an advantage as they export to overseas markets</li> <li>• Fishing closures of 2.5 months affect prawn fishers</li> <li>• Commercial fishers required to look for off season employment</li> <li>• Fish effort indicates fisheries are in decline</li> </ul>  |
|                                 | Indigenous peoples’ dependency on the river changes due to food and food sources being affected by sedimentation                        | Traditional owners<br>Other stakeholder groups due to established access and lack of understanding of traditional hunting and fishing rights                | <ul style="list-style-type: none"> <li>• Cultural connection and identity to food source</li> <li>• Social and economic reliance on fishery resource – estuary fish, turtle, dugong</li> <li>• Good health relies on fish and seafood as staple diet</li> <li>• Perceived health risk to consuming fish</li> <li>• Fish caught above the barrage are perceived to have poor taste</li> <li>• Community affected through health, breakdown in social structures, relationships with other stakeholders and traditional owner groups</li> <li>• Displacement of fisheries influences population shift to access the resource</li> <li>• Shift of fishery activities puts increased pressure on other areas</li> </ul> |

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| <b>Secondary environmental impacts</b> | <b>Social issues</b>  | <b>Stakeholders affected</b>   | <b>Social impacts</b>   |
|--|---|--|---|
|  | Resource accessibility and use affected by crocodiles above the barrage   | Recreational river users<br>Indigenous community   | <ul style="list-style-type: none"> <li>Prevents use of the river for social and competitive sporting events</li> <li>Presence of crocodiles deters use of river for recreation and social gatherings</li> </ul>   |
| Lack of accessible water               | Competing interests for a limited water resource → need for equitable allocation of water use among users   | Local community<br>Farmers<br>Industry<br>Mining<br>Fishers<br>Indigenous community  | <ul style="list-style-type: none"> <li>Environment (flora and fauna) above Fitzroy barrage changed due to water extraction</li> <li>Agriculture benefits with regular water supply</li> <li>Licenses have low flow conditions on them reducing water available for extraction</li> <li>Development increases demand for resources, population increases, traditional laws and culture of Indigenous people affected</li> <li>Water supply for agriculture sector and urban areas affected</li> </ul>  |
| Sediment and pollutants                | Increased pollutants, sediment and nutrients impact on:<br>(1) visual appearance of the river,<br>(2) blue-green algae affecting recreational use,<br>(3) marine habitat and fish and seafood stock and<br>(4) water pollutants affecting human use and consumption | Local community<br>Fishers<br>Recreational users of the river and causeway<br>Irrigators<br>Indigenous community<br>Tourists<br>Tourism operators/small businesses | <ul style="list-style-type: none"> <li>Change in frequency of use of recreation areas</li> <li>Effect on marine flora and fauna, with negative impact on diving</li> <li>Decline in aesthetics of coastal beaches and river result in loss of tourist appeal and community use</li> <li>Accessibility to river for boats and use of ramps</li> <li>Blue-green algae impacts on treatment process, cost of treatment and ability to treat available water</li> <li>Fish kills from algae reduce fish stock</li> <li>Water high in nutrients and sediment effected estuary and river resource (2-3 month shift in prawn inshore fishery)</li> <li>Impact on fish habitat and spawning from runoff into estuary – low water flows, stagnant water and pollutants cause poor fish catch and low fish meat quality</li> <li>Concern water quality impact on tourism – expectation of tourists and deter visitors</li> <li>Impacts on water supply, affect tourism and local community, including farms supplying local markets</li> <li>Pollution from yachts, tankers etc. in creeks and beach affecting use and consumption of fish</li> <li>Indigenous people have limited recreational access/use of creek and lagoon and loss of meeting places</li> <li>Indigenous public health issue – children get sore eyes and ears from swimming in creek and water not good for human consumption or use</li> <li>Sediment is washed into river affecting the health and management of riparian zone</li> </ul> |
|  | Access and use of recreational areas due to sediment deposit  | Community<br>Recreational fishers  | <ul style="list-style-type: none"> <li>Shallow water levels prevent boating activities</li> </ul>   |

## 4 VPSIRR assessment tool: Vulnerability-Pressure-State-Impact-Risk-Response

The VPSIRR assessment tool was developed for the specific purpose of assisting stakeholders and decision-makers to assess the condition of coastal waterways (Moss, 2005; Rissik *et al.*, 2005). It offers the opportunity to direct management responses to where they are required through the use of indicator signals. The VPSIRR approach is an adaptation from the Pressure-State-Response (PSR) and its other derivatives (e.g. Driver-Pressure-State-Impact-Response (DPSIR) of Turner *et al.* (2003)).

This user-friendly software and approach has many positive features. It:

- Shows links between pressures, system vulnerability and resultant condition;
- Is able to assess risks facing the system as a consequence of different pressures;
- Is accessible to a range of users with differing technical ability and knowledge;
- Provides outputs that are easy to decipher such as colour-coded report cards;
- Provides information on the different potential indicators, along guidelines for data collection and analysis;
- Features data and indicators within the VPSIRR software that can be updated when new information comes available;
- Allows stakeholders and the community to set the issues;
- Leads to better stakeholder understanding of the system's functioning and response;
- Allows alternate and future scenarios to be constructed and explored; and
- Assesses that quality and certainty of the data that is used and of the recommendations that are based on this data (Rissik *et al.* 2005).

However, the lack of social data on values in some areas may limit use of the software. In general, the approach is biophysically focused and further development on the social aspects will contribute to the improved management of estuarine and coastal systems. Addition of basic features to the 'scenario' approach used by the VPSIRR framework could include information on social stressors and pressures, condition, social vulnerability, ability to respond and risk.

The VPSIRR software is relatively new and was produced through a joint venture between researchers from the Coastal CRC, Queensland Environmental Protection Agency, NSW Department of Infrastructure, Planning and Natural Resources, and Victorian Environmental Protection Agency. Further details on this assessment tool are available, along with instructions on its use (Moss 2005; Rissik *et al.* 2005).

## 5 Conclusion

This report has outlined the PSIR framework, and its derivatives, with a view to promoting these as appropriate models for the development of validated sets of indicators and supporting software with which to monitor progress towards sustainable resource use (see also Lockie *et al.* 2004; Moss 2005; Rockloff *et al.* 2005).

The PSIR model offers a framework for indicator identification that avoids *ad hoc*, and potentially inefficient, indicator selection and monitoring. The model builds our understanding of complex human-biophysical interactions associated with natural resource management, especially from the view of how social factors affect and are affected by the biophysical environment. Use of this framework advances our understanding of the nature of relationships between the biophysical and social environments, and helps to demonstrate the sequence of social effects for relevant estuarine and freshwater stressors. The PSIR framework helps to link biophysical and social research activities and provide a starting point for integration across the disciplines. The biophysical stressors identified and defined, for example, in the Coastal CRC's *User's guide to estuarine, coastal and marine indicators for regional NRM monitoring* (Scheltinga *et al.* 2004) formed the basis for the social impact assessment component of this research.

We recognise that much remains to be done in furthering this framework and indicator set, including:

- Promoting to regional NRM groups and government agencies the value and need for integrated approaches to monitoring and reporting on natural resource changes;
- Developing adequate data systems to support an integrated approach to monitoring and reporting and making these databases easily accessible;
- Improving harmonisation of biophysical and social indicator sets to deal with the assessment and measurement of progress towards sustainability and the use of triple bottom line accounting;
- Linking assessment and measurement work to decision-making and policy-making by embracing an adaptive management approach in decision-making;
- Attending to impacts on livelihoods and the vulnerability of communities from management decisions;

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- Refining indicators of adaptive capacity for both social and natural environments; and
- Determining equitable distribution of costs and benefits arising from management changes.

Further work will require the provision of adequate resources (time, expertise and funds) and a commitment to collect new data if required.

The potential contribution of a set of integrated indicators and their associated conceptual framework resides in their function to assess the performance of governance processes involved in integrated coastal management. They possess the potential to improve adaptive management and accountability in decision-making when focused on the evaluation phase. Working within an adaptive management framework supports current NRM approaches being advocated at regional, state and national levels.

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<[http://www.sidsnet.org/docshare/other/20040220144153\\_Final\\_report\\_on\\_USP\\_capacity\\_meeting\\_education.doc](http://www.sidsnet.org/docshare/other/20040220144153_Final_report_on_USP_capacity_meeting_education.doc)>.

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## Appendix A

### Modified SMART filter criteria for assessing prospective indicators

| <b>Modified SMART filter criteria</b> |   |
|---------------------------------------|---|
| <b>Simple</b>                         | Easily interpreted<br>Easily monitored<br>Industry acceptance<br>Professional acceptance<br>Appropriate for community use   |
| <b>Measurable</b>                     | Mappable<br>Statistically verifiable, reproducible and comparable<br>Can be aggregated<br>Can be combined with others to form indices<br>Can show trends over time  |
| <b>Accessible</b>                     | Regularly monitored<br>In use by managers<br>Cost effective<br>Consistent with other data sources   |
| <b>Relevant</b>                       | Related to highly valued NRM factor<br>Linked to regional NRM policies/goals<br>Linked to state and national processes  |
| <b>Timely</b>                         | Early warning of potential problems<br>Highlights future needs/issues:<br>Where is data collected?<br>Problems with data (reliability/validity) or collection?<br>How do you deal with uncertainty in data?<br>How do you deal with conflicting data? |

## Appendix B

### List of general references and social data sources

The references and data sources are categorised under 16 subject headings and organised according to their geographical areas: The following subject headings were used:

- 1) Water quality
- 2) Water quantity/supply
- 3) Air quality
- 4) Safety
- 5) Boating/shipping movements
- 6) Fish/seafood catch/stock
- 7) Turtles/dugongs
- 8) Coral reefs
- 9) Tourism
- 10) Recreation
- 11) Access
- 12) Economics
- 13) Education and awareness
- 14) Health
- 15) Other Indigenous Issues
- 16) General/other

The abbreviations at the left of each reference indicate if the reference pertains to:

- |     |                    |
|-----|--------------------|
| Q   | Queensland         |
| CQ  | Central Queensland |
| PC  | Port Curtis        |
| F   | Fitzroy            |
| GBR | Great Barrier Reef |

**Acronyms used:**

|           |  |
|-----------|--|
| AMSA      | Australian Maritime Safety Agency  |
| CEM       | Centre for Environmental Management                                      |
| CFISH     | Commercial Fisheries Information System                                  |
| CQ        | Central Queensland   |
| CQPA      | Central Queensland Port Authority (formerly GPA)                         |
| CQU       | Central Queensland University  |
| CRC       | Cooperative Research Centre  |
| DEH       | Department of Environment and Heritage                                   |
| DNRMW     | Department of Natural Resources, Mines and Water                         |
| DPIF      | Department of Primary Industries and Fisheries                           |
| DSDI      | Department of State Development and Innovation                           |
| EPA       | Environmental Protection Agency  |
| F         | Fitzroy Area   |
| FBA       | Fitzroy Basin Association  |
| FBEC      | Fitzroy Basin Elders Committee   |
| FOI       | Freedom of Information   |
| FRDC      | Fisheries Research and Development Corporation                           |
| FRW       | Fitzroy River Water  |
| GAPDL     | Gladstone Area Promotion and Development Limited                         |
| GCCI      | Gladstone Chamber of Commerce and Industry                               |
| GIS       | Geographic information system  |
| GBR       | Great Barrier Reef   |
| GBRMPA    | Great Barrier Reef Marine Park Authority                                 |
| GPA       | Gladstone Port Authority (now CQPA)                                      |
| IMO       | International Maritime Organisation                                      |
| ISRD      | Institute for Sustainable Regional Development                           |
| JCU       | James Cook University  |
| LGAQ      | Local Government Association of Queensland                               |
| LSC       | Livingstone Shire Council  |
| MSQ       | Maritime Safety Queensland   |
| NNTT      | National Native Title Tribunal   |
| PC        | Port Curtis Area   |
| Q or QLD  | Queensland   |
| QAL       | Queensland Alumina Limited   |
| QCCAP     | Queensland Coastal Contingency Action Plan                               |
| QPWS      | Queensland Parks and Wildlife Service                                    |
| QSIA      | Queensland Seafood Industry Association                                  |
| QSIO      | Queensland Seafood Industry Organisation                                 |
| REIA/REIQ | Real Estate Institute of Australia / Real Estate Institute of Queensland |
| RCC       | Rockhampton City Council   |
| RFISH     | Recreational Fishing Information System                                  |
| ROP       | Resource Operations Plan   |
| SPP       | Southern Pacific Petroleum   |
| TEOM      | Tapered-Element Oscillating Microbalance                                 |
| UQ        | University of Queensland   |
| WAMP      | Water Allocation and Management Plan                                     |
| WRP       | Water Resource Plan  |

## 1. Water quality

- Q John Wright (QCCAP) Manager of Pollution Response 3120 7411
- CQ Local councils – Number and size of residential development applications
- F Coastal CRC – M. Dobbie, B. Harch and R. Packett (2003) *Statistical analysis of the water quality of the Fitzroy River estuary: recommendations for improving current monitoring practices*. Technical Report 10  
[http://www.coastal.crc.org.au/pdf/TechnicalReports/10-fitzroy\\_water\\_qual.pdf](http://www.coastal.crc.org.au/pdf/TechnicalReports/10-fitzroy_water_qual.pdf)
- F FBA – A strategic plan for water quality can be found in *The Central Queensland Strategy for Sustainability – 2004 and Beyond (CQSS2)*  
[http://www.fba.org.au/files/CQss2\\_for\\_accreditation\\_v5.pdf](http://www.fba.org.au/files/CQss2_for_accreditation_v5.pdf)
- F DNRMW – Water quality monitoring  
<http://www.nrm.qld.gov.au/asdd/qsi2/ANZQL0132001677.html>
- F QPWS Marine Parks Office – Water quality program for Keppel Bay (monthly)
- F Woorabinda Council's Water Office (Keith Nunn) – Water sampling data for bores (sent to CQU for analysis)
- F Coastal CRC and CQU - *Engineering the Fitzroy*  
<http://www.coastal.crc.org.au/envhist/engineering/index.htm>
- F CQU – B Soetanto and J Piorewicz (2005) *Causeway Lake, Capricorn Coast Queensland: field data analysis*. Research Report No CE34 (for siltation changes)
- F Coastal CRC – *Sources of sediment in the Fitzroy River Basin and Estuary*  
[http://www.coastal.crc.org.au/pdf/brochure\\_sources\\_sediment\\_fitzroy.pdf](http://www.coastal.crc.org.au/pdf/brochure_sources_sediment_fitzroy.pdf)
- F LSC – Stormwater Quality Management Plan (Draft)
- F LSC – R Ellison and Associates (2003) *Yeppoon urban storm water quality study* (Revision No 2)
- F LSC's Civil Operations Dept – Analysis of garbage from pollutant traps  
<http://www.livingstone.qld.gov.au/>
- F FRW – Monitoring of discharge from treatment plants (EPA requirement), inflows and outflows from the barrage and actual storage (ROP), bank slumping and erosion (ROP; Data with DNRMW) with video footage, algal bloom incidents; Records of costs for drinking water treatment; Salinity; etc.  
<http://www.frw.com.au/environment.php>
- F RCC – Water quality reports from FRW <http://www.rockhampton.qld.gov.au/>
- F EPA and RCC – Monitoring of landfill leakage into Fitzroy River and creeks
- F RCC's Environmental Services – Generally in charge of water weed collection from the Fitzroy River
- F Private landowners – Also in charge of cleaning up water weeds found adjacent to their properties along the Fitzroy River
- PC CQPA – Continuous monitoring of water quality of Gladstone Harbour (Data at CQPA's Kullaroo House) <http://www.gpa.org.au/Sections/Student/Student.htm>
- PC EPA – Water quality tests outside of port operations and other areas (e.g. Boyne and Calliope Rivers)  
[http://www.epa.qld.gov.au/environmental\\_management/water/water\\_quality\\_monitoring/](http://www.epa.qld.gov.au/environmental_management/water/water_quality_monitoring/)
- PC CQPA (training and equipment) and MSQ (manpower) – Monitoring pollution, including Transport Safety Marine Pollution Act and Regulations

- PC MSQ – Monitoring and inspection of logbooks on board vessels with data on sewerage disposal and other pollutants  
[http://www.msq.qld.gov.au/qt/msq.nsf/index/sewage\\_mgt](http://www.msq.qld.gov.au/qt/msq.nsf/index/sewage_mgt)
- PC MSQ – Annual reports (for data on spillage from boats)
- PC CQPA – Tests for impacts of coal dust on water quality (EPA requirement) and own water quality monitoring (for internal use only)
- PC Coastal CRC – L Andersen (2004) *Imposex in the City: A survey to monitor the effects of TBT contamination in Port Curtis, Queensland*, Coastal CRC Technical Report 14; Leonie Andersen (CQU-CEM)  
<http://www.coastal.crc.org.au/Publications/download-14Imposex.asp>
- PC Coastal CRC – Port Curtis Contaminant Risk Assessment Team (2004) *Contaminants in Port Curtis: screening level risk assessment*. Draft final report.
- PC CQU – Jones, M. (2002). *Assessing the risk from chemical contaminants in the Port Curtis Estuary, Australia*. Unpublished Masters Thesis.
- PC Coastal CRC, CQU-CEM, Griffith University – Use of Contaminant-sensitive oysters to monitor water quality; Leonie Andersen (CQU-CEM) 4970 7315 or [l.andersen@cqu.edu.au](mailto:l.andersen@cqu.edu.au)
- PC MSQ – Spills from cargo/ships resulting in pollution within the Gladstone Region are reported to the Regional Harbourmaster via Vessel Traffic Service (date, location, names of owner and operator, name and type of vessel, amount of oil spilled, type of pollutant spilled, circumstances surrounding the spill, etc.)
- PC Magistrate’s Court or MSQ Prosecutors Branch – Details on prosecution of offenders (i.e. oil spills)
- PC QLD Transport – Monitoring of oil spills in the harbour with surveillance cameras; Inspections done by Environmental Officers
- PC QLD Transport, Harbourmaster, and AMSA – Severe cases of oil spills
- PC Impact assessment statements (in general) – Social impacts of oil spills
- PC EPA – Information on license breaches and spills
- PC Annual returns reports (for details on spills not covered by QLD Transport)
- PC AMSA and IMO – Data in ship logs on ballast water release and collection
- PC National study (DEH) - Introduced pests from ships  
<http://www.deh.gov.au/coasts/imps/>
- PC CQPA (with Coastal CRC and CQU-CEM) – Ballast water testing study; Monitoring of marine pests <http://www.gpa.org.au/Sections/Student/Student.htm>
- PC GPA – L Andersen, A Storey and S Fox (2004) *Assessing the effects of harbour dredging using transplanted oysters as biomonitors*; Leonie Andersen (CQU-CEM) [www.ahs.cqu.edu.au/cem/staff/leonie.htm](http://www.ahs.cqu.edu.au/cem/staff/leonie.htm)
- PC CQPA – Long term dredging studies (information on frequency and location of dredging in harbour); All dredging data is submitted to EPA (including dredging plans for EPA approval)
- PC DEH – Spoil site (dredging) data
- PC EPA – Land (dredging) information
- PC Spoil grounds for dredging (Map)
- PC Magistrate’s Court – Records of prosecutions involving developers breaching plans and regulations on sediment and erosion control; Calliope Shire Council - Records on correspondence (i.e., letters) between Council and developers; Development applications lodged with Council (and presented at Council meetings)  
<http://www.calliope.qld.gov.au/Publications/Docs/minutes.htm>

- PC Gladstone Shire Council – Meeting minutes and development applications
- PC QLD Transport – Number of boat and jet ski registrations, number of people with water skis (for river bank erosion); Gladstone Area Promotion and Development – Boat ownership records
- PC Coastal CRC – Research on sedimentation
- PC CQPA – Stormwater management control (water quality testing data for runoff into the harbour from stormwater holding ponds); Monitoring of drains; Severe cases reported to EPA
- PC L Andersen (with Coastal CRC) – Ecological risk assessment of contaminants + Sources of contaminants and their biological effects (Phase 2)
- PC CQPA and CQU-CEM – Benthic fauna monitoring in area of port operations  
<http://www.gpa.org.au/Sections/Student/Student.htm>

## **2. Water quantity/supply**

- Q DNRMW – Routine water quantity monitoring <http://www.nrm.qld.gov.au/index.html>
- Q LSC – Local Government Association of Queensland (no date). Water conservation options for urban settings. <http://www.livingstone.qld.gov.au/commser/wcou.pdf>
- Q DSDI – Information on the Central Queensland Regional Water Supply Study  
[http://www.sdi.qld.gov.au/dsdweb/v3/guis/templates/content/gui\\_cue\\_cntnhtml.cfm?id=4117](http://www.sdi.qld.gov.au/dsdweb/v3/guis/templates/content/gui_cue_cntnhtml.cfm?id=4117)
- CQ DNRMW – Central Queensland Regional Water Supply Study
- F LSC – Sample of Council general meeting minutes on water supply and further subdivisional developments
- F FRW's Business Support Services and Process Manager – Complaints collected as part of the Strategic Asset Management Plan (Water Act; DNRMW); Corrective action request procedure (Community Comment form) and a customer assistance tracker procedure <http://www.frw.com.au/comment.php>
- F FRW – Media releases on water supply status (For instance, see Water supply back online)  
<http://www.frw.com.au/pressreleases/Water%20shutdown%20follow%20up%20040217.pdf>
- F LSC – Cardno MBK (2005) Capricorn Coast Water Supply Sources Study  
<http://www.livingstone.qld.gov.au/commser/watersupply.htm>
- F DNRMW – DNR (1999) Water Allocation Management Plan (Fitzroy Basin) (for regulation of water flows and their effects)
- F DNRMW – Gutteridge Haskins & Davey Pty Ltd (1998) WAMP for the Fitzroy Basin Catchment: Indigenous consultation (Progress Report for Sep/Oct 1998)
- F DNRMW – DNRMW (2001) Information report: Fitzroy Water Resource Plan (WRP)
- F DNRMW – Fitzroy Water Resource Plan (will be finalized around July 2005)
- F DNRMW – DNRMW (2004) Fitzroy Basin social and economic assessment: overland flow water  
[http://www.nrm.qld.gov.au/wrp/pdf/fitz/wrp\\_amend\\_social\\_rep.pdf](http://www.nrm.qld.gov.au/wrp/pdf/fitz/wrp_amend_social_rep.pdf)

- PC DNRMW – DNRMW (2005) Calliope River Basin draft water resource plan: economic and social assessment report (including Indigenous cultural heritage values) [http://www.nrm.qld.gov.au/wrp/pdf/calliope\\_economic\\_social\\_rep.pdf](http://www.nrm.qld.gov.au/wrp/pdf/calliope_economic_social_rep.pdf)
- PC Gladstone Observer – Articles on rise in water costs; Residents seek water answers and Price may discourage industry (01 Feb 2005)
- PC Productivity Commission – Impacts of native vegetation and biodiversity regulations: public inquiry (Attached: Letter/Supplementary submission from the East End Mine Action Group, Inc attached)

### 3. Air quality

- Q EPA – National Environment Protection Measure (NEPM) for monitoring of air pollution levels  
[http://www.epa.qld.gov.au/environmental\\_management/air/air\\_quality\\_monitoring/air\\_quality\\_reports/](http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_quality_reports/)
- CQ FOI (EPA) through Jamie Abbott 3237 1048 – Data from all industries in Port Curtis (measuring/monitoring whatever is on their license) (e.g. Boyne Smelter measures fluoride in the air)  
[http://www.epa.qld.gov.au/about\\_the\\_epa/freedom\\_of\\_information/](http://www.epa.qld.gov.au/about_the_epa/freedom_of_information/)
- CQ EPA – Air quality bulletin: Central Queensland (Jan 2004)
- CQ EPA – Annual return reports submitted by industries (required by licensing agreement) including spills/blowouts, emission information, incidents and breaches
- CQ EPA – Complaints database (including investigation associated with complaint and associated mitigation strategies taken by EPA)
- PC EPA – National Pollution Index website [www.npi.gov.au](http://www.npi.gov.au)
- PC CQPA – Complaints register/database for coal dust impacts, including photos (internal use only)
- PC Gladstone City Council and EPA – Database for complaints about coal dust; Meeting minutes (e.g. where increased buffers are required)  
<http://www.gladstonecc.qld.gov.au/>
- PC CQPA – Tests for coal dust on various properties (e.g. Auckland Hill using automatic TEOM) <http://www.gpa.org.au/Sections/Student/Student.htm>
- PC CQU-CEM and EPA – CEM monitoring of coal dust and impacts; Results are lodged with Annual Returns and submitted to EPA
- PC QAL or QAL's insurance company or through FOI – Number of cars repainted by QAL; Annual budget/expenses associated with car painting and damages from caustic emissions
- PC Lawyers and Settlements – Case registration form for a class action lawsuit filed against SPP and eight other companies for alleged personal injury, nuisance and property devaluation in regards to the Stuart Shale Oil Project  
[https://www.lawyersandsettlements.com/case/southern\\_pacific](https://www.lawyersandsettlements.com/case/southern_pacific)
- PC Greenpeace – Sample letter of appeal to investors of the Stuart Shale Oil Project to withdraw from investment
- PC Greenpeace – Shale oil campaign overview  
<http://www.greenpeace.org.au/climate/causes/criminals/shaleoil/overview.html>

- PC Department of Treasury – Fuel Taxation Inquiry website for shale oil; 2001 letter from the Wildlife Preservation Society of QLD  
[http://fueltaxinquiry.treasury.gov.au/content/Submissions/Industry/WPSQ\\_135.asp](http://fueltaxinquiry.treasury.gov.au/content/Submissions/Industry/WPSQ_135.asp)

#### **4. Safety**

- Q Australian Transport Safety Bureau – Detailed reports and investigations on shipping and boating accidents <http://www.atsb.gov.au/marine/incident/index.cfm>
- F CQU/Coastal CRC – Piorewicz, J (ed) (2002) Proceedings of the public workshop “Beach protection: risk and management”
- PC CQPA and MSQ – Monitoring the Transport Operations Marine Safety Act and Regulations and the Maritime Safety Queensland Act  
[http://www.msq.qld.gov.au/qt/MSQ.nsf/index/tomsa\\_review\\_standards](http://www.msq.qld.gov.au/qt/MSQ.nsf/index/tomsa_review_standards)
- PC MSQ – Internal records monitoring maritime safety (number of fatalities or serious injuries, speeding fines, etc.)
- PC Emergency services and Coastguard response databases
- PC MSQ – Marine incidents annual reports (information on commercial/recreational boat numbers by region, statistics on commercial/recreational incidents by boat type and region, as well as fatalities and emergency involvement, etc.)  
[http://www.msq.qld.gov.au/qt/MSQ.nsf/index/incidents\\_annual\\_report](http://www.msq.qld.gov.au/qt/MSQ.nsf/index/incidents_annual_report)
- PC Boat sales
- PC Spaces in Marina for boats <http://www.gpa.org.au/Pages/Marina/Marina.asp>
- PC MSQ – GIS data for surveying dredged channels for safety purposes (depth, tide lapses, etc.)

#### **5. Boating/shipping movements**

- PC CQPA and MSQ websites – Shipping movements in the harbour  
<http://www.smd4.transport.qld.gov.au/>; Including lists of import/export commodities on an annual basis and may have individual loadings of coal ships  
[http://www.transport.qld.gov.au/qt/RPF.nsf/ReferenceLookup/TSR2004%20reformatted\\_010305.pdf/\\$file/TSR2004%20reformatted\\_010305.pdf](http://www.transport.qld.gov.au/qt/RPF.nsf/ReferenceLookup/TSR2004%20reformatted_010305.pdf/$file/TSR2004%20reformatted_010305.pdf)
- PC Marina – Reports on breaches in Marina (recorded conversations)

#### **6. Fish/seafood catch/stock**

- Q Reef CRC – Fenton, D M, Marshall, N A (2001) A guide to the fishers of Queensland. Part A: TRC analysis and social profiles of Queensland's commercial fishing industry. CRC Reef Research Centre Technical Report No. 36  
[http://www.reef.crc.org.au/research/fishing\\_fisheries/commercial.html](http://www.reef.crc.org.au/research/fishing_fisheries/commercial.html)
- Q Reef CRC – Fenton, D M, Marshall, N A (2001) A guide to the fishers of Queensland. Part B: TRC analysis and social profiles of Queensland's harvest industry. CRC Reef Research Centre, Technical Report. No. 37  
[http://www.reef.crc.org.au/research/fishing\\_fisheries/harvest.html](http://www.reef.crc.org.au/research/fishing_fisheries/harvest.html)

- Q Reef CRC – Fenton, D M, Marshall, N A (2001) A guide to the fishers of Queensland. Part C: TRC analysis and social profiles of Queensland's charter fishing industry. CRC Reef Research Centre Technical Report No. 38  
[http://www.reef.crc.org.au/research/fishing\\_fisheries/charter.html](http://www.reef.crc.org.au/research/fishing_fisheries/charter.html)
- Q DPIF – Commercial fishing: East Coast Trawl Fishery Logbook and Reef Line Fishery Logbooks (for GBR) (CFISH) <http://www.dpi.qld.gov.au/fishweb/2984.html>
- Q DPIF – Coastal Habitat Resources Information System (CHRIS)  
<http://chrisweb.dpi.qld.gov.au/CHRIS/>
- Q DPIF – Recreational fishing: Personal logbook (RFISH)  
<http://www.dpi.qld.gov.au/fishweb/2871.html>
- Q DPIF – 2005 Online Diary Survey (RFISH)  
<http://www.dpi.qld.gov.au/fishweb/16507.html>
- Q Sunfish – Recreational catch data  
[http://www.sunfishqld.com.au/\(5u2gg0e4ebwhfx45pbhnd55\)/Default.aspx](http://www.sunfishqld.com.au/(5u2gg0e4ebwhfx45pbhnd55)/Default.aspx)
- Q DNRMW – Biological monitoring (e.g. fish movements) during events
- Q DPIF – Environmental flows for estuaries – Summary of Barramundi Talk at “Estuaries and Change” Conference 2004 <http://www.dpi.qld.gov.au/far/15554.html>
- Q William Sawynok – Sunfish for fish stocking and Suntag for tagging [www.info-fish.net/default.asp](http://www.info-fish.net/default.asp)
- Q EPA – Fish kills data; Annual reports  
[http://www.epa.qld.gov.au/environmental\\_management/water/water\\_quality\\_monitoring/fish\\_kill\\_reporting/recently\\_reported\\_fish\\_kills/](http://www.epa.qld.gov.au/environmental_management/water/water_quality_monitoring/fish_kill_reporting/recently_reported_fish_kills/)
- Q DPIF – SJ Hyland (Mar 2000) An investigation of the impacts of ponded pastures on barramundi and other fin fish populations in tropical coastal wetlands; Poned Pastures Steering Committee (Dec 1997) Policy Options Paper (Project and research report descriptions found on <http://www.dpi.qld.gov.au/far/9278.html>)
- Q QSIA – (no date) GBR SAP: results of buyback scheme – initial summary.  
[www.seafoodsite.com.au/pdfmedia/GBRSAP%20Results2.doc](http://www.seafoodsite.com.au/pdfmedia/GBRSAP%20Results2.doc)
- CQ Coastal CRC – (May 2002) Exploring coastal science: flowing estuaries needed for healthy fisheries management.  
[http://www.coastal.crc.org.au/pdf/exploring\\_coastal\\_science/flow\\_estuaries.pdf](http://www.coastal.crc.org.au/pdf/exploring_coastal_science/flow_estuaries.pdf)
- CQ Fish shops, retailers, licensed buyers – Sources of local catch data
- GBR GBRMPA – A report assessing the potential impact on commercial fishing and associated communities (Bureau of Rural Sciences)  
[http://www.affa.gov.au/corporate\\_docs/publications/pdf/rural\\_science/social\\_science/GBRMP.pdf](http://www.affa.gov.au/corporate_docs/publications/pdf/rural_science/social_science/GBRMP.pdf)
- GBR Coastal CRC – Monitoring of fisheries production
- GBR North Keppel Environmental Centre – Involved in research on introduced species
- F Coastal CRC – (Feb 2004) The role of environmental flows and estuarine habitats, fisheries and biodiversity. In New Coastal Science for the Fitzroy Estuary.  
[http://www.coastal.crc.org.au/pdf/exploring\\_coastal\\_science/Fitzroy\\_4pager.pdf](http://www.coastal.crc.org.au/pdf/exploring_coastal_science/Fitzroy_4pager.pdf)
- F Coastal CRC – (Feb 2004) The influence of altered river flow on trophic relationships of estuarine fish faunas. In New Coastal Science for the Fitzroy Estuary.  
[http://www.coastal.crc.org.au/pdf/exploring\\_coastal\\_science/Fitzroy\\_4pager.pdf](http://www.coastal.crc.org.au/pdf/exploring_coastal_science/Fitzroy_4pager.pdf)
- F Coastal CRC – Fitzroy Estuary conceptual model (barramundi and prawns) (Draft, Mar 2005) outlines spawning and distribution based on estuarine conditions after flow events

- F Newspaper articles – Conflict between commercial and recreational fishing sectors
- F Bruce Sagnol – Fitzroy River Fish Stocking Group (or Fitzroy River Fish Management Group – Fitzroy Barrage: 25 Lindley's Road Rockhampton Mail Centre QLD 4701)
- F RCC – Maintenance of fish ladder at the barrage  
<http://www.rockhampton.qld.gov.au/>
- F Malcolm Vanderheiden (QSIO Yeppoon) – 1973 Aerial video footage of ponded pastures (impacting fish stock and catch)
- PC Jacqui Johnson (head of local Indigenous group in Gladstone) 4972 2430
- PC Griffith University/Coastal CRC – Connolly, R and M Guest (no date) Critical estuarine habitats for foodwebs supporting fisheries in Port Curtis, Central Queensland, Australia
- PC CQU-CEM – Investigation of mud crab shell disease due to contaminants in the water; Andersen, L.E. (2003) A study into the epidemiology of mud crab (*Scylla serrata*) shell disease. Master of Applied Science thesis. And Andersen, L.E. and Norton, John (2001) Port Curtis mud crab shell disease: nature, distribution and Management. Final Report to FRDC for project No. 98/210. CQU-CEM and DPIF  
<http://ahs.cqu.edu.au/cem/staff/leonie.htm>
- PC Canadian Council of Ministers of the Environment (2000) Canadian environmental quality guidelines; Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota: methyl mercury
- PC EPA - Effects of Boyne Smelter operations on fish/seafood
- PC CQU-CEM – Andersen, L.E., Storey, A.W., Sinkinson, A and Dytlewski, N. (2003) Transplanted oysters and resident mud crabs as biomonitors in Spillway Creek. (Report to Boyne Smelters Limited) <http://ahs.cqu.edu.au/cem/staff/leonie.htm>
- PC Fish processors – Monitoring of toxin levels in fish/seafood
- PC DPIF – Fish kills
- PC Coastal CRC and CQU-CEM – Lewis, S, Hewitt, C. and Melzer, A. (2001) Port survey for introduced marine species—Port Curtis. Final report (PC4.7)
- PC GPA and CQU – Lewis, S, Hewitt, C. and Melzer, A. (2001) Port survey for introduced marine species—Port Curtis. Final report; Lewis, S., Hewitt, C. and Melzer, A. (2000) Port survey for introduced marine species—Port Curtis. Preliminary report.

## **7. Turtles/dugongs**

- Q DPIF – Electronic Catch Effort Reporting System (ECERS) and the Species of Conservation Interest Logbook for interactions in threatened or protected species (to be reported to Environment Australia and other organisations)
- Q QPWS/EPA – Marine wildlife stranding and mortality database annual reports (compiled by Dr Colin Limpus 3227 7718); 1999 Annual stranding report (dugong)  
[http://www.epa.qld.gov.au/nature\\_conservation/wildlife/caring\\_for\\_wildlife/marine\\_strandings/](http://www.epa.qld.gov.au/nature_conservation/wildlife/caring_for_wildlife/marine_strandings/)
- CQ Victoria Shearer (nee Rogers) (CQU-CEM) – Monitoring of fish/turtles and habitats  
<http://ahs.cqu.edu.au/cem/staff/victoria.htm>
- PC CQU and Coastal CRC – Marine Animal Watch

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|----|--|
| PC | CQU – Turtle monitoring (Curtis Island)  |
| PC | CQPA – Research on flatback turtles<br><a href="http://www.gpa.org.au/Sections/Student/Student.htm">http://www.gpa.org.au/Sections/Student/Student.htm</a> |
| PC | CQU – Dugongs (Targinni Flats)   |
| PC | Environmental Science Division (EPA) – Annual records of dugong movements through satellite tracking   |
| PC | Steve Platt (Boating and Fisheries Patrol) 4972 0699   |
| PC | EPA – Dugong and turtle boat strikes and drowning (e.g. in the Great Sandy Strait)   |
| PC | QPWS – Turtle and dugong stranding (not monitoring)  |

## 8. Coral reefs

|     |   |
|-----|---|
| GBR | University of Washington (May 2004) Australian Parliament passes re-zoning bill for Great Barrier Reef, creating world's largest reserve system. MPA News Vol 5(10).<br><a href="http://depts.washington.edu/mpanews/MPA52.htm#GBR">http://depts.washington.edu/mpanews/MPA52.htm#GBR</a>   |
| GBR | National Geographic Society – Jennifer Hile (15 June 2004) Largest no-fishing zone declared in Great Barrier Reef. National Geographic Channel.<br><a href="http://news.nationalgeographic.com/news/2004/06/0615_040615_tvgreatbarrierreef.html">http://news.nationalgeographic.com/news/2004/06/0615_040615_tvgreatbarrierreef.html</a>  |
| GBR | John Platten (Sunfish) – Impacts of no take zones   |
| GBR | GBRMPA – PDP Australia P/L (Nov 2003) An economic and social evaluation of implementing the Representative Areas Program by rezoning the Great Barrier Reef Marine Park: report on the revised zoning plan<br><a href="http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/PDP_Report_23-12-03.pdf">http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/PDP_Report_23-12-03.pdf</a> |
| GBR | GBRMPA – Summary report of the social and economic impacts of the rezoning of the Great Barrier Reef Marine Park (Dec 2003)<br><a href="http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/JUG_SR_09-12-03.pdf">http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/JUG_SR_09-12-03.pdf</a>  |
| GBR | GBRMPA – Zoning plan for the Great Barrier Reef Marine Park: Regulatory Impact Statement<br><a href="http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/RIS_25-11-03.pdf">http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/RIS_25-11-03.pdf</a>   |
| GBR | DPIF – Localized community meetings/consultations for the Fisheries Management Plan   |
| GBR | GBRMPA – Use of chemicals and impacts on reefs  |
| GBR | David Hagues (GBRMPA) – Monitoring of sediment impact on reefs (e.g. from dredging in PC) 4750 0853   |
| GBR | Bob Miles (ISRD) – Changes from coral core drilling over time<br><a href="http://www.isrd.cqu.edu.au/">http://www.isrd.cqu.edu.au/</a>  |
| Q   | Sunfish – Shipp, R.L. (no date) No take marine protected areas (nMPAs) as a fishery management tool, a pragmatic perspective. (Report submitted to the FishAmerica Foundation) <a href="http://www.sunfishqueensland.org/Submission%20-%20Final%20-%20RAP%20GBRMPA%2004-08-03ANNEX.doc">http://www.sunfishqueensland.org/Submission%20-%20Final%20-%20RAP%20GBRMPA%2004-08-03ANNEX.doc</a>                    |

## 9. Tourism

- Q Tourism QLD – Roy Morgan Research (Aug 2002) Tourism and Travel Market Insight No. 8: the fishing market  
[http://www.tq.com.au/tq\\_com/dms/2F0DF685D56871DAA6B1DFC679B08005.pdf](http://www.tq.com.au/tq_com/dms/2F0DF685D56871DAA6B1DFC679B08005.pdf)
- Q Tourism QLD – Indigenous tourism  
[http://www.tq.com.au/tq\\_com/dms/50E01489E86C4131684C06571E25C4A5.pdf](http://www.tq.com.au/tq_com/dms/50E01489E86C4131684C06571E25C4A5.pdf)
- Q Tourism QLD – Surveys involving visitors  
<http://www.tq.com.au/index.cfm?F6B6D091-D9F5-E0D5-C942-0E441F500802>
- Q Tourism QLD – Visitor surveys, regional summaries, and regional updates (including Central QLD, Gladstone and Capricorn)  
[http://www.tq.com.au/tq\\_com/index.cfm?F6C45D14-FE24-B6B2-096A-40C3DAC84E11](http://www.tq.com.au/tq_com/index.cfm?F6C45D14-FE24-B6B2-096A-40C3DAC84E11)
- GBR Reef CRC – Moscardo G, Saltzer R, Galletly A, Burke A, Hildebrandt A (2003) Changing patterns of reef tourism. CRC Reef Research Centre Technical Report No. 49  
<http://www.reef.crc.org.au/publications/techreport/pdf/Technical%20Report%2049.pdf>
- GBR Harriott, VJ (2002) Marine tourism impacts and their management on the Great Barrier Reef. CRC Reef Research Centre Technical Report No 46  
<http://www.reef.crc.org.au/publications/techreport/pdf/Harriott46.pdf>
- GBR GBRMPA – Bailey, G, et al (Nov 2003) Assessment of tourism activity in the Great Barrier Reef Marine Park Region. Bureau of Tourism Research  
[http://www.gbrmpa.gov.au/corp\\_site/management/zoning/rap/rap/pdf/BTR\\_Report\\_23-12-03.pdf](http://www.gbrmpa.gov.au/corp_site/management/zoning/rap/rap/pdf/BTR_Report_23-12-03.pdf)
- GBR Reef CRC – C. Scott Shafer, Graeme J. Inglis, Victoria Y. Johnson and Nadine A. Marshall (1998) Visitor experiences and perceived conditions on day trips to the Great Barrier Reef. Technical Report No. 21  
<http://www.reef.crc.org.au/publications/techreport/TechRep21.html>
- F Dive shops and charter boats (for diving as affected by water quality); The Dive Shop on Goondoon St, Gladstone keeps records on numbers of divers taken out to Great Keppel Island (depending on turbidity in Keppel Bay)
- F Susie Christensen (FBA) – Indigenous tourism <http://www.fba.org.au/programs-heritage.htm>
- F Mary Carroll (Capricorn Coast Tourism Organisation) – Records of visitors to the Yeppoon Information Centre
- F Visitor surveys for Yeppoon and Great Keppel Island on expectations, observations, etc.
- PC Gladstone Area Promotion and Development – Number of tourists and facilities in the region <http://www.gladstoneregion.org.au/>

## 10. Recreation

- Q DPIF – DPIF (no date) The national recreational and Indigenous fishing survey (on fishers attitudes and awareness)  
[http://www.dpi.qld.gov.au/extra/pdf/fishweb/natrecfish\\_survey.pdf](http://www.dpi.qld.gov.au/extra/pdf/fishweb/natrecfish_survey.pdf);  
 For a full report [www.daff.gov.au](http://www.daff.gov.au)
- Q DPIF – Recreational fishing surveys – List of surveys and information under the RFISH program <http://www.dpi.qld.gov.au/fishweb/2871.html>
- Q DPIF – Recreational fishing survey results under the RFISH program  
<http://www.dpi.qld.gov.au/fishweb/2897.html>
- Q MSQ – (2004) Recreational boating survey report 2003  
[http://www.msq.qld.gov.au/qt/MSQ.msf/ReferenceLookup/rec\\_survey\\_report\\_march\\_2004.pdf/\\$file/rec\\_survey\\_report\\_march\\_2004.pdf](http://www.msq.qld.gov.au/qt/MSQ.msf/ReferenceLookup/rec_survey_report_march_2004.pdf/$file/rec_survey_report_march_2004.pdf)
- Q Sport and Recreation QLD – Source of funds for recreation planning research  
[http://www.srq.qld.gov.au/funding/funding\\_programs/funding\\_programs.cfm](http://www.srq.qld.gov.au/funding/funding_programs/funding_programs.cfm)
- Q/GBR Stephen Sutton (Reef CRC/JCU) – Social issues in recreational fishing (report nearing completion); Email: [stephen.sutton@jcu.edu.au](mailto:stephen.sutton@jcu.edu.au)
- F RCC – Rockhampton 1995/1996 (Pilot) and 1997 Open Space and Recreation Plans through RCC’s Customer Service 4936 8000 or Nick Hauser (Sports and Recreation Manager) 4922 1654
- F RCC – Rockhampton 2004 Youth Needs Analysis through Melissa Porter (Social Planner, Community Information Planning Office) [porterm@rcc.qld.gov.au](mailto:porterm@rcc.qld.gov.au) or 4927 0955
- F LSC – Livingstone Shire 2001/2002 Open Space and Recreation Plan
- F LSC – Livingstone Shire 2003/2004 Facilities Needs Study
- F Various clubs using the Fitzroy River (e.g. Fitzroy Canoe Club, rowing club, Emu Park Surf Lifesaving Club, outrigger club) - In charge of maintaining their own facilities and should keep records of frequency of use
- PC Calliope Shire Council – Ongoing survey on Sport and Recreation Facility Plan; 2004/2005 Calliope Shire: Boyne Island Tannum Sands Sport and Recreation Facility Needs Plan; Boyne Island Tannum Sands Sport and Recreation Precinct Master Plan; 1997/1998 Calliope Shire Open Space Development Plan  
<http://www.calliope.qld.gov.au/>
- PC Gladstone City Council – Gladstone 1993/1994 Pilot Recreation Plan  
<http://www.gladstone.qld.gov.au/>
- PC Mt Larcom public swimming pool’s manager – Cleaning pool with black scum line from coal dust
- PC Gladstone and Calliope Councils – Development and infrastructure applications and meeting minutes (for aesthetics in planning) <http://www.gladstone.qld.gov.au/> and <http://www.calliope.qld.gov.au/>

## 11. Access

- CQ Boating Facilities Advisory Group (local authorities, Sunfish) – Boat ramps for recreational fishers, etc.
- CQ QLD Transport and RCC – Documentation of boat ramps
- F Newspaper articles, letters to RCC, RCC meeting notes – Crocodile presence along the Fitzroy River
- F Steve Kemp (Woorabinda Council) – Foleyvale Station and Indigenous access to water in the property <http://www.accq.org.au/comm/woora.htm>
- PC Court proceedings or local agreements; Native Title rights (on Indigenous usage and visitation to infrastructure/development areas)
- PC Boating Infrastructure Branch (Brisbane), QLD Transport – Standards for boat ramps
- PC Robbie Williams (Superintendent of Marina) supervises maintenance of boat ramps <http://www.gpa.org.au/Pages/Marina/Marina.asp>

## 12. Economics

- Q ISRD-CQU and DSDI – Miles, B, Marshall, C, Rolfe, J and Noonan, S (2004) Attraction and retention of professional services in regional, rural and remote Queensland [http://www.isrd.cqu.edu.au/about/2005\\_New%20Isrd%20Pub.htm](http://www.isrd.cqu.edu.au/about/2005_New%20Isrd%20Pub.htm)
- PC Rod Jensen (Economics Dept, UQ) – Economic performance of the Gladstone area (since 1970s) (Input/output of industries, demographic changes and economic growth) [r.jensen@uq.edu.au](mailto:r.jensen@uq.edu.au)
- PC GAPDL/GCCI/DSDI – Doing business: tabulated results of the 2004 Gladstone Doing Business Survey
- PC Small business study – Availability of skilled labour to small businesses
- PC Census – Population figures (including transient and permanent residents) <http://www.abs.gov.au/>
- PC REIQ and local newspapers – Living, housing and rental costs
- PC GDP and incomes of residents

## 13. Education and awareness

- CQ Brian Otone (CEO at Emerald) – Best water use and educational program
- F FRW – Media releases on education campaign activities (For instance, see Local kids– our water conservation experts <http://www.frw.com.au/pressreleases/031111%20waterwise%20primary%20education.pdf>)
- F FRW – Primary School Education Program activity reports (2001-2002 and 2003-2004) (internal use only) through Tracy Sweeny (Business Development Manager) 4936 8721

- F FBA –Monitoring educational programs on water quality (frequency, location, any results/outcomes from these programs) <http://www.fba.org.au>
- F FBA – Trying to coordinate education programs on effluent water reuse <http://www.fba.org.au>
- F QPWS Marine Parks Office – Taking up an educational role in terms of Indigenous involvement in management (e.g. Indigenous marine park rangers)

## 14. Health

- Q QLD Health – Data sources for public health; The purpose of this fact sheet is to provide an introductory listing of data sources relevant to Queensland public health professionals; Before going into more specific sources, the key areas of general data sources and those relating to broad public health disciplines are listed <http://www.health.qld.gov.au/phs/documents/cphun/25953.pdf>
- Q QLD Health – QLD Health (2004) Health determinants: Queensland 2004 (annual data reported by 33 health districts, including Capricornia, Rockhampton, Gladstone/Calliope) <http://www.health.qld.gov.au/phs/hdq/>
- Q QLD Health – Social Determinants of Health Support Package (a tool) [http://www.health.qld.gov.au/HealthyLiving/Social\\_Determinants\\_HP.htm](http://www.health.qld.gov.au/HealthyLiving/Social_Determinants_HP.htm)
- Q QLD Health – Public Health Services (2001) The impact of the Integrated Planning Act 1997 on public health in Queensland's remote Indigenous communities. Public Health Law and Indigenous Health Project. <http://www.health.qld.gov.au/phs/Documents/osm/15684.pdf>
- Q QLD Health – Public Health Services (2002) The impact of the Environmental Protection Act 1994 on public health in Queensland's remote Indigenous communities. Public Health Law and Indigenous Health Project. <http://www.health.qld.gov.au/phs/Documents/osm16774.pdf>
- Q QLD Health – Public Health Services (2001) The impact of the Water Act 2000 on public health in Queensland's remote Indigenous communities. Public Health Law and Indigenous Health Project. <http://www.health.qld.gov.au/phs/Documents/osm16378.pdf>
- Q enHealth Council – enHealth Council (2004) The health effects of environmental noise – other than hearing loss <http://enhealth.nphp.gov.au/council/pubs/pdf/noise.pdf>
- Q QLD Health – Public health databases with data about health related illnesses by specific medical category (e.g. inpatient/outpatient hospital records)
- Q QLD Health – Incidence of diarrhoeal disease, outbreaks of Cryptosporidiosis, E. coli and Campylobacte (due to poor water quality); Notification rates for conditions associated with these microbiological contaminants can be found in QLD Health's Notifiable Diseases Report 1997–2001 <http://www.health.qld.gov.au/phs/Documents/cdu/15896.pdf>
- Q QLD Health – Respiratory health as a primary health outcome related to poor air quality (lung function, respiratory symptoms and exacerbations of respiratory disease, cancer, cardiovascular health, hospital admissions and mortality)
- Q QLD Health – Health Service District Profile (Rockhampton District) [http://www.health.qld.gov.au/wwwprofiles/id\\_rocky.pdf](http://www.health.qld.gov.au/wwwprofiles/id_rocky.pdf)
- Q QLD Health – QLD Health (1999) Towards a Queensland Aboriginal and Torres Strait Islander environmental health strategy – a scoping paper; Statistical data from the QLD Health Hospital Admitted Patient Data Collection <http://www.health.qld.gov.au/phs/Documents/ehu/5079.pdf>

- Q QLD Health – QLD Health (2002) The Queensland Health Aboriginal and Torres Strait Islander Environmental Health Strategy 2001-2006  
<http://www.health.qld.gov.au/phs/Documents/ehu/13766.pdf>
- Q QLD Health – Public Health Services (2003) Developing a shared perspective on the public health role of local government in Aboriginal and Torres Strait Islander communities: discussion paper. Public Health Law and Indigenous Health Project  
<http://www.health.qld.gov.au/phs/Documents/osm/19308.pdf>
- Q Australian Indigenous HealthInfoNet – Environment  
<http://www.healthinfonet.ecu.edu.au/frames.htm>
- F RCC – RCC (no date). Rockhampton Community Health Plan 2003-2008: vitality and vision [www.rockhampton.qld.gov.au](http://www.rockhampton.qld.gov.au)
- F QLD Health – Health Service District Facility Profile (Rockhampton Hospital)  
[http://www.health.qld.gov.au/wwwprofiles/if\\_rocky.pdf](http://www.health.qld.gov.au/wwwprofiles/if_rocky.pdf)
- F QLD Health – Health Service District Facility Profile (Yeppoon Hospital and Nursing Home) [http://www.health.qld.gov.au/wwwprofiles/if\\_yeppoon.pdf](http://www.health.qld.gov.au/wwwprofiles/if_yeppoon.pdf)
- F Woorabinda Hospital – For impacts of water quality on Indigenous public health (e.g. sore eyes and ears); Val Tye (Sr Aboriginal Health Worker) and Robert Cody (Director of Nursing) 4935 0222
- F QLD Health – Health Service District Facility Profile (Woorabinda Multipurpose Health Service) [http://www.health.qld.gov.au/wwwprofiles/if\\_woorabinda.pdf](http://www.health.qld.gov.au/wwwprofiles/if_woorabinda.pdf)
- F Bidgerdii Community Health – Amy Lester 4921 3080
- F RCC – RCC (2001). Mosquito control.  
<http://www.rockhampton.qld.gov.au/searchresultdetail.asp?ITEM=7819>
- PC DSDI – Research on impacts of the shale oil plant in the Gladstone region, including a specific environmental health study in conjunction with CQU [www.sd.qld.gov.au/](http://www.sd.qld.gov.au/)
- PC EPA – E. coli incidents
- PC Dr Sloan (QLD Health) – Asthma cases
- PC QLD Health – Health Service District Profile (Gladstone District)  
[http://www.health.qld.gov.au/wwwprofiles/id\\_gladstone.pdf](http://www.health.qld.gov.au/wwwprofiles/id_gladstone.pdf)
- PC QLD Health – Health Service District Facility Profile (Gladstone Hospital)  
[http://www.health.qld.gov.au/wwwprofiles/if\\_gladstone.pdf](http://www.health.qld.gov.au/wwwprofiles/if_gladstone.pdf)

## 15. Other Indigenous issues

- Q QLD Health – Public Health Services (2001) Aboriginal and Torres Strait Islander communities: local governance, land tenure and land management systems in Queensland. Public Health Law and Indigenous Health Project  
<http://www.health.qld.gov.au/phs/Documents/osm/15430.pdf>
- Q NNTT – Native Title applications and Indigenous land use agreements  
<http://www.nntt.gov.au/>
- CQ CQU-ISRD – L Godwin (2001) Indigenous natural resource management in Central Queensland. In Alderton, M., Norton, J. and Godwin, L. Organics, biotechnology and Indigenous natural resource management in Central Queensland (Occasional Paper # 1/2001). CQU-ISRD  
[http://www.isrd.cqu.edu.au/about/2005\\_New%20Isrd%20Pub.htm](http://www.isrd.cqu.edu.au/about/2005_New%20Isrd%20Pub.htm)

- CQ CQU-ISRD – Windle, J. and Rolfe, J (2002) Natural resource management and the protection of Aboriginal cultural heritage (Occasional Paper # 5/2002). CQU-ISRD [http://www.isrd.cqu.edu.au/about/2005\\_New%20Isrd%20Pub.htm](http://www.isrd.cqu.edu.au/about/2005_New%20Isrd%20Pub.htm)
- CQ CQU – John Rolfe and Jill Windle (2003) Valuing the protection of Aboriginal cultural heritage sites. The Economic Record 79:S85-S95
- CQ CQ Regional Training Centre for Social and Emotional Wellbeing – Mona Kielly (Coordinator) and Joan Smith (Training Coordinator) 4923 7661
- GBR Reef CRC – George M, Innes J, Ross H (2004) Managing sea country together: key issues for developing co-operative management for the Great Barrier Reef World Heritage Area. CRC Reef Research Centre Technical Report No 50 <http://www.reef.crc.org.au/publications/techreport/documents/TechnicalReport50.pdf>
- GBR Reef CRC – Ross H, Innes J, George M, Gorman K (eds) (2004) Traditional Owner aspirations towards co-operative management of the Great Barrier Reef World Heritage Area: community case studies. CRC Reef Research Centre Technical Report No 56 <http://www.reef.crc.org.au/publications/techreport/Technical%20Report%2056.pdf>
- F Delilah MacGillivray (Department of Aboriginal and Torres Strait Islander Policy) <http://www.datsip.qld.gov.au/>
- F FBEC and FBA – Native Titles [www.fitzroybasinelders.com.au](http://www.fitzroybasinelders.com.au) and <http://www.fba.org.au>
- F Malcolm Mann and Ethel Speedy (Darumbal) – Darumbal Working Group (with Woppa Burra) on the draft of the Traditional Use of Marine Resources Agreement (TUMRA)
- CQ Emerald Agricultural College – Encouraging Indigenous people to go back to their land and learn land management <http://www.eac.qld.edu.au/index.htm>

## **16. General/others**

- Q Coastal CRC – T Smith, M Sant and B Thom (2001) Australian estuaries: a framework for management. [http://www.coastal.crc.org.au/pdf/smith\\_book\\_orderform.pdf](http://www.coastal.crc.org.au/pdf/smith_book_orderform.pdf)
- Q LGAQ - News releases on research on Community Attitudes to Local Government <http://www.lgaq.asn.au/portal/dt>
- Q Coastal CRC – (March 2001) Exploring coastal science: time running out for estuaries. Or see Flotsam & Jetsam, Coastal CRC Newsletter [http://www.coastal.crc.org.au/newsletters/f\\_j\\_march\\_2001.html#10](http://www.coastal.crc.org.au/newsletters/f_j_march_2001.html#10)
- Q DPIF – (May 2004) Fishways. <http://www.dpi.qld.gov.au/fishweb/1932.html>
- CQ CQ A New Millennium – 2002 Central Queensland Regional Growth Management Framework
- CQ FBA – Fitzroy Basin Association (May 2004). Central Queensland Strategy for Sustainability – 2004 and beyond. [http://www.fba.org.au/files/CQss2\\_for\\_accreditation\\_v5.pdf](http://www.fba.org.au/files/CQss2_for_accreditation_v5.pdf)
- CQ FBA – Discussions of key issues covering river health, water management, weeds, salinity, land management, biodiversity, urban areas, economic viability, community viability, cultural heritage, and regional coordination <http://www.fba.org.au>
- CQ Coastal CRC – (2003) Central Queensland information paper: to support regional natural resource management planning. [http://www.fba.org.au/plan\\_investments.htm](http://www.fba.org.au/plan_investments.htm)

- GBR GBRMPA – An introduction to using our GBRMP (Booklet)
- GBR GBRMPA/EPA – (Apr 2004) Introductory guide to the GBRMP (Mackay/Capricorn) (Map)
- GBR GBRMPA/EPA – (Apr 2004) Detailed map to the GBRMP (Gladstone) (Map)
- GBR GBRMPA/EPA – (Apr 2004) Detailed map to the GBRMP (Byfield) (Map)
- F LSC's Community Development – Social Plan (currently being developed)  
<http://www.livingstone.qld.gov.au/>
- F RCC – Rockhampton City Council Annual Report 2002-2003 (Parts 1 and 2)  
<http://www.frw.com.au/Uploads/AnnualReportPrt1.pdf> and  
<http://www.frw.com.au/Uploads/AnnualReportPrt2.pdf>
- F RCC – 2005 Community Satisfaction Survey through Melissa Porter (Social Planner, Community Information Planning Office) [porterm@rcc.qld.gov.au](mailto:porterm@rcc.qld.gov.au) or 4927 0955
- F Coastal CRC – Historical coastlines (community perspectives) – assessing intergenerational attitudes to environmental change  
<http://www.coastal.crc.org.au/envhist/index.html>
- PC GAPDL – (2001) Sustainability report for the Gladstone Region
- PC EPA – Curtis Coast Regional Management Plan  
<http://www.epa.qld.gov.au/publications?id=528> or  
[http://www.epa.qld.gov.au/environmental\\_management/coast\\_and\\_oceans/coastal\\_management/regional\\_coastal\\_management\\_plans/curtis\\_coast/](http://www.epa.qld.gov.au/environmental_management/coast_and_oceans/coastal_management/regional_coastal_management_plans/curtis_coast/)
- PC Curtis Coast Study
- PC FBA/Coastal CRC – Draft Boyne and Calliope Natural Resource Management Plan (Amended Draft Sep 2004)
- PC EPA – Gladstone Harbour Protection and Enhancement Strategy (available on EPA website); Research Modules (Public Access and Infrastructure) (With attached map); Katrina Clarke (EPA Rockhampton) facilitates the Plan  
[katrina.clarke@epa.qld.gov.au](mailto:katrina.clarke@epa.qld.gov.au)
- PC Port Curtis/Gladstone Industries Integrated Monitoring Group/Strategy (through EPA and CQU-CEM's Leonie Andersen) – Monitoring data from industries
- PC QLD Transport's Integrated Management System – Environmental Officers conduct assessments and identify issues and requirements (e.g. sediment control, endangered marine and terrestrial species, vegetation) which are done during planning stage before construction proceeds; Available paper based documentation, mostly outcomes and some incidents
- PC QLD Transport and EPA – Environmental incident reports (for severe incidents involving main roads)
- PC QLD State Development – Community consultation information about environmental assessments and social impact assessments (e.g. Mt Larcom commissioned a report examining issues for residents)
- PC CQ A New Millennium – Community forums
- PC REIA/REIQ – Real estate values/property prices <http://www.reiaustralia.com.au/> and  
<http://www.reiq.com.au/>
- PC GAPDL – (Sep 2004) The Gladstone Region overview [www.gladstoneregion.org.au](http://www.gladstoneregion.org.au)
- PC GAPDL – (Jan 2005) The Gladstone Region project status report  
[www.gladstoneregion.org.au](http://www.gladstoneregion.org.au)

- PC GAPDL – (Dec 2004) Profiles of major industry and infrastructure providers in the Gladstone Region [www.gladstoneregion.org.au](http://www.gladstoneregion.org.au)
- PC GPA – Environmental performance  
<http://www.gpa.org.au/Pages/Publications/Environment/environment.pdf>
- PC GAPDL – Gladstone Region: make the move.

## Appendix C

### *Definition and description of biophysical stressors*

*(Information supplied by M. Cox (Coastal CRC/EPA), see Scheltinga et al. (2004).*

**Toxicants** – These have been divided into three sub-categories: pesticides, metals and TBT.

#### **Pesticides**

Pesticides, herbicides and insecticides are commonly used in both rural and urban areas to control pest plants, insects and other animals. Pesticides can be used to kill animal and plant pests (weed control, mosquito control and insect pests on crops). Pesticides are of concern as they commonly have some effect on non-target organisms, particularly in aquatic systems. Pesticides can enter waterways via a number of pathways – leaching through the groundwater, surface runoff, soil erosion, aerial drift or spills. Pesticides vary in the time it takes to break down (half-life), toxicity of break-down products, their tendency to adsorb to sediment or be taken up by organisms and their toxicity to non-target organisms, and may present problems even after their use has been discontinued.

#### **Metals**

Trace metals, metalloids and organometallics are used in many common items and may enter coastal waterways through point source discharges (e.g. industrial discharges, sewage discharges), deliberate dumping or disposal, or through diffuse runoff. Concentrations in diffuse run-off are usually higher in run-off originating from urban areas; for example, copper is used in car brake linings and is therefore higher in areas with high road density; tin concentrations in runoff may be related to roof density. High concentrations of metals in coastal waters can lead to health problems in aquatic biota, including diseases and fish kills; human health problems can also result from consumption of contaminated seafood.

#### **TBT**

Tributyltin (TBT) is commonly used in paint on large ships and vessels to prevent fouling by marine sessile organisms. It is highly toxic and has been widely used, although use is now restricted in most countries (in Australia, it can no longer be used on vessels less than 25 m in length). Adverse effects from TBT contamination include mortality, growth and behavioural abnormalities, reproductive failure, imposex, immune system dysfunction and nervous system disorders.

**Sediment** – Estuarine sediment loads and distribution can change as a result of point sources discharges and changed catchment loads. Catchment loads typically increase as a result of loss of vegetation and hardening of surfaces (e.g. replacement of vegetation or grass with paving or bitumen etc); impoundments typically reduce the amount of sediment entering the estuary. Erosion in the coastal or riparian zones can also increase sediment input. Impacts of changed sediment loads include turbidity, changed sediment grain size, changed erosion or sedimentation patterns within the estuary, changed water depth, and loss of biota due to smothering or lowered light availability.

**Hydrodynamics** – This includes any modifications that impact the hydrodynamic features (local patterns of waves, currents or tidal exchange) of the estuary. These could include artificial closing/ opening of entrances, breakwaters, canals, marinas, retention walls, training walls, levees, sea walls, spits, water barriers, artificial islands/ reefs, dredging/ extraction or aquaculture structures. Impacts from changed hydrodynamics include changes to water depth, coastal currents, wave patterns, entrance opening pattern, turbidity, salinity, erosion and deposition patterns, erosion, impeded fish/ animal passage, eutrophication, algal blooms and loss of biota.

**Habitat removal or disturbance** – This stressor includes both direct removal of areas of habitat and activities that disturb or damage habitat areas. Removal may occur for several reasons, including construction work, foreshore development, marine facilities, aquaculture, urbanisation, or for other reasons. Disturbance of habitat includes things such as anchor damage, bank or beach erosion as a result of boat or vehicle use (causing instability in the underlying soils), oil spills, changes in sedimentation resulting in smothering, shading, etc. Habitat damage may also be caused by natural events, particularly storms, but these are not considered here. The potential impacts of negative changes in habitat include erosion, sediment deposition, poor water quality (particularly turbidity), loss of habitat dependent species, and a loss in visual amenity.

**Biota** – This includes direct removal of biota through commercial, recreational and subsistence fishing, bait collection, aquarium trade, natural shellfish collection, hunting, accidental killing through boat strikes, netting etc, disturbance through use of area (powerboats, jet skis, excessive tourist numbers), disturbance to breeding/migration through barriers. Removal of coral through anchor damage etc is included in habitat removal. Changes in habitat can also cause changes in biota – these are considered under the habitat section. This section deals only with direct interference with biota.

**Freshwater flow regime** – Changes to the freshwater flow regime include water abstractions, dams, weirs and other impoundments, and any changes to the timing or magnitude of freshwater flows to the estuary. Potential consequences of changed freshwater flows include changes in erosion and deposition patterns, eutrophication, changes in salinity patterns and changes to abundance and/or distribution of fauna and flora.

**Nutrients** – Nutrients such as nitrogen and phosphorus are essential for the growth of plants. Sources of nutrients include point source discharges (particularly sewage discharges) and runoff from urban and rural areas. Catchment areas that have been cleared of vegetation typically provide more nutrients than areas in their natural state. Potential consequences of increased nutrient loads to estuaries include eutrophication, algal blooms or excessive macrophyte growth, anoxic events due to decay of plant matter, and fish or animal kills from lack of oxygen.

**Organic matter** – Organic matter is carbon based material derived from plants or animals (e.g. decaying plant matter or animal wastes) in dissolved or particulate forms. Sources include catchment runoff (from both urban and rural areas, point source discharges (particularly sewage discharges and overflows) and decaying of algal blooms or other vegetative matter. Possible effects of excessive organic matter include fish kills and anoxic events (due to the increased oxygen demand of bacteria responsible for breaking down organic matter).

**Bacteria/ pathogens** – Bacteria and pathogens in coastal waterways can cause problems to the health of aquatic biota (particularly in aquaculture), human consumers of seafood and recreational users of coastal areas. Consumption of contaminated seafood can lead to food poisoning; recreation in contaminated waters can lead to gastrointestinal illnesses and ear, nose or throat infections. Sources of contamination can include point sources, particularly sewage discharges and overflows, and diffuse runoff, especially in areas of high animal populations.

**pH** – pH refers to the acidity or alkalinity of the water (freshwater – usually neutral pH of 7, seawater – more alkaline around 8). Main cause of changes to pH is exposure of acid sulfate soils leading to acid sulfate runoff, and some industrial discharges. Potential effects of changed pH include fish kills and disease, decay of infrastructure, changed abundance and/or distribution of fauna and flora, and increases in metal concentrations.

**Temperature** – Coastal water temperature is typically changed by industrial point sources or dam discharges. Changes to water temperature can result in changes to the abundance and/or distribution of fauna and flora, and water stratification (poor water column mixing).

**Litter** – Litter in the coastal zone can be sourced from the shore or from rubbish dumped at sea. Animals and plants can become trapped or entangled in litter, or may ingest litter, resulting in injury or death.

**Pest species** – Pest species are defined as invasive organisms that are detrimental to an ecosystem. They are usually exotic to the system, but may include local pest species. Exotic species enter the system as escapees from aquaculture, aquaria, or gardens, and during transport, attached to hulls, in ballast water or via dredge spoil. Effects of pest species include loss of native species, reductions in biodiversity and reductions in habitat.

## Appendix D (Part 1)

### *Summary of social impacts from changed water quality & potential data sources – Port Curtis Catchment*

| Secondary impacts  | Social issues and stakeholders affected  | Social impacts   | Potential data sources  |
|--|--|--|---|
| Diffuse & point source pollutants & discharges from industry & urban areas | Availability of fish for catch & consumption<br>Ability to undertake Indigenous hunting & fishing<br>Risk to health & safety<br><br>Commercial & recreational fishers<br>Local community<br>Indigenous community &<br>Tourism sector | <ul style="list-style-type: none"> <li>– Fish &amp; seagrass kills affect fishery</li> <li>– Effects on health of dugongs &amp; other marine life</li> <li>– Viability of commercial &amp; recreational fishing</li> <li>– Effect on indigenous fishing &amp; hunting.</li> <li>– Effects on waterway, coastal &amp; marine water quality (&amp; groundwater) from point &amp; diffuse pollutant sources</li> <li>– Effects on GBR – marine life, recreation use of reef &amp; tourism industry (&amp; secondary businesses in CQ region)</li> </ul> | <ul style="list-style-type: none"> <li>– Fish kills data &amp; reports available from EPA. Fish kill annual reports from EPA website. (regional information available) &amp; online Marine wildlife stranding and mortality database annual reports (Tri-Annual reports). Forensic testing for cause of death is often inconclusive</li> <li>– Curtis Coast Study documents sediment movement from the Fitzroy into Narrows area of Port Curtis</li> <li>– Water quality testing through EPA &amp; CQ Port Authority is publicly available Unknown if CQPA test for agrochemicals &amp; sediment from Narrows area</li> <li>– Comalco (2002). EIS Report, Section 10: Hazard &amp; Risk</li> <li>– CQPA test water quality along Ship Creek.</li> <li>– CQPA test water quality whenever there is run off from the stormwater holding ponds into the harbour.</li> <li>– Recreational boat ownership and use – QLD Dept of Transport maintain records on boat registrations and boat licences. Also Recreational Boating Survey Report (biannual report) available on-line</li> </ul> |

| Secondary impacts   | Social issues and stakeholders affected  | Social impacts  | Potential data sources   |
|---|--|---|--|
|   | <p>Lifestyle, wealth, business success and human health impacts from increased industrial activity &amp; decline in water quality</p> <p>Local community<br/>Yarwun-Targinnie community<br/>Susceptible individuals within the community (young, aged, Indigenous)</p> | <ul style="list-style-type: none"> <li>- Decline in market land values for residences in close proximity to industry</li> <li>- Health effects from industry emissions</li> <li>- Demand for housing located away from the effects of industry lead to large-scale development and land clearing near the coast &amp; higher housing price</li> <li>- Cost to government to provide infrastructure &amp; services to new areas</li> <li>- Demand for skilled workers due to industry &amp; regional growth leads to high employment levels some sectors</li> <li>- Small business must compete with industry for skilled workers. Downsizing of social services and infrastructure by government, can lead to population migration or movement.</li> <li>- Migration to Port Curtis region for employment creates increased demand for and use of recreational areas along coast &amp; waterways</li> </ul> | <ul style="list-style-type: none"> <li>- Real Estate values through REIQ provide an indication of market change, however, this does not identify the cause of market change</li> <li>- QLD Health, Reported Health Effects related to the Stuart Shale Oil Project (Interim Report), 2001</li> <li>- Public Health database on hospital inpatient/outpatient admissions, geographical location &amp; patient condition (using WHO criteria)</li> <li>- Industry blowouts and breaches to license reported to EPA &amp; data lodged in annual returns to EPA. (data may be correlated with health data)</li> <li>- Complaints databases for data on emissions and health problems</li> <li>- Air quality data collected by EPA is available online &amp; CQPA collects data</li> <li>- Tabulated Results 2004: Gladstone Doing Business Survey by Queensland Government</li> <li>- Attraction and retention of services in regional, remote &amp; rural Qld by Institute for sustainable regional development., 2005 from Institute for Sustainable Regional Development at CQU</li> <li>- GDP of Gladstone region or income of residents</li> <li>- Comalco (2002).EIS Report, Section 14: Social &amp; Economic Environment</li> <li>- State of Queensland (2005). CQRIS: Regional Overview</li> <li>- Department of Local Government and Planning, Queensland's Future Population (2003 edition). Local Government Area Profile for Gladstone region</li> <li>- The State of Queensland (2005). Migration within Queensland: Census 2001 Bulletin #7</li> <li>- Population &amp; housing forecasts for Gladstone &amp; Calliope shires at CQRIS website</li> </ul> |
| <p>Infrastructure &amp; development along the coast affects water quality</p> | <p>Use of beaches and foreshore areas for recreation</p>   | <ul style="list-style-type: none"> <li>- Diminished recreational opportunities due to increasing industry development and restricted access to areas</li> <li>- Changed Indigenous usage and visitation to areas</li> </ul>   | <ul style="list-style-type: none"> <li>- Sport &amp; Recreation QLD funded survey research into recreational needs &amp; uses of local recreational facilities in Calliope. (Data for Gladstone 1993/94 (pilot rec plan); Calliope Shire 1997/98 (open space development plan); 2004/05 Calliope Shire: Boyne Island Tannum Sands Sport &amp; rec facility needs plan; Boyne Island Tannum Sands Sport &amp; recreation precinct master</li> <li>- Comalco Cultural Heritage Environmental Impact Assessment Includes survey data from Barker (1993) &amp; ARCHAEO (2000).</li> </ul>  |
| <p>Air emissions affect water quality</p>                                     | <p>Airshed impacts affect water quality, along with health &amp; quality of life.</p> <p>Effectiveness of buffer zones between industry and residential areas.</p>   | <ul style="list-style-type: none"> <li>- Use of buffer zones in planning between industry &amp; residential areas to minimise impacts of industry (e.g. airshed outfall from smelter) &amp; so neighbourhoods are more appealing.</li> <li>- Toxins released into air from certain industry emissions, make it into estuary and impact on water quality. High levels of toxins released in air can impact on</li> </ul>   | <ul style="list-style-type: none"> <li>- EPA have publicly available annual reports of air quality on-line, with monthly breakdown by region</li> <li>- Complaints database details number, type of complaint, location, specifics of complaint</li> <li>- EPA licensing agreements require industry to report spills/blowouts. Industry annual reports to EPA include emission information &amp; incidents &amp; breaches. Information accessible through Freedom of Information</li> <li>- Record of caustic discharges from QAL &amp; damage incurred accessible through EPA &amp; freedom of information</li> <li>- Complaints databases maintained at councils, most government departments &amp; larger</li> </ul>   |

| Secondary impacts | Social issues and stakeholders affected   | Social impacts   | Potential data sources  |
|-------------------|---|--|---|
|                   |   | health of people, animals & fish.<br>– People reside in areas outside of Gladstone where health of air & water are perceived to be acceptable.<br>– Increased costs to planners to provide infrastructure to other locations.  | organisations, including CQPA<br>– Council meeting minutes document buffer requirements for public health & safety<br>– QLD Health – Public health databases of inpatient & outpatient hospital records Able to link emissions/blow-outs & incidence of health related illnesses<br>– Comalco (April, 2002). EIS Section 5: Air Quality<br>– State of Queensland (2005). CQRIS: Regional Overview   |
| Shipping/boating  | Economic devt impacts on water quality due to<br>(1) ballast water discharges<br>(2) trace metal concentrations | – Increased risk from higher shipping activity of ballast water introducing unknown disease & organisms which may impact on estuary & GBR<br>– Local industries dependent on the estuary & reef affected (e.g. tourism, fisheries) & have unknown consequences<br>– Potential human health risks from TBL on large ships due to higher trace metal levels in water & food chain affecting fish & seafood | – Ballast water baseline study by CEM at CQU funded by CQPA. Continued monitoring of marine pests at strategic sites. Commercial ship logs detail time, date & place of release of ballast waters<br>– State of Queensland (2005). CQRIS: Regional Overview on CQRIS website<br>– Coastal CRC research on Contaminants in Port Curtis: Screening Level Risk Assessment by Port Curtis Contaminant Risk Assessment Team. Assessment of Imposex in gastropods as a reliable and sensitive indicator of exposure to antifoulant contaminants. Study by CEM at CQU Gladstone.<br>– Long-term benthic monitoring program by CQPA in vicinity of port operations (data from 1996). Benthic fauna studies conducted by CQPA and CEM at CQU Gladstone on metal accumulations in bottom feeders (oysters).<br>– Parks & wildlife/EPA data on fish kills & impacts on dugong.<br>– Continuous water quality monitoring of Gladstone Harbour at 2 locations using automatic Aqualabs to collect & analyse standard water samples every 6 hours. Monitoring results are available for public viewing at CQPA.<br>– EPA conducts water quality testing outside of Port operations and in Boyne & Calliope Rivers |
|                   | Spillage from boats, ships and recreational boaters   | – Spillage from port operations, ships & recreational boaters (fuel, oil, bauxite, coal) impact on marine life & health of GBR. Affect on recreation use of area & fishery, along with tourism activities  | – Dept. Maritime Safety collects data on spills from boats & in annual report.<br>– Biannual Recreational Boating Survey Report from MSQ. Available online<br>– Dept Maritime Safety report pollution incidents from spills. No specific database on incidents, but if offenders prosecuted through the Magistrates court or prosecutors branch of MSQ a report is available. Also, access information about licence breaches and spills through EPA  |
|                   | Boating & shipping accidents.<br>(1) pollution from accidents   | – Greater risk of shipping/boating accidents due to increased port facility activities, shipping & number of recreational boat users   | – Annual report & Recreational Boating survey available from Maritime Safety QLD, comprises info on commercial and recreation ship numbers by region, statistics on commercial & recreation incidents by boat type and region   |

| <b>Secondary impacts</b> | <b>Social issues and stakeholders affected</b>          | <b>Social impacts</b>  | <b>Potential data sources</b>  |
|--------------------------|---|--|--|
|                          | (2) dredging effects on water quality & use of resource | <ul style="list-style-type: none"> <li>- Increased frequency of channel dredging in the harbour to enable shipping &amp; dredged material dumped at sea</li> <li>- Turbulence from dredging creates resuspension of bottom sediments. Turbulent water is unattractive to water users &amp; tourists, &amp; impacts on water visibility.</li> <li>- Stirred sediment is deposited at locations around the harbour &amp; changes water condition (e.g. inlet between Curtis &amp; Facing Island)</li> <li>- Surveying of channel after dredging stirs bottom sediments &amp; water appears turbid &amp; unsightly</li> <li>- Diving activity affected by water clarity in local reef area</li> </ul> | <ul style="list-style-type: none"> <li>- CQPA &amp; Maritime Safety QLD maintain data on frequency &amp; location of dredging in harbour. All dredging data submitted to EPA/DEH before &amp; after dredging.</li> <li>- Suspension from dredging is likely to be short lived &amp; to have minimal social impacts. CQPA collects data on time between sediment disturbance &amp; settlement by taking water quality tests. CQPA data shows that 80% of sediment settled within 12 hours; 100% within 24 hours.</li> <li>- Complaints registers with council, CQPA, EPA may detail complaints about dredging.</li> <li>- Diving activity information from local dive shop. Correlate dive information with turbid conditions &amp; dredging Records about number of divers &amp; dates maintained</li> </ul> |

| <b>Secondary impacts</b> | <b>Social issues and stakeholders affected</b> | <b>Social impacts</b>  | <b>Potential data sources</b> |
|--------------------------|--|--|-------------------------------|
| Sand dredging            | Sand dredging impacts                          | <ul style="list-style-type: none"> <li>- Dredging activity &amp; poor water visibility reduces sightings of marine species and reefs by tourists. Sightings of dugong are also affected by boat strikes, possibly from poor visibility.</li> <li>- Concentrations of TBT in water &amp; sediment contaminants may affect commercial fisheries &amp; tourism -seagrass fish habitat &amp; feedings ground for fisheries, mangrove &amp; mud flats health, food sources &amp; habit for dugongs, turtles &amp; dolphins.</li> <li>- Metal contaminants released to the estuary pose a health risk (e.g. copper, zinc, naphthalene)</li> <li>- Recreational fishers purchasing bigger, &amp; better equipped boats to access remote locations to fish</li> <li>- Indigenous hunters less likely to catch traditional foods due to limited availability of fish &amp; seafood. Implications for diet &amp; health. Cost of buying fish &amp; seafood.</li> <li>- Traditional activities associated with fishing at a site occur less frequently &amp;/or practices changed. Changes can impact on Native Title rights</li> </ul> |                               |

## Appendix D (Part 2)

### *Social impact matrix for changed water quality – Port Curtis catchment*

| Impact details                              | Social impacts  |   |  |   |
|---|---|---|--|---|
|   | Agricultural pollutants enter Port Curtis impacting on water quality  | Industry pollutants enter Port Curtis via waterways & stormwater drains (i.e. from air onto land and then into stormwater)  | Stormwater pollutants from urban areas enter Port Curtis impacting on water quality? | Population increase leads to rapid development, land clearing & greater sediment entering waterways |
| <b>Geographical/spatial scale</b>           | - From the Fitzroy, then down the Narrows - Calliope River  | - Areas within vicinity of industry & emissions.<br>- Areas downwind of industry, e.g. Oil Shale, QAL, wherever coal & alumina dust are a problem   | - Lower coastal part of catchment where runoff enters stormwater drains & waterways. | - Cleared land & urban development areas, i.e. Calliope, Tannum Sands/ Boyne Island, Agnes Water.   |
| <b>Temporal aspects</b>                     | - During rainfall & flood events  | - Ongoing until sufficient buffers created or action taken to remedy the impact<br>- Low property values to remain until Shale Oil project completed or land acquired by industry/govt<br>- Coal & bauxite dust worst at certain times, e.g. windy days.                | - Ongoing & during storm events  | - Immediately following clearing & rain.<br>- Following large scale development.                    |
| <b>Magnitude &amp; frequency of problem</b> | - Ongoing but more severe during pulse events<br>- Fish kills may occur immediately following pulse event due to high nutrient levels | - Ongoing.<br>- Problem is worst when blowouts occur or when industry emissions breach regulations.<br>- Coal & alumina dust ongoing problem but worse on windy days – high number of complaints on windy days.<br>- Oil Shale project suspended due to severe problems | - During rain events   | - Mainly in coastal & steep areas   |
| <b>Data sources available</b>               | - Water quality data<br>- EPA Fish kill data & reports  | - REIQ real estate values<br>- Complaints database<br>- EPA data on industry license breaches & reported blowouts<br>- EPA & CQPA air quality data  | - Water quality data   | - Water quality data<br>- Local govt development approvals  |

| Impact details                                    | Social impacts  |  |   |  |
|---|---|--|---|--|
|   | Agricultural pollutants enter Port Curtis impacting on water quality  | Industry pollutants enter Port Curtis via waterways & stormwater drains (i.e. from air onto land and then into stormwater)   | Stormwater pollutants from urban areas enter Port Curtis impacting on water quality?  | Population increase leads to rapid development, land clearing & greater sediment entering waterways  |
| <b>Stakeholders affected &amp; type of impact</b> | <p>All fishers<br/>Indigenous community<br/>Future tourism sector</p> <ul style="list-style-type: none"> <li>- Health of fishery resource &amp; habitat areas</li> <li>- Availability &amp; health of fishery impact local business &amp; tourists</li> <li>- Fish kills produce negative public perception of fishery &amp; health of waterways &amp; beaches</li> </ul> | <p>QAL employees &amp; residents within vicinity of industry in &amp; surrounding Gladstone<br/>Businesses &amp; people exposed to dust from coal trains<br/>Residents affected by Oil Shale project<br/>Councils/developers to meet housing demand &amp; need to locate urban development away from industry</p> <ul style="list-style-type: none"> <li>- Yarwun school moved due to noise &amp; dust from increasing number of coal trains</li> <li>- Mt Larcom pool affected by coal dust – cost of pool cleaning &amp; public health perceptions</li> <li>- Perceived impacts of dust &amp; emissions on human health</li> <li>- Lower property values in Targinnie. area close to shale oil industry</li> <li>- Greater pressure on planners to establish buffers &amp; locate population to other areas e.g. Calliope, Boyne Island/Tannum Sands. Costs to planners to provide infrastructure &amp; services to these rapid growth areas.</li> <li>- Paint on residents &amp; QAL employees within vicinity of caustic emission fallout</li> </ul> | <p>All fishers<br/>Indigenous community<br/>Water-based recreation users<br/>Tourists</p> <ul style="list-style-type: none"> <li>- Urban pollutants &amp; coal dust may impact on fish habitat (seagrass) &amp; affect fishery</li> <li>- Water quality decline in recreational areas &amp; threat to public safety</li> <li>- Negative public perceptions of waterways &amp; beaches from visual &amp; odour changes (turbidity)</li> <li>- Higher pollutant loads in stormwater from population increase &amp; expansion of road network (road runoff)</li> </ul> | <p>Tourists,<br/>Community<br/>Indigenous community<br/>All fishers</p> <ul style="list-style-type: none"> <li>- Sediment from land deposits on seagrass affecting fishery habitat &amp; food source</li> <li>- Water quality declines - murky &amp; unattractive</li> <li>- Deposited sediment changes composition of sand. Tourism may be affected as the attractiveness of the resource is changed following development</li> <li>- Access &amp; use of waterways for recreation affected by deposition of sediments</li> <li>- Access for ships entering harbour &amp; channel affected – cost of additional dredging</li> </ul> |
| <b>Data source information</b>                    | <ul style="list-style-type: none"> <li>- EPA fish kill data</li> <li>- Availability &amp; consumption of local fish &amp; seafood – Commercial fisher logbooks &amp; retailers</li> <li>- Public health database on incidences of seafood poisoning</li> </ul>  | <ul style="list-style-type: none"> <li>- Calliope Local Council – school information &amp; public pool</li> <li>- QLD Health report on health effects related to the Stuart Shale Oil Project (Interim Report), 14 May, 2001.</li> <li>- REIQ real estate prices</li> <li>- Dept of State Devt. Land purchase in Targinnie/Yarwun area</li> <li>- QAL fallout information &amp; repair costs from QAL or insurer</li> </ul>  | <ul style="list-style-type: none"> <li>- Public notices on waterway &amp; beach closures</li> <li>- Water quality data from local council &amp; state govt departments, &amp; CQPA</li> </ul>   | <ul style="list-style-type: none"> <li>- Water quality data from state government departments &amp; CQPA</li> <li>- Recreational &amp; commercial fisher logbooks on catch amounts &amp; location of catch</li> <li>- Information from Dept Maritime Transport &amp; CQPA on dredging activity</li> </ul>  |
| <b>Information on impact monitoring</b>           | <ul style="list-style-type: none"> <li>- EPA water quality testing data</li> <li>- EPA annual report on fish kills &amp; marine wildlife mortality</li> <li>- DPI Fisheries</li> </ul>  | <ul style="list-style-type: none"> <li>- CQPA (&amp; CQU) long term monitoring program of benthic fauna for trace metal contamination in vicinity of port operations &amp; in Gladstone Harbour</li> <li>- EPA water quality testing data</li> <li>- Individual industry water monitoring /end of pipe discharge data</li> </ul>   | <ul style="list-style-type: none"> <li>- Qld Health – public health database for specific medical conditions &amp; Hospital patient inpatient &amp; outpatient information</li> <li>- Recreational fisher diary</li> </ul>  | <ul style="list-style-type: none"> <li>- EPA &amp; CQPA water quality data</li> <li>- Boat ramp surveys of recreational fishers by CapReef</li> <li>- Recreational fisher diary</li> <li>- Local council monitoring of stormwater traps</li> </ul>   |

| Impact details  | Social impacts   |  |   |   |
|---|--|--|---|---|
|   | Agricultural pollutants enter Port Curtis impacting on water quality   | Industry pollutants enter Port Curtis via waterways & stormwater drains (i.e. from air onto land and then into stormwater)   | Stormwater pollutants from urban areas enter Port Curtis impacting on water quality?  | Population increase leads to rapid development, land clearing & greater sediment entering waterways   |
|   | information on fishery resource through short & long term monitoring   | <ul style="list-style-type: none"> <li>- Complaints database</li> <li>- Qld Health public health database &amp; hospital patient information</li> <li>- EPA &amp; CQPA air quality data</li> </ul>   | data for Gladstone Harbour & waterways in Calliope & Gladstone shires   |   |
| <b>Mitigation strategies to manage impacts</b>            | - Sustainable farming practices to reduce soil erosion & runoff into waterways (e.g. fence waterways to stop stock damaging banks) | <ul style="list-style-type: none"> <li>- Better residential planning &amp; buffer zones between industry &amp; residents</li> <li>- Property buy outs</li> <li>- CQPA, industry, &amp; Gladstone Council use holding/storage ponds for stormwater; sediments/pollutants; drop out before reaching water-ways.</li> <li>- Industry plans to reduce dust problems, incl. building attractive wind break/hill in front of coal wharf.</li> <li>- QAL re-paints cars affected by caustic emissions &amp;/or blow out.</li> </ul>     | <ul style="list-style-type: none"> <li>- Stormwater/litter traps installed in new development but no funds to maintain them by Council</li> <li>- Rules &amp; regulations to manage inputs into stormwater</li> </ul> | <ul style="list-style-type: none"> <li>- Restrictions on builders/developers to reduce sediment loads. Developers able to spray for dust to minimise impacts.</li> <li>- Council has stormwater pond to collect sediment before entering the sea</li> </ul> |
| <b>Associated social impacts of mitigation strategies</b> |  | <ul style="list-style-type: none"> <li>- Property prices decrease following health impacts&amp; mass govt buy out of property in Targinnie area</li> <li>- Targinnie/Yarwun residents can't afford to buy property in region because industry has increased the demand for housing &amp; elevated housing prices</li> <li>- Class action against Stuart Oil Shale (Southern Pacific Petroleum) due to health related, property devaluation &amp; other concerns.</li> <li>- QAL emissions are caustic and cause rust.</li> </ul> | - Blocked up sediment/litter may block flow of water into drain & lead to localised flooding.   | - Council does not have funds/resources to maintain sediment traps once developers have done their work   |
| <b>Sources of information</b>                             |  |  |   |   |

| Impact details                              | Social impacts   |   |  |   |   |
|---|--|---|--|---|---|
|   | Clearing & reclamation of coastal areas for economic development/ industry affect water quality              | Marine pests brought in to via ship ballast water   | Trace metal concentrations   | Marine pollution from boats, ships & recreational boaters (e.g. sewage, spillage & accidents)   | Indigenous visitation to coastal & waterway areas & usage of resources  |
| <b>Geographical/ spatial scale</b>          | - Lower catchment & harbour.<br>- Shale Oil project expansion of activities into the marine environment      | - Harbour & GBR   | - Areas where heavy shipping & boating (e.g. harbour & marina).  | - Harbour, marina, rivers & creeks  | - Coastal & waterway areas  |
| <b>Temporal aspects</b>                     | - Depending on impact as there may be delayed environmental effects & damage to areas further away over time | - Depends on how quickly the pest proliferates and disturbs the current flora & fauna.          | - Levels of metals in fish/seafood may be elevated following activities associated with dredging. – Accumulation over long time  | - Immediate<br>- Depends on severity of spill, substance & response time  | - Depends on extend of impact e.g. beach closures due to water quality decline, fish kills,                                 |
| <b>Magnitude &amp; frequency of problem</b> | - Development in region ongoing & extensive area affected, including outlying islands & Narrows.             | - Occurs if ships breach regulations to dump ballast water at sea<br>- No current pest problems | - Large ships have antifoulants high in metals – depends on shipping activity<br>- Metals in mud may be stirred up during dredging.  | - An increasing problem due to higher number of ships & recreational boaters.   | No data   |
| <b>Data sources available</b>               | - CQPA strategic plan for Gladstone/Port Curtis<br>- Stuart Shale Oil proposed plans/EIS                     | - Ballast water baseline study by CQPA & CEM/CQU  | - Coastal CRC study on Contaminants in Port Curtis: Screening level risk assessment by Port Curtis Contaminant Risk Assessment Team at CEM/CQU<br>- CQPA monitoring data on metal accumulation in benthic fauna near port operations | - Maritime Safety Qld data on marine spills<br>- Prosecution branch of MSQ on pollution incidents<br>- Biannual recreational boating survey report at MSQ | -EPA & CQPA water quality data<br>- EPA fish kill data & marine wildlife mortality<br>- Local council beach closure notices |

| Impact details   | Social impacts   |  |   |  |  |
|--|--|--|---|--|--|
|  | Clearing & reclamation of coastal areas for economic development/ industry affect water quality  | Marine pests brought in to via ship ballast water  | Trace metal concentrations  | Marine pollution from boats, ships & recreational boaters (e.g. sewage, spillage & accidents)  | Indigenous visitation to coastal & waterway areas & usage of resources |
| <p><b>Stakeholders affected &amp; type of impact</b></p> <p>Fish &amp; seafood retailers<br/>Indigenous community<br/>Fishers<br/>Tourists</p> <ul style="list-style-type: none"> <li>- Indigenous use of cultural sites in coastal area may be affected by industrial development &amp; associated impacts</li> <li>- Fisheries resource affected by reclamation of mudflats &amp; mangrove that are seafood &amp; fish nursery areas.</li> <li>- Availability of fishery resource impacted &amp; monetary &amp; non-monetary losses for commercial &amp; recreational fishers (incl. local retail businesses)</li> <li>- Availability of fishery resource for Indigenous community affected, leading to dietary changes, higher food costs &amp; human health problems</li> <li>- Tourism &amp; attractiveness of the area (water activities) affected by change in land use &amp; visual appearance</li> <li>- Fishers will have to travel further to access fishery</li> </ul> | <p>Tourists<br/>Residents<br/>Fishers<br/>boaters</p> <ul style="list-style-type: none"> <li>- Pest species may impact on local fishery resources</li> <li>- Pest species may affect perceived quality of marine environment &amp; impact on tourism</li> <li>- Pest species affect on human health</li> </ul> | <p>Fishers<br/>Local businesses<br/>Indigenous community</p> <ul style="list-style-type: none"> <li>- Accumulation of metals in fish &amp; seafood may affect commercial viability of certain species &amp; human health</li> <li>- Reduction in the availability of local seafood product</li> <li>- Recreational fishing activity affected if metal in fish exceed safe levels</li> <li>- Fishers will have to travel further to access fishery</li> </ul> | <p>Recreational users (boaters, swimmers, fishers)<br/>Tourism<br/>Emergency services</p> <ul style="list-style-type: none"> <li>- Major spill could have large impacts on local marine environment &amp; wildlife, &amp; GBR with short &amp; long term affects on tourism &amp; recreational users.</li> <li>- Costs of clean up operations to local govt &amp; state depts</li> <li>- Greater demand on emergency services</li> <li>- Higher accident risk due to increased marine boating &amp; shipping activity</li> <li>- Damage to fishery nursery &amp; habitat areas reduce fishery resource</li> </ul> | <p>Indigenous community</p> <ul style="list-style-type: none"> <li>- Limited from or unable to access traditional land &amp; resources, participate in traditional customs or rituals of local indigenous culture.</li> <li>- Loss of traditional knowledge. Hence, loss of culture, sense of place &amp; identity. May lead to increase in undesirable activities, e.g. drinking, fighting.</li> <li>- Impact on community wellbeing from unable to use traditional areas for relaxation, story telling &amp; fishing/hunting</li> <li>- Traditional food part of staple diet</li> <li>- Indigenous people perceive risk to consuming fish &amp; seafood</li> </ul> |  |

| Impact details  | Social impacts   |   |  |  |   |
|---|--|---|--|--|---|
|   | Clearing & reclamation of coastal areas for economic development/ industry affect water quality  | Marine pests brought in to via ship ballast water   | Trace metal concentrations   | Marine pollution from boats, ships & recreational boaters (e.g. sewage, spillage & accidents)  | Indigenous visitation to coastal & waterway areas & usage of resources  |
| <b>Data source information</b>                            | <ul style="list-style-type: none"> <li>- Indigenous impacts known from anecdotal evidence &amp; observation of changed behaviour</li> <li>- Seagrass &amp; mangrove spatial survey data</li> <li>- Commercial catch per unit effort data</li> <li>- Fisher buyer &amp; retailer records -fish biomass, location</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> <li>- ABS data from tourist accommodation &amp; holiday tracking survey</li> </ul> | <ul style="list-style-type: none"> <li>- DPI Fisheries data on pest species</li> <li>- Statistical data from Qld Health Hospital Admitted Patient Data</li> <li>- Commercial catch per unit effort data</li> <li>- Fisher buyer &amp; retailer records -fish biomass, location</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/pers. logbook</li> </ul> | <ul style="list-style-type: none"> <li>- Statistical information on incidence rates, links &amp; comparisons to non-Indigenous people.</li> <li>- Qld Health Hospital Admitted Patient Data</li> <li>- Fisher buyer &amp; retailer records -fish biomass, location</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> </ul> | <ul style="list-style-type: none"> <li>- ABS data from tourist accommodation &amp; holiday tracking survey</li> <li>- Local council &amp; state govt expenditure &amp; budget for clean-up operations</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> <li>- DPI Fisheries data on Commercial Fisheries Information System (CFISH)</li> </ul> | <ul style="list-style-type: none"> <li>- Indigenous anecdotal evidence</li> <li>- Statistical data from QLD Health Hospital Admitted Patient Data Collection</li> </ul> |
| <b>Mitigation strategies to manage impacts</b>            |  | Testing of water in harbour for pest species.   | - Regulations now require less toxic antifoulants be used  | - Use of holding tanks etc during fuelling, etc to minimise spills   | No Data   |
| <b>Information on impact monitoring</b>                   |  |   |  |  |   |
| <b>Associated social impacts of mitigation strategies</b> |  |   | - Increased cost to boat & ship owners who must clean boats more often, as less toxic antifoulants less effective  | - Perception by public that industry is environmentally responsible  | - Loss of culture & cultural heritage<br>- Potential for Indigenous tourism lost if no assessment of this in development applications.                                  |
| <b>Sources of information</b>                             |  |   |  |  |   |

## Appendix E (Part 1)

### *Social impacts of water quality decline from marine activities – Port Curtis Catchment*

| Impact details                                    | Social impacts  |  |   |
|---|---|--|---|
|   | Marine pests brought in via ship ballast water  | Trace metal concentrations from shipping   | Marine pollution from boats, ships & recreational boaters (e.g. sewage, spillage & accidents)   |
| <b>Geographical/spatial scale</b>                 | - Harbour & GBR   | - Areas where heavy shipping & boating (e.g. harbour & marina).  | - Harbour, marina, rivers & creeks  |
| <b>Temporal aspects</b>                           | - Depends on how quickly the pest proliferates and disturbs the current flora & fauna.  | - Levels of metals in fish/seafood may be elevated following activities associated with dredging. – Accumulation over long time  | - Immediate<br>- Depends on severity of spill, substance & response time  |
| <b>Magnitude &amp; frequency of problem</b>       | - Occurs if ships breach regulations to dump ballast water at sea<br>- No current pest problems   | - Large ships have antifoulants high in metals – depends on shipping activity<br>- Metals in mud may be stirred up during dredging.  | - An increasing problem due to higher number of ships & recreational boaters.   |
| <b>Data sources available</b>                     | - Ballast water baseline study by CQPA & CEM/CQU<br>- EPA monitoring data on ballast water dumping  | - Coastal CRC study on Contaminants in Port Curtis: Screening level risk assessment by Port Curtis Contaminant Risk Assessment Team at CEM/CQU<br>- CQPA monitoring data on metal accumulation in benthic fauna near port operations   | - Maritime Safety Qld data on marine spills<br>- Prosecution branch of MSQ on pollution incidents<br>- Biannual recreational boating survey report at MSQ   |
| <b>Stakeholders affected &amp; type of impact</b> | Tourists<br>Residents<br>Fishers<br>boaters<br><br>- Pest species may impact on local fishery resources<br>- Pest species may affect perceived quality of marine environment & impact on tourism<br>- Pest species affect on human health | Fishers<br>Local businesses<br>Indigenous community<br><br>- Accumulation of metals in fish & seafood may affect commercial viability of certain species & human health<br>- Reduction in the availability of local seafood product<br>- Recreational fishing activity affected if metal in fish exceed safe levels<br>- Fishers will have to travel further to access fishery | Recreational users (boaters, swimmers, fishers)<br>Tourism<br>Emergency services<br>- Major spill could have large impacts on local marine environment & wildlife, & GBR with short & long term affects on tourism & recreational users.<br>- Costs of clean up operations to local govt & state depts<br>- Greater demand on emergency services<br>- Higher accident risk due to increased marine boating & shipping activity<br>- Damage to fishery nursery & habitat areas reduce fishery resource |

| Impact details  | Social impacts   |  |  |
|---|--|--|--|
|   | Marine pests brought in via ship ballast water   | Trace metal concentrations from shipping   | Marine pollution from boats, ships & recreational boaters (e.g. sewage, spillage & accidents)  |
| <b>Data source information</b>                            | <ul style="list-style-type: none"> <li>- DPI Fisheries data on pest species</li> <li>- Statistical data from Qld Health Hospital Admitted Patient Data</li> <li>- Commercial catch per unit effort data</li> <li>- Fisher buyer &amp; retailer records -fish biomass, location</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> </ul> | <ul style="list-style-type: none"> <li>- Statistical information on incidence rates, links &amp; comparisons to non-Indigenous people.</li> <li>- Qld Health Hospital Admitted Patient Data</li> <li>- Fisher buyer &amp; retailer records -fish biomass, location</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> </ul> | <ul style="list-style-type: none"> <li>- ABS data from tourist accommodation &amp; holiday tracking survey</li> <li>- Local council &amp; state govt expenditure &amp; budget for clean-up operations</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> <li>- DPI Fisheries data on Commercial Fisheries Information System (CFISH)</li> </ul> |
| <b>Mitigation strategies to manage impacts</b>            | Ballast water exchange & treatment (trial program)   | - Regulations now require less toxic antifoulants be used  | - Use of holding tanks etc during fuelling, etc to minimise spills   |
| <b>Information on impact monitoring</b>                   |  |  |  |
| <b>Associated social impacts of mitigation strategies</b> | Additional cost of treatment passed onto consumers in general  | - Increased cost to boat & ship owners who must clean boats more often, as less toxic antifoulants less effective  | - Perception by public that industry is environmentally responsible  |

## Appendix E (Part 2)

### *Potential social indicators for monitoring the effects of contamination from marine activities – Port Curtis Catchment*

| <b>Social impact</b>   | <b>Potential indicators</b>  | <b>Data sources</b>   | <b>Limitations</b>   |
|--|--|---|--|
| <b>Pressure/Driving Force</b>  |  |   |  |
| Changes in coastal activities - shipping   | Level of shipping in harbour (ship movements per year)<br>Number of large (25m+) ships   | Maritime Safety Qld data on shipping movements & ship size<br>Harbour Master records on pilotage  | Data only covers large ships & not recreational boats or water craft   |
| Pollution – Maritime pollution incidents   | Number of pollution incidents reported   | Maritime Safety Qld data on marine spills<br>Number of prosecutions for pollution incidents   | Limited to data on reported or known incidents   |
| <b>Impact</b>  |  |   |  |
| Water quality  | Number & frequency of fish kills<br>Number & frequency of algae outbreaks<br>Incidence of marine spills<br>Prosecutions for marine pollution   | CQPA water quality monitoring data<br>EPA ambient water quality in rivers & harbour<br>EPA fish kill data & reports<br>Maritime Safety Qld data on marine spills & prosecutions   | Fish monitoring for water quality health<br>No data on contaminant or cause of death<br>Under reporting for marine spills & pollution incidents  |
| Ballast water  | Notification of pest species   | AQIS data<br>DPI Fisheries  | No monitoring of ballast water dumping at sea. Requires on voluntary compliance & reporting  |
| Public health<br>- effect on human health from fish & seafood consumption                  | Notification rates of microbial contamination conditions (seafood poisoning)<br>Emergency/out-patient admissions for gastroenteritis illness<br>Number of outbreaks which exceed health standards<br>Toxin level in seafood, fish & marine vertebrates<br>Exceedence of pollution guidelines<br>Incidence of health problems with traditional food sources (turtle, dugong, oysters)<br>Number of marine wildlife deaths | Hospital admitted patient data<br>Fisheries retailer & commercial fishing data<br>Food contamination data may be a surrogate for water contamination<br>Government department statistics on Indigenous community health<br>EPA water quality testing<br>Community health water quality testing<br>EPA database & statistics in tri-annual report on marine wildlife mortality | Health data limited to hospitals & does not include GP patient data<br>Does not account for lost work days & medical costs<br>No regular testing of fish & seafood for contaminants & residual levels<br>Relies on public reporting of outbreaks |
| Natural resource condition<br>- effect on fish species<br>- effect on local fish available | Commercial catch per unit effort<br>Commercial fishery biomass<br>Fisheries closure periods – No. of days  | DPI Fisheries Commercial & recreational catch data in diary system<br>Monthly commercial logbook catch figures<br>Fish & seafood retailers & licensed buyers records on local product supply  | Relies on voluntary reporting<br>Estimation of recreational fish catch is difficult<br>Other factors may cause changes in fish biodiversity & numbers  |

| <b>Social impact</b>   | <b>Potential indicators</b>  | <b>Data sources</b>  | <b>Limitations</b>  |
|--|--|--|---|
| Natural resource availability<br>- availability of fishery resource for extraction | Seafood catch per unit effort<br>Cost of accessing alternative fishing location  | DPI Fisheries Recreational fish data collected through Recreational Fishing Information System (RFISH), diary system<br>Commercial logbook catch figures   | Relies on voluntary reporting by recreational fishers<br>Availability of fishery resource may be the result of a number of factors<br>Difficult to collect data & estimate cost of accessing alternative locations                                |
| Seagrass biomass   | Disturbance of seagrass habitat<br>% loss of seagrass area   | DPI Fisheries spatial data<br>CQPA seagrass survey   | A number of factors may contribute to & cause seagrass loss. Seagrass is a proxy indicator.   |
| Human health   | Closure of foreshore/beach due to marine pollution levels<br>Notification rates for conditions associated with microbiological contaminants<br>Clean up cost of removing pollutants from spills & discharges<br>Number of disease outbreaks per year associated with contaminated marine water, fish & other species | Local government water monitoring data<br>Local government foreshore closure notices<br>Local & state government expenditure & budget for clean-up operations<br>EPA water quality monitoring data<br>QLD Health data on human exposure to polluted water in hospital records<br>Record of community complaints. | Some data available. Need to correlate incidences of water quality decline with human health statistics. Data for different geographical areas required to identify Indigenous communities at risk. No monitoring system for algae health effects |
| Recreational amenity of waterways & coast  | Perception of health of the resource in waterways & coastal areas  | Anecdotal evidence only<br>GBRMPA tourist visitor survey to GBR  | Quality of the waterway or coastal for use is a subjective measure. Perceptions change & costly to monitor  |
| <b>Response</b>  |  |  |   |
| Marine pest management action  |  |  |   |
| Pollution control measures   | Frequency & % use of holding tanks to minimise spills during refuelling  |  | Requires collecting monitoring data   |
| Implementation of water quality measures   | Usage of antifoulant on ship hulls<br>Level of toxicant in harbour   | CQPA benthic monitoring data   | Toxicant sampling of water for TBT may be costly  |

## Appendix F (Part 1)

### *Social impacts of water quality decline effects from land use changes – Port Curtis Catchment*

| Impact details                                    | Social impacts  |  |
|---|---|--|
|   | Clearing & reclamation of coastal areas for economic development/ industry affect water quality   | Population increase leads to rapid development, land clearing & greater sediment entering waterways  |
| <b>Geographical/ spatial scale</b>                | <ul style="list-style-type: none"> <li>- Lower catchment &amp; harbour.</li> <li>- Shale Oil project expansion of activities into the marine environment</li> </ul>   | <ul style="list-style-type: none"> <li>- Cleared land &amp; urban development areas, i.e. Calliope, Tannum Sands/ Boyne Island, Agnes Water.</li> </ul>  |
| <b>Temporal aspects</b>                           | <ul style="list-style-type: none"> <li>- Depending on impact as there may be delayed environmental effects &amp; damage to areas further away over time</li> </ul>  | <ul style="list-style-type: none"> <li>- Immediately following clearing &amp; rain.</li> <li>- Following large scale development.</li> </ul>   |
| <b>Magnitude &amp; frequency of problem</b>       | <ul style="list-style-type: none"> <li>- Development in region ongoing &amp; extensive area affected, including outlying islands &amp; Narrows.</li> </ul>  | <ul style="list-style-type: none"> <li>- Mainly in coastal &amp; steep areas</li> </ul>  |
| <b>Data sources available</b>                     | <ul style="list-style-type: none"> <li>- CQPA strategic plan for Gladstone/Port Curtis</li> <li>- Stuart Shale Oil proposed plans/EIS</li> </ul>  | <ul style="list-style-type: none"> <li>- Water quality data</li> <li>- Local govt development approvals</li> </ul>   |
| <b>Stakeholders affected &amp; type of impact</b> | <p>Fish &amp; seafood retailers<br/>Indigenous community<br/>Fishers<br/>Tourists</p> <ul style="list-style-type: none"> <li>- Indigenous use of cultural sites in coastal area may be affected by industrial development &amp; associated impacts</li> <li>- Fisheries resource affected by reclamation of mudflats &amp; mangrove that are seafood &amp; fish nursery areas.</li> <li>- Availability of fishery resource impacted &amp; monetary &amp; non-monetary losses for commercial &amp; recreational fishers (incl. local retail businesses)</li> <li>- Availability of fishery resource for Indigenous community affected, leading to dietary changes, higher food costs &amp; human health problems</li> <li>- Tourism &amp; attractiveness of the area (water activities) affected by change in land use &amp; visual appearance</li> <li>- Fishers will have to travel further to access fishery</li> </ul> | <p>Tourists,<br/>Community<br/>Indigenous community<br/>All fishers</p> <ul style="list-style-type: none"> <li>- Sediment from land deposits on seagrass affecting fishery habitat &amp; food source</li> <li>- Water quality declines - murky &amp; unattractive</li> <li>- Deposited sediment changes composition of sand. Tourism may be affected as the attractiveness of the resource is changed following development</li> <li>- Access &amp; use of waterways for recreation affected by deposition of sediments</li> <li>- Access for ships entering harbour &amp; channel affected – cost of additional dredging</li> </ul> |

| <b>Impact details</b>                                     | <b>Social impacts</b>  |   |
|---|--|---|
|   | <b>Clearing &amp; reclamation of coastal areas for economic development/ industry affect water quality</b>   | <b>Population increase leads to rapid development, land clearing &amp; greater sediment entering waterways</b>  |
| <b>Data source information</b>                            | <ul style="list-style-type: none"> <li>- Indigenous impacts known from anecdotal evidence &amp; observation of changed behaviour</li> <li>- Seagrass &amp; mangrove spatial survey data</li> <li>- Commercial catch per unit effort data</li> <li>- Fisher buyer &amp; retailer records -fish biomass, location</li> <li>- Recreational Fishing Information System (RFISH) data &amp; recreational fisher diary/personal logbook</li> <li>- ABS data from tourist accommodation &amp; holiday tracking survey</li> </ul> | <ul style="list-style-type: none"> <li>- Water quality data from state government departments &amp; CQPA</li> <li>- Recreational &amp; commercial fisher logbooks on catch amounts &amp; location of catch</li> <li>- Information from Dept Maritime Transport &amp; CQPA on dredging activity</li> </ul> |
| <b>Mitigation strategies to manage impacts</b>            |  | <ul style="list-style-type: none"> <li>- Restrictions on builders/developers to reduce sediment loads.</li> <li>- Developers spray for dust to minimise impacts.</li> <li>- Council has stormwater pond to collect sediment before entering the sea</li> </ul>  |
| <b>Information on impact monitoring</b>                   |  | <ul style="list-style-type: none"> <li>- EPA &amp; CQPA water quality data</li> <li>- Boat ramp surveys of recreational fishers by CapReef</li> <li>- Recreational fisher diary</li> <li>- Local council monitoring of stormwater traps</li> </ul>  |
| <b>Associated social impacts of mitigation strategies</b> |  | <ul style="list-style-type: none"> <li>- Council does not have funds/resources to maintain sediment traps once developers have done their work</li> </ul>   |

## Appendix F (Part 2)

### *Potential social indicators for monitoring the effects of land use change and water quality decline due to economic development and population pressure – Port Curtis Catchment*

| <b>Social impact</b>   | <b>Potential indicators</b>  | <b>Data sources</b>   | <b>Limitations</b>   |
|--|--|---|--|
| <b>Pressure/Driving Force</b>  |  |   |  |
| Resource demand<br>- population growth<br>- infrastructure development<br>- Industrial use<br>- Urban development<br>- change in land use<br>- change in coastal use | Population trends, In-migration & out-migration<br>Area of port & assoc infrastructure<br>Area of industry activity along coast<br>Level of industry development<br>Area of urban development<br>% land area for industry, port facilities<br>% length of coast used for industry, port facilities<br>Area of land cleared | ABS & Census data<br>CQPA records/strategic plan<br>Dept NRMW land clearing data<br>Local government data   | Difficult to find satisfactory land use map  |
| Disturbance of foreshore & marine habitat  | % area of habitat subject to reclamation<br>% area of mudflats & mangrove loss in region<br>Fishery habitat area destroyed   | CQPA data<br>Dept NRMW land use data  |  |
| Amount of land reclamation   | % land reclaimed for industry & port development   | Dept NRMW land use data<br>CQPA data  |  |
| <b>Impact</b>  |  |   |  |
| Coastal development on cultural heritage   | Cultural heritage sites damaged or destroyed   | Dept NRMW<br>Cultural Heritage database   | Data on condition & retention of cultural heritage sites may no exist, beyond initial listing                    |
| Resource availability  | Total seafood catch (biomass)<br>Catch per unit effort<br>Seagrass area  | DPI fisheries on commercial & recreational fishers' biomass volume, location etc.<br>Records of fish retailers & licensed buyers<br>CQPA & EPA baseline seagrass data | Numerous factors may influence fishery resource & seagrass loss  |
| traditional food resource availability   | Commercial & recreational crab numbers<br>Level of traditional hunting & fishing   | DPI Fisheries commercial & recreational fisher catch data & location<br>Anecdotal evidence  | Requires the use of indirect measures & anecdotal evidence<br>Requires primary data collection using survey tool |

| <b>Social impact</b>                                  | <b>Potential indicators</b>  | <b>Data sources</b>  | <b>Limitations</b>   |
|---|--|--|--|
| Indigenous health                                     | Prevalence of health problems associated with poor diet/nutrition  | Qld Health statistical data from hospital admitted patient data collection.<br>Statistical information on incidence rates & comparison to non-Indigenous people  | Disaggregating effect of diet from other factors difficult   |
| Attractiveness/amenity of area                        | %positive & negative media coverage<br>beach & reef quality<br>Sediment load<br>Tourist numbers  | ABS data from tourist accommodation & holiday tracking survey<br>Local & state newspaper articles<br>Local government record of complaints about amenity of area & stormwater trap monitoring data<br>CQPA & EPA water quality monitoring data<br>Dept Maritime Transport & CQPA data on dredging activity | Difficult to disaggregate effect of several factors  |
| <b>Response</b>                                       |  |  |  |
| Environmental health<br>- diffuse source contaminants | Level of implementation of stormwater quality improvement devices (SQIDs)<br>Level of implementation of erosion & sediment controls in urban developments<br>Level of restriction on urban development<br>Funds for sediment control | Local government data on urban development controls & SQIDs<br>Local government funding allocation for sediment control  | Difficult to collect data on controls used & maintained by urban developers to manage erosion & sediment impacts |

## Appendix G (Part 1)

### *Social impacts of water quality decline from pollutant effects from industry, agriculture and urban activities on human use of resources – Port Curtis Catchment*

| Impact details                                     | Social impacts  |   |  |   |
|--|---|---|--|---|
|  | Agricultural pollutants enter Port Curtis impacting on water quality  | Industry pollutants enter Port Curtis via waterways & stormwater drains (i.e. from air onto land and then into stormwater)  | Stormwater pollutants from urban areas enter Port Curtis impacting on water quality? | Indigenous visitation to coastal & waterway areas & usage of resources  |
| <b>Geographical/spatial scale.</b>                 | - From the Fitzroy, then down the Narrows - Calliope River  | - Areas within vicinity of industry & emissions.<br>- Areas downwind of industry, e.g. Oil Shale, QAL, wherever coal & alumina dust are a problem   | - Lower coastal part of catchment where runoff enters stormwater drains & waterways. | - Coastal & waterway areas  |
| <b>Temporal aspects</b>                            | - During rainfall & flood events  | - Ongoing until sufficient buffers created or action taken to remedy the impact<br>- Low property values to remain until Shale Oil project completed or land acquired by industry/govt<br>- Coal & bauxite dust worst at certain times, e.g. windy days.                                | - Ongoing & during storm events  | - Depends on extend of impact e.g. beach closures due to water quality decline, fish kills,   |
| <b>Magnitude &amp; frequency of problem</b>        | - Ongoing but more severe during pulse events<br>- Fish kills may occur immediately following pulse event due to high nutrient levels | - Ongoing.<br>- Problem is worst when blowouts occur or when industry emissions breach regulations.<br>- Coal & alumina dust ongoing problem but worse on windy days – high number of complaints on windy days.<br>- Oil Shale project suspended due to severe problems                 | - During rain events   | No data   |
| <b>Data sources available</b>                      | - Water quality data<br>- EPA Fish kill data & reports  | - REIQ real estate values<br>- Complaints database<br>- EPA data on industry license breaches & reported blowouts<br>- EPA & CQPA air quality data  | - Water quality data   | -EPA & CQPA water quality data<br>- EPA fish kill data & marine wildlife mortality<br>- Local council beach closure notices   |
| <b>Stakeholders affected &amp; type of impact.</b> | All fishers<br>Indigenous community<br>Future tourism sector<br><br>- Health of fishery resource & habitat areas                      | QAL employees & residents within vicinity of industry in & surrounding Gladstone<br>Businesses & people exposed to dust from coal trains<br>Residents affected by Oil Shale project<br>Councils/developers to meet housing demand & need to locate urban development away from industry | All fishers<br>Indigenous community<br>Water-based recreation users<br>Tourists      | Indigenous community<br><br>- Limited from or unable to access traditional land & resources, participate in traditional customs or rituals of local indigenous culture. |

| Impact details                          | Social impacts  |   |   |   |
|---|---|---|---|---|
|   | Agricultural pollutants enter Port Curtis impacting on water quality  | Industry pollutants enter Port Curtis via waterways & stormwater drains (i.e. from air onto land and then into stormwater)  | Stormwater pollutants from urban areas enter Port Curtis impacting on water quality?  | Indigenous visitation to coastal & waterway areas & usage of resources  |
|   | <ul style="list-style-type: none"> <li>- Availability &amp; health of fishery impact local business &amp; tourists</li> <li>- Fish kills produce negative public perception of fishery &amp; health of waterways &amp; beaches</li> </ul>                       | <ul style="list-style-type: none"> <li>- Yarwun school moved due to noise &amp; dust from increasing number of coal trains</li> <li>- Mt Larcom pool affected by coal dust – cost of pool cleaning &amp; public health perceptions</li> <li>- Perceived impacts of dust &amp; emissions on human health</li> <li>- Lower property values in Targinnie. area close to shale oil industry</li> <li>- Greater pressure on planners to establish buffers &amp; locate population to other areas e.g. Calliope, Boyne Island/Tannum Sands. Costs to planners to provide infrastructure &amp; services to these rapid growth areas.</li> <li>- Paint on residents &amp; QAL employees within vicinity of caustic emission fallout affected</li> </ul> | <ul style="list-style-type: none"> <li>- Urban pollutants &amp; coal dust may impact on fish habitat (seagrass) &amp; affect fishery</li> <li>- Water quality decline in recreational areas &amp; threat to public safety</li> <li>- Negative public perceptions of waterways &amp; beaches from visual &amp; odour changes (turbidity)</li> <li>- Higher pollutant loads in stormwater from population increase &amp; expansion of road network (road runoff)</li> </ul> | <ul style="list-style-type: none"> <li>- Loss of traditional knowledge. Hence, loss of culture, sense of place &amp; identity. May lead to increase in undesirable activities, e.g. drinking, fighting.</li> <li>- Impact on community wellbeing from unable to use traditional areas for relaxation, story telling &amp; fishing/hunting</li> <li>- Traditional food part of staple diet</li> <li>- Indigenous people perceive risk to consuming fish &amp; seafood</li> </ul> |
| <b>Data source information</b>          | <ul style="list-style-type: none"> <li>- EPA fish kill data</li> <li>- Availability &amp; consumption of local fish &amp; seafood – Commercial fisher logbooks &amp; retailers</li> <li>- Public health database on incidences of seafood poisoning</li> </ul>  | <ul style="list-style-type: none"> <li>- Calliope Local Council – school information &amp; public pool</li> <li>- QLD Health report on health effects related to the Stuart Shale Oil Project (Interim Report), 14 May, 2001.</li> <li>- REIQ real estate prices</li> <li>- Dept of State Devt. Land purchase in Targinnie/ Yarwun area</li> <li>- QAL fallout information &amp; repair costs from QAL or insurer</li> </ul>  | <ul style="list-style-type: none"> <li>- Public notices on waterway &amp; beach closures</li> <li>- Water quality data from local council &amp; state govt departments, &amp; CQPA</li> </ul>   | <ul style="list-style-type: none"> <li>- Indigenous anecdotal evidence</li> <li>- Statistical data from QLD Health Hospital Admitted Patient Data Collection</li> </ul>   |
| <b>Information on impact monitoring</b> | <ul style="list-style-type: none"> <li>- EPA water quality testing data</li> <li>- EPA annual report on fish kills &amp; marine wildlife mortality</li> <li>- DPI Fisheries information on fishery resource through short &amp; long term monitoring</li> </ul> | <ul style="list-style-type: none"> <li>- CQPA (&amp; CQU) long term monitoring program of benthic fauna for trace metal contamination in vicinity of port operations &amp; in Gladstone Harbour</li> <li>- EPA&amp; CQPA water quality testing data &amp; air quality data</li> <li>- Individual industry water monitoring /end of pipe discharge data</li> <li>- Complaints database</li> <li>- Qld Health public health database &amp; hospital patient information</li> </ul>  | <ul style="list-style-type: none"> <li>- Qld Health – public health database for specific medical conditions &amp; Hospital patient inpatient &amp; outpatient information</li> <li>- Recreational fisher diary data for Gladstone Harbour &amp; waterways in Calliope &amp; Gladstone</li> </ul>   | No Data   |

| Impact details  | Social impacts   |   |   |  |
|---|--|---|---|--|
|   | Agricultural pollutants enter Port Curtis impacting on water quality   | Industry pollutants enter Port Curtis via waterways & stormwater drains (i.e. from air onto land and then into stormwater)  | Stormwater pollutants from urban areas enter Port Curtis impacting on water quality?  | Indigenous visitation to coastal & waterway areas & usage of resources   |
| <b>Mitigation strategies to manage impacts</b>            | <ul style="list-style-type: none"> <li>- Sustainable farming practices to reduce soil erosion &amp; runoff into waterways (e.g. fence waterways to stop stock damaging banks)</li> </ul> | <ul style="list-style-type: none"> <li>- Better residential planning &amp; buffer zones between industry &amp; residents</li> <li>- Property buy outs</li> <li>- CQPA, industry, &amp; Gladstone Council use holding/storage ponds for stormwater; sediments/pollutants; drop out before reaching water-ways.</li> <li>- Industry plans to reduce dust problems, incl. building attractive wind break/hill in front of coal wharf.</li> <li>- QAL repaints cars damaged by caustic emissions or blow out.</li> </ul>              | <ul style="list-style-type: none"> <li>- Stormwater/litter traps installed in new development but no funds to maintain them by Council</li> <li>- Rules &amp; regulations to manage inputs into stormwater</li> </ul> |  |
| <b>Associated social impacts of mitigation strategies</b> |  | <ul style="list-style-type: none"> <li>- Property prices decrease following health impacts&amp; mass govt buy out of property in Targinnie. area</li> <li>- Targinnie/Yarwun residents can't afford to buy property in region because industry has increased the demand for housing &amp; elevated housing prices</li> <li>- Class action against Stuart Oil Shale (Southern Pacific Petroleum) due to health related, property devaluation &amp; other concerns.</li> <li>- QAL emissions are caustic and cause rust.</li> </ul> | <ul style="list-style-type: none"> <li>- Blocked up sediment/litter may block flow of water into drain &amp; lead to localised flooding.</li> </ul>   | <ul style="list-style-type: none"> <li>- Loss of culture &amp; cultural heritage</li> <li>- Potential for Indigenous tourism lost if no assessment of this in development applications.</li> </ul> |

## Appendix G (Part 2)

### *Potential social indicators for monitoring the effects of water quality decline from pollution (industry, urban, agriculture) – Port Curtis Catchment*

| <b>Social impact</b>  | <b>Potential indicators</b>  | <b>Data sources</b>  | <b>Limitations</b>  |
|---|--|--|---|
| <b>Pressure/Driving Force</b>   |  |  |   |
| Environmental health<br>- water quality decline from pollutants<br>- rainfall/episodic pulse events | No. & frequency of fish kills<br>No. & frequency of marine wildlife mortality<br>No. & frequency of blue-green algae outbreaks<br>No. foreshore/beach closures<br>Occurrence of high rainfall/episodic pulse event | EPA Fish kill & marine wildlife mortality data & reports – regional information available<br>EPA & CQPA<br>Local government data on closures   | No data on contaminant or cause of death<br>Indirect measure using rainfall to predict higher nutrient loads  |
| Resource demand<br>- coastal & catchment development  | Level/rate of industrial development<br>Level/rate of urban development<br>Level/rate of agricultural activity   | CPQA port expansion data<br>Local government development approvals & area under development<br>Dept NRMW land use data   | Documents changes in land use patterns but hard to disaggregate the different effects from the numerous activities under way  |
| Pollution<br>- discharges from point sources<br>- discharges from diffuse sources                   | Total nutrient load from diffuse & point source pollution<br>Nutrient load from point source pollution<br>Discharges from point sources<br>Trace metal contaminants  | EPA data on industry license breaches & reported blowouts<br>EPA air quality data<br>Complaints database<br>CQPA (& CQU) long term monitoring program of benthic fauna for trace metal contamination | No limitations for point source pollutants discharging loads to coastal water systems. Indicator is a direct measure of the pressure. Diffuse pollutants much harder. |
| <b>Impact</b>   |  |  |   |
| Toxin in fish & seafood   | Exceedences of the maximum residue levels (MRL) in food  | Qld Health   | National programs monitor residues. MRL is a surrogate for land/water contamination. Indicator applies to food from freshwater & marine environments                  |
| Protection of Native Title rights   | Level of access & use of coastal areas for hunting & fishing   | Anecdotal evidence   | Problematic due to ill-defined legislation & judicial processes on Native Title<br>Requires primary data collection   |
| Health  | Exceedences of marine & estuarine water quality guidelines   | EPA water quality data & ANZECC water quality guidelines   |   |

| Social impact  | Potential indicators   | Data sources  | Limitations  |
|--|--|---|--|
| Public health & safety<br>- effect from exposure to recreational water contaminated by pollutants<br>- effect on human health from fish & seafood consumption<br>- threat to public safety | Notification rates of microbial contamination conditions (seafood poisoning)<br>Incidences of recreational-water-related illness<br>Morbidity associated with contaminated recreational water – Emergency/hospital admissions for gastrointestinal illnesses, upper respiratory tract, eye, ear, nose or throat infections & skin ailments<br>Number of outbreaks which exceed health standards<br>Toxin level in seafood, fish & marine vertebrates<br>Exceedence of pollution guidelines<br>Incidence of health problems with traditional food sources (turtle, dugong, oysters) | Qld Health statistical data<br>Hospital admitted patient data<br>Fisheries retailer & commercial fishing data<br>Food contamination data may be a surrogate for water contamination<br>Government department statistics on Indigenous community health<br>EPA water quality testing<br>Community health water quality testing | Health data limited to hospitals & does not include GP patient data<br>Does not account for lost work days & medical costs<br>No regular testing of fish & seafood for contaminants & residual levels<br>Relies on public reporting of outbreaks<br>Need to disaggregate data on water-borne illnesses for children & adults due to greater susceptibility<br>Very difficult to account for health burden & economic burden (medical costs, lost productivity, impaired quality of life, lost leisure time). No data on recreational values & lost business (tourism) revenue. |
| Attitudes towards health of fishery resource   | Consumption of local fish & seafood<br>Negative media reports  | Local fish & seafood retailers & licensed buyers records on local demand<br>Local media   | No direct measures unless survey used to collect primary data on attitudes   |
| Quality of public access experience  | Usability of the public access points & condition of the surrounding environment   | Local government data on closures   | Quality of the waterway or coastal area for use is a subjective measure. Perceptions change & costly to monitor  |
| Quality of life  | Real estate values   | REIQ real estate price statistical information  | May be numerous factors influencing the housing prices in the more popular & more desirable places to live   |
| <b>Response</b>  |  |   |  |
| Level of management action<br>- sustainable land management practices  | % agricultural area of catchment under sustainable farming practices   | Dept NRMW<br>Regional NRMW group - FBA  | Difficult as need to specify area under land management to reduce soil erosion & runoff into waterways   |
| Level of management action<br>-  | Level of implementation of stormwater quality improvement devices (SQIDs)  | Local government data on urban stormwater development controls & SQIDs  | Difficult to collect data on controls used & maintained  |

## Appendix H (Part 1)

### *Summary of social impacts from changed water quality & potential data sources – Fitzroy Catchment*

| Secondary impacts        | Social issues and stakeholders affected  | Social impacts   | Potential data sources   |
|--------------------------|--|--|--|
| Reduced fish and seafood | <p>Fishery resource affected by water storage infrastructure (Barrage, weirs) &amp; obstructed river flows → Reduced opportunity for recreational &amp; commercial fishing of estuarine fish species → Shift in fishing activity to coast &amp; offshore</p> <p>Local community<br/>Fishers<br/>Indigenous community</p> | <ul style="list-style-type: none"> <li>• Altered system favours less desirable fish species above the barrage &amp; they dominate</li> <li>• Reduced fishing opportunity for communities above the barrage</li> <li>• Recreational fisher catch has decreased</li> <li>• Significant change to amount of commercial fishing in marine park</li> <li>• Changed river structure – no separate waterholes now for recreational use</li> <li>• Infrastructure affects traditional use of the river by Indigenous people - social gatherings, swimming &amp; fishing</li> </ul> | <ul style="list-style-type: none"> <li>• Commercial &amp; recreational catch data documented in diary system</li> <li>• Recreational data collected through Recreational Fishing Information System (RFISH)</li> <li>• Monthly catch figures (East Coast Trawl Fishery Logbook)</li> <li>• -Recreational Fishing Information System or RFISH &amp; DPI&amp;F for recreational fishing surveys</li> <li>• Commercial Fisheries Information System (CFISH) at DPI&amp;F &amp; Electronic Catch Effort Reporting System (ECERS) &amp; Species of Conservation Interest Logbook (QDPIF)</li> <li>• National recreational &amp; Indigenous fishing survey cover fishers' attitudes &amp; awareness</li> <li>• Suntag data for Qld since 1996/97 -catch per effort &amp; monitoring data for all recreational fish species, monitor growth &amp; movement of stocked fish, mixing with wild stock</li> <li>• Coastal CRC research on stock quantity &amp; effect of environmental flows on fish species</li> <li>• CQU research on fish breeding habits in Fitzroy River</li> <li>• Coastal CRC Fitzroy Estuary conceptual model (Barramundi &amp; prawns)</li> <li>• State of Queensland (2005) on CQRIS website for regional overview.</li> <li>• Water Resources document on CQRIS website</li> </ul> |
|                          | <p>Conflict between commercial &amp; recreational fishers over access to limited fishery resource &amp; the sustainability of the resource</p> <p>Fishers</p>  | <ul style="list-style-type: none"> <li>• Negative public perceptions of commercial fishers, however, not all commercial fishers are large-scale operators.</li> </ul>  | <ul style="list-style-type: none"> <li>• Anecdotal evidence from newspapers, online sources etc</li> </ul>   |

| Secondary impacts | Social issues and stakeholders affected  | Social impacts   | Potential data sources   |
|-------------------|--|--|--|
|                   | <p>Changed access to fisheries resource in GBRMP due to reduced fishery stock</p> <p>All fishers but commercial fishers more affected<br/>Small commercial fishers &amp; family owned businesses<br/>Local community<br/>Local fish/seafood retailers</p>                          | <ul style="list-style-type: none"> <li>• Controlled access to fishing areas &amp; gear used</li> <li>• Bag &amp; size limits reduce the recreational fishers fish amount</li> <li>• Fish cooperative sold out &amp; local buyers affected</li> <li>• Larger commercial fishery operators at an advantage as they export to overseas markets</li> <li>• Fishing closures for 2.5 months affects prawn fishers</li> <li>• Commercial fishers required to look for off season employment</li> <li>• Fish effort indicates fisheries is in decline</li> </ul>  | <ul style="list-style-type: none"> <li>• Retailers/licensed buyers maintain records on local product:- amount of product, type, value to fisherman/ wholesale price, date, name of operator, location caught</li> <li>• Recreational &amp; commercial fisher log books</li> </ul>  |
|                   | <p>Indigenous peoples' dependency on the river changes due to food &amp; food sources being affected by sedimentation</p> <p>Traditional Owners<br/>Other stakeholder groups due to established access &amp; lack of understanding of traditional hunting &amp; fishing rights</p> | <ul style="list-style-type: none"> <li>• Cultural connection &amp; identity to food source</li> <li>• Social &amp; economic reliance on fishery resource - estuary fish, turtle, dugong</li> <li>• Good health relies on fish &amp; seafood as staple diet</li> <li>• Perceived health risk to consuming fish</li> <li>• Fish above the barrage don't taste good</li> <li>• Community affected through health, breakdown in social structures, relationships with other stakeholders &amp; Traditional Owner groups</li> <li>• Displacement of fisheries influences population shift to access the resource</li> <li>• Shift of fishery activities puts increased pressure on other areas</li> </ul> | <ul style="list-style-type: none"> <li>• Towards a Queensland Aboriginal and Torres Strait Islander Environmental Health Strategy – A Scoping Paper (1999)</li> <li>• Statistical data from QLD Health: Hospital Admitted Patient Data Collection</li> <li>• Queensland Health food poisoning &amp; levels of metals &amp; pollutants in fish/seafood</li> <li>• Water monitoring in creeks &amp; rivers by community health officers</li> </ul> |
|                   | <p>Resource accessibility &amp; use affected by crocodiles above the barrage</p> <p>Recreational river users<br/>Indigenous community</p>  | <ul style="list-style-type: none"> <li>• Prevents use of the river for social &amp; competitive sporting events</li> <li>• presence of crocodiles deters use of river for recreation &amp; social gatherings</li> </ul>  | <ul style="list-style-type: none"> <li>• Local newspaper</li> <li>• Complaints databases</li> <li>• Council minutes</li> </ul>   |

| Secondary impacts        | Social issues and stakeholders affected  | Social impacts   | Potential data sources   |
|--------------------------|--|--|--|
| Lack of accessible water | <p>Competing interests for a limited water resource → need for equitable allocation of water use amongst users – urban, industry, agriculture, environment</p> <p>Local community<br/>Farmers/Primary producers<br/>Fishers<br/>Indigenous community</p> | <ul style="list-style-type: none"> <li>• Environment (flora &amp; fauna) above Fitzroy barrage changed due to water extraction</li> <li>• Agriculture benefits with regular water supply</li> <li>• Licenses have low flow conditions on them reducing water available for extraction</li> <li>• Development increases demand for resources, population increases, traditional laws &amp; culture of Indigenous people affected</li> <li>• Water supply for agriculture sector &amp; urban areas affected</li> </ul> | <ul style="list-style-type: none"> <li>• CQ regional water supply study</li> <li>• Water quality &amp; quantity continuously monitored &amp; information available on government web site</li> <li>• 1998 WAMP for the Fitzroy Basin Catchment Indigenous Consultation (Progress Report)</li> <li>• Community complaints databases</li> <li>• State of Queensland (2005) on CQRIS see regional overview</li> </ul> |

| Secondary impacts     | Social issues and stakeholders affected  | Social impacts   | Potential data sources   |
|-----------------------|--|--|--|
| Sediment & pollutants | <p>Increased pollutants, sediment &amp; nutrients impacts on:</p> <p>(1) visual appearance of the river,<br/>                     (2) blue green algae affecting recreational use,<br/>                     (3) marine habitat &amp; fish &amp; seafood stock &amp;<br/>                     (4) Water pollutants affecting human use &amp; consumption</p> <p>Local community<br/>                     Fishers<br/>                     Recreational users of the river &amp; causeway<br/>                     Irrigators<br/>                     Indigenous community<br/>                     Different types of communities – degradation of the physical environment risks impact on human health<br/>                     Tourists<br/>                     Tourism operators/<br/>                     small businesses<br/>                     Woorabinda Aboriginal<br/>                     Community</p> | <ul style="list-style-type: none"> <li>• Change in frequency of use of recreation areas</li> <li>• Effect on marine flora &amp; fauna, with negative impact on diving</li> <li>• Decline in aesthetics of coastal beaches &amp; river result in loss of tourist appeal &amp; community use</li> <li>• Accessibility to river for boats &amp; use of ramps</li> <li>• Blue green algae impacts on treatment process, cost of treatment &amp; ability to treat available water</li> <li>• Fish kills from algae reduce fish stock</li> <li>• Water high in nutrients &amp; sediment effected estuary &amp; river resource (2-3 month shift in prawn inshore fishery)</li> <li>• Impact on fish habitat &amp; spawning from runoff into estuary - low water flows, stagnant water &amp; pollutants cause poor fish catch &amp; low fish meat quality</li> <li>• Concern water quality impact on tourism – expectation of tourists &amp; deter visitors</li> <li>• Impacts on water supply, affect tourism &amp; local community, incl. farms supplying local markets</li> <li>• Pollution from yachts, tankers etc in creeks &amp; beach affecting use &amp; consumption of fish</li> <li>• Indigenous people have limited recreational access/use of creek &amp; lagoon &amp; loss of meeting places</li> <li>• Indigenous public health issue – children get sore eyes &amp; ears from swimming in creek &amp; water not good for human consumption or use</li> <li>• Sediment is washed into river affecting the health &amp; management of riparian zone</li> </ul> | <ul style="list-style-type: none"> <li>• No data on frequency of recreation use</li> <li>• Collecting information for 2004 Health Determinants (annual). Indicators developed by the World Health Organisation. Reports available on internet &amp; data presented by key population groups (children, young/old, Indigenous), not by district</li> <li>• See Health Determinants: Queensland 2004 report (incl. methodology)</li> <li>• No monitoring system for algae health effects. Record of community complaints</li> <li>• Hospital data on health of people.</li> <li>• Records on visitor numbers – regional activity monitor to track occupancy rate but voluntary submission of figures by operators (8/60)</li> <li>• Visitor survey at Yeppoon &amp; Great Keppel in 2003. ABS conducts Survey of Tourist Accommodation &amp; Holiday Tracking Survey.</li> <li>• Indigenous social impacts known from anecdotal evidence/story telling &amp; observation</li> <li>• Qld &amp; national Indigenous Tourism information available from Tourism Qld website (incl. regional summaries)</li> <li>• Recreational Boating Survey Report: (biannual report) by Maritime Safety, QLD. Available online from MSQ website.</li> <li>• Local streams tested by local government to determine pollution levels &amp; information from Stormwater Quality Management Plan</li> <li>• EPA test water quality &amp; data available online</li> <li>• CRC research examining contaminants and impacts upon fish</li> <li>• Survey of landholders in Fitzroy Basin and their intention to manage riparian zones. Fielding et al. (2004). <i>Queensland Landholders' and riparian zone management</i></li> </ul> |
|                       | <p>Access &amp; use of recreational areas due to sediment deposit</p> <p>Community<br/>                     Recreational fishers</p>   | <ul style="list-style-type: none"> <li>• Shallow water levels prevent boating activities</li> </ul>  | <ul style="list-style-type: none"> <li>• CQU engineering study of Causeway Lake</li> </ul>   |

## Appendix H (Part 2)

### *Social impact matrix for changed water quality – Fitzroy Catchment*

| Impact details             | Social impacts   |   |  |  |  |   |
|----------------------------|--|---|--|--|--|---|
|                            | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)  | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)  | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment  | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)   | Resource accessibility and use affected by crocodiles above barrage                                 |
| Geographical/spatial scale | <ul style="list-style-type: none"> <li>- <b>No specific location</b></li> <li>- <b>WaterparkCreek – major supply of water for Livingston Shire</b></li> <li>- <b>Impact of soil migration on inshore reefs in Keppel Bay Beach health &amp; Fitzroy river system linked</b></li> <li>- <b>weirs, Cario bay, Waterpark Creek, Fitzroy River, Fig Tree Creek, Ross Creek for fish kills &amp; pollution</b></li> </ul> | <ul style="list-style-type: none"> <li>- <b>Upper Fitzroy River</b></li> <li>- <b>Lower Fitzroy</b></li> <li>- <b>Lower streams &amp; creeks</b></li> <li>- <b>Areas along the coast &amp; inland used for ponded pastures – sandflats, mangrove areas</b></li> </ul> | <ul style="list-style-type: none"> <li>- <b>Fitzroy River, - Rockhampton, - Capricorn Coast</b></li> </ul>   | <ul style="list-style-type: none"> <li>- <b>Habitat destruction (mangroves) in estuary displaced fish population away from river</b></li> <li>- <b>Keppel Bay affected by sedimentation</b></li> <li>- <b>Change in the Fitzroy River affects connected coastal environments</b></li> <li>- <b>above barrage in Fitzroy River</b></li> </ul> | <ul style="list-style-type: none"> <li>- <b>Upper Fitzroy, above barrage</b></li> <li>- <b>Rockhampton part of the river</b></li> <li>- <b>Fitzroy River</b></li> <li>- <b>Capricorn Coast</b></li> <li>- <b>Waterpark Creek catchment (major water supply for Capricorn Coast)</b></li> <li>- <b>Woorabinda Aborigine Community – Mimosa Creek &amp; lagoon</b></li> </ul>                                  | <ul style="list-style-type: none"> <li>- <b>Upstream of barrage in the Fitzroy River</b></li> </ul> |
| Temporal aspects           | <ul style="list-style-type: none"> <li>- <b>Heavy rain after dry period causes greater problem due to lack of vegetation cover</b></li> <li>- <b>Weirs – annual event</b></li> <li>- <b>pollutants high after rain</b></li> </ul>  | <ul style="list-style-type: none"> <li>- <b>Steady reduction in fish catch since 1997 for all recreational species (except barramundi – stable numbers)</b></li> <li>- <b>Delay in release of water for environmental flows impact on mud crabs</b></li> </ul>        | <ul style="list-style-type: none"> <li>- <b>Legislated release of base flow under specific upstream conditions</b></li> <li>- <b>Climate change extending dry periods &amp; impacting on water supply</b></li> </ul> | <ul style="list-style-type: none"> <li>- <b>Reef recovering from 1992 flood event</b></li> <li>- <b>Periodic big tides</b></li> <li>- <b>Upstream activities have a delayed impact on estuary &amp; coast (spatial influence)</b></li> <li>- <b>decreasing river flows each year</b></li> </ul>  | <ul style="list-style-type: none"> <li>- <b>Periods of low &amp; high rainfall</b></li> <li>- <b>High flow events after high rainfall, especially after dry periods</b></li> <li>- <b>Water temperature increases after long periods without rain</b></li> <li>- <b>Large flows move weeds to river mouth</b></li> <li>- <b>water deteriorate in creek at Woorabinda after dam built in 1980s</b></li> </ul> |   |

| Impact details                     | Social impacts   |   |   |  |   |  |
|------------------------------------|--|---|---|--|---|--|
|                                    | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)  | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)  | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment   | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)  | Resource accessibility and use affected by crocodiles above barrage  |
| Magnitude and frequency of problem | <ul style="list-style-type: none"> <li>- Coral bleaching or high turbidity levels affect coral, seagrass &amp; marine life</li> <li>- Direct impact on seafood stock &amp; marine habitat</li> <li>- Resident &amp; migratory recreational &amp; commercial fish stock impacted</li> <li>Causeway Lake shallower over time causing habitat &amp; fish species changes</li> </ul> | <ul style="list-style-type: none"> <li>- issue with water quality</li> <li>- unregulated access &amp; harvesting of groundwater</li> <li>- issue of grasses blocking waterways &amp; access for recreational use (fishing, boating, water skiing)</li> <li>- spread of grasses &amp; weeds to surrounding areas</li> <li>- impedes fish movement</li> <li>- impacts on biodiversity &amp; biological effect (provides habitat only to certain species)</li> </ul> |   | <ul style="list-style-type: none"> <li>- Ongoing sedimentation &amp; episodic flood events</li> <li>- Source of the sediment unknown</li> </ul>              | <ul style="list-style-type: none"> <li>- Water quality affects many biophysical responses in the river &amp; under certain conditions the water becomes unusable</li> <li>- Wet season coincides with high tourist season &amp; negative perceptions by tourists &amp; local community</li> <li>- Visual appearance of the water (not water quality)</li> <li>- Unknown impact of stormwater on the river</li> <li>- Large &amp; Ongoing sedimentation problem. Agriculture blamed.</li> <li>- Algae serious problem for users of the river water – recreational &amp; agricultural</li> <li>- areas cleared closer to waterways will have greater impact</li> <li>- clearing of land &amp; heavy rainfall cause high sediment along coast</li> </ul> |  |
| Data sources available             | <ul style="list-style-type: none"> <li>- community</li> <li>- Livingstone Shire tested local streams (upper catchment, major creeks – Waterpark Creek, Corio Bay, Keppel Sands) to determine pollution levels. Found heavy sediments &amp; high nitrogen from urban runoff. Information from Elison &amp; Assoc – part of Stormwater Quality Management Plan</li> </ul>          | <ul style="list-style-type: none"> <li>- commercial &amp; recreational catch data documented in diary system – voluntary participation (10 yrs of data)</li> <li>- History of catch</li> <li>- Recreational data collected through Recreational Fishing Information System (RFISH)</li> <li>- Sntag collects data for Qld since 1996/1997 (catch per effort &amp; monitoring</li> </ul>   | <ul style="list-style-type: none"> <li>- community complaints when restrictions on Rockhampton residents &amp; water released from the barrage</li> </ul> | <ul style="list-style-type: none"> <li>- Decline in crab numbers</li> <li>- Build up of sediment</li> <li>- Indigenous Elders &amp; crab catchers</li> </ul> | <ul style="list-style-type: none"> <li>- Coastal CRC research on water quality in the Fitzroy</li> <li>- Community aware of discharges of sediment in the bay from development or upper catchment event</li> <li>- community aware of direct results of soil migration – discoloured beaches &amp; ocean, impact on marine flora &amp; fauna</li> <li>- Livingstone Shire tested local streams (upper catchment, major creeks – Waterpark Creek, Corio Bay, Keppel Sands) to determine pollution levels. Found heavy</li> </ul>   | <ul style="list-style-type: none"> <li>Sources of information include: local newspaper, complaint letters to Local Council &amp; discussion issue at meetings</li> </ul> |

| Impact details | Social impacts  |   |   |  |  |   |
|----------------|---|---|---|--|--|---|
|                | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality) | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)  | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)   | Resource accessibility and use affected by crocodiles above barrage |
|                | <p>- No hard evidence of reduced fish stock/catch for waterways due to soil migration.</p>                                  | <p>data for all recreational fish species) Suntag monitor growth &amp; movement of stocked fish, &amp; mixing with wild stock</p> <ul style="list-style-type: none"> <li>- Coastal CRC studying stock quantity &amp; environmental flows on fish species</li> <li>- Anecdotal information only</li> <li>- CQU research on fish breeding habits in Fitzroy River show the barrage is not the problem. Issue is survival of juvenile fish &amp; affected by development in the estuary area.</li> <li>- known fact that barramundi respond to flooding</li> <li>- aerial video footage of ponded pastures in Broadsound areas, Fitzroy River &amp; Capricorn Coast</li> <li>- studies on effects of ponded pastures</li> <li>- monthly catch figures (East Coast Trawl Fishery Logbook for Rosslyn Bay, Reef Line Fishery Logbook for GBR)</li> <li>-Recreational Fishing Information System or RFISH &amp; DPI&amp;F for recreational fishing surveys</li> </ul> |   |  | <p>sediments &amp; high nitrogen from urban runoff. Information from Elison &amp; Assoc – part of Stormwater Quality Management Plan</p> <ul style="list-style-type: none"> <li>- Elison's water quality study looked at social impacts of sedimentation from community consultation</li> <li>- Algal blooms information held by Fitzroy River Water</li> <li>Community complaints to Local Council about weeds</li> <li>- Anecdotal evidence/storytelling &amp; observation by Indigenous community</li> <li>- Human exposure to polluted water (potable or otherwise) reflected in incidence of diarrhoeal disease, outbreaks of Cryptosporidiosis, E. coli &amp; Campylobacte. Notification rates for conditions associated with microbiological contaminants found in QLD Health's Notifiable Diseases Report 1997-2001.</li> <li>- Presence of chemical pollutants (dioxins, trace metals, arsenic, pesticides) can be monitored but health effects may not be immediate (proportion of human disease attributed to poor water quality in Australia is unknown &amp; importance of some microorganisms &amp; chemicals to health is unknown)</li> </ul> |   |

| Impact details                         | Social impacts   |  |  |  |   |   |
|--|--|--|--|--|---|---|
|  | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)  | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)   | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment  | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)  | Resource accessibility and use affected by crocodiles above barrage   |
|  | <ul style="list-style-type: none"> <li>- Commercial Fisheries Information System (CFISH) at DPI&amp;F &amp; Electronic Catch Effort Reporting System (ECERS) &amp; Species of Conservation Interest Logbook (QDPIF)</li> <li>- Research reports on impacts of ponded pastures on barramundi &amp; other fin fish populations in tropical coastal wetlands</li> <li>Ponded Pastures Steering Committee (1997) Policy Options paper &amp; Discussion paper (1996)</li> <li>- Coastal CRC Fitzroy Estuary conceptual model (Barramundi &amp; prawns)</li> </ul> |  |  |  |   |   |
| Stakeholders affected & type of impact | <p><b>Local community</b><br/>                     Recreational fishers<br/>                     Commercial fishers<br/>                     Indigenous people<br/>                     Recreational users of Causeway Lake</p> <p>- Impacted due to beaches, seagrass areas &amp; marine life – aesthetics of beaches &amp; ocean, effect on marine flora &amp; fauna<br/>                     - runoff into estuary impact on fish habitat &amp;</p>   | <p><b>Local community</b><br/>                     Recreational fishers<br/>                     Commercial fishers<br/>                     Indigenous community</p> <p>- negative social effect on opportunity to communities above the barrage to fish<br/>                     - altered system favours some less desirable fish species above the barrage &amp; they dominate</p> | <p><b>Local community</b><br/>                     Farmers/Primary producers (cattle, cotton)<br/>                     Commercial &amp; recreational fishers</p> <p>- Cattle &amp; cotton farmers benefit from use of ponded pastures &amp; dams to harvest freshwater for private use<br/>                     - Nathan Dam will reduce water from Upper Fitzroy (Dawson catchment) when built &amp; affect</p> | <p><b>Traditional Owners</b><br/>                     Other stakeholder groups due to established access &amp; lack of understanding of traditional hunting &amp; fishing rights</p> <p>- Cultural connection &amp; identity to food source<br/>                     - Social &amp; economic reliance on estuary fish, turtle, dugong<br/>                     - Good health relies on fish &amp; marine food as staple diet<br/>                     - Indigenous people view</p> | <p><b>Local community</b><br/>                     Recreational users of the river<br/>                     Irrigators<br/>                     Indigenous community<br/>                     Different types of communities – degradation of the physical environment risks impact on human health<br/>                     Tourists<br/>                     Tourism operators/small businesses<br/>                     Woorabinda Aborigine Community</p> <p>- Change in frequency of use (indicator)</p> | <p><b>Recreational users of the river (skiers)</b><br/>                     Indigenous community</p> <p>- Prevents use of the river for social &amp; competitive sporting events<br/>                     - presence of crocodiles deters</p> |

| Impact details   | Social impacts   |  |   |  |  |   |
|--|--|--|---|--|--|---|
|  | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)  | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing) | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment   | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae) | Resource accessibility and use affected by crocodiles above barrage |
| <p><b>spawning</b></p> <ul style="list-style-type: none"> <li>- Waterpark Creek is food production area &amp; tourism. Impacts on water supply impacts affect tourism, local community &amp; farms supplying local markets</li> <li>- anecdotal evidence of impact on Indigenous people</li> <li>- Low water flows, stagnant water &amp; pollutants cause poor fish catch &amp; low fish meat quality</li> </ul> | <ul style="list-style-type: none"> <li>- Significant change to amount of commercial fishing in marine park</li> <li>- control access to areas &amp; gear used</li> <li>- Significant reduction in effort through management – bag &amp; size limits reduce the recreational fishers fish amount</li> <li>- national recreational &amp; indigenous fishing survey cover fishers' attitudes &amp; awareness</li> <li>- late year on mud crabs due to delayed environmental flows in dry year</li> <li>- infrastructure (barrage, weirs) obstruct river flows affect fishery resource</li> <li>- change in river structure – no separate waterholes now for recreational use</li> <li>- Change in how the river flows</li> <li>- Barrage changed river used by Indigenous people for social gatherings – swimming &amp; fishing</li> <li>- Poned pastures negatively impact barramundi consumers &amp; fish retailers due to low supply</li> <li>- Tourists &amp; recreational</li> </ul> | <p><b>environmental flows</b></p>  | <ul style="list-style-type: none"> <li>risk to consuming fish from river</li> <li>- fish from above the barrage don't taste good</li> <li>- Negative impact influences shift from Country - affects community</li> <li>- Community affected through health, breakdown in social structures, relationships with other stakeholders &amp; TO groups</li> <li>- Displacement of fisheries influences population shift to access the resource</li> <li>- Shift of activities to puts increased pressure on other areas</li> <li>Indigenous people</li> <li>- Rezoning of GBRMPA displaced commercial &amp; recreational fishers &amp; put pressure on crab industry &amp; areas within Fitzroy River. - Result is conflict over reduced fish stock</li> </ul> | <ul style="list-style-type: none"> <li>- Impacted due to beaches, seagrass areas &amp; marine life – aesthetics of beaches &amp; ocean, effect on marine flora &amp; fauna</li> <li>- Accessibility to river &amp; putting boats in and out of the river</li> <li>- Kills coral &amp; impacts on aesthetics for divers</li> <li>- Urban devt reduces vegetation filtering stormwater flows (impacts on water for human consumption negligent due to water treatment)</li> <li>- Blue green algae impacts on treatment process, cost of treatment &amp; ability to treat available water (unusable water)</li> <li>-Fish kills from algae</li> <li>- Water high in nutrients &amp; sediment effected estuary &amp; river resource</li> <li>(2-3 month shift in prawn inshore fishery)</li> <li>- Concern water quality impact on tourism – expectation of tourists &amp; deter visitors</li> <li>- GBR &amp; clear water big assets but high sediment loads in Fitzroy River. Bay is shallow &amp; wind or big flows muddy the water</li> <li>- Pollution from yachts, tankers etc in creeks &amp; beach</li> <li>- Weeds stop access for fishing, kayaking &amp; hazard for water skiers, &amp; blocks streams</li> <li>- Indigenous people have limited recreational access/use of creek</li> </ul> | <p><b>use of river for recreation &amp; social gatherings</b></p>  |   |

| Impact details          | Social impacts  |   |   |  |   |   |
|-------------------------|---|---|---|--|---|---|
|                         | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality) | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)  | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment   | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)  | Resource accessibility and use affected by crocodiles above barrage |
|                         |   | <b>fisher catch is low</b>  |   |  | <b>&amp; lagoon &amp; loss of gathering place. Birdlife gone</b><br>- Indigenous public health issue – children get sore eyes & ears from swimming in creek & water not good for human consumption or use (water used by cows only)   |   |
| Data source information |   | <b>Anecdotal information</b><br><b>Aerial video footage</b><br><br><b>Reef CRC research on social issues of fishing</b><br><b>Future research planned on social assessment of management changes in the GBR marine park by James Cook University, CQU, GBRMPA</b> | <b>Complaints information – Business Support Services &amp; Process Manager of Fitzroy River Water</b><br><b>Information collected under Strategic Asset Management Plan (required by DNRMWW for customer service standards, Water Act).</b><br><b>Includes a corrective action request procedure &amp; customer assistance tracker</b> | <b>Towards a Queensland Aboriginal and Torres Strait Islander Environmental Health Strategy – A Scoping Paper (1999) – ch 9. – Environmental health &amp; diseases among Aboriginals &amp; Torres Strait Islander people in QLD. Discuss statistical information on incidence rates, links &amp; comparison to non-Indigenous people. Statistical data from QLD Health Hospital Admitted Patient Data Collection – hospitalisation rates only (some illnesses though not serious &amp; don't need hospitalisation lead to morbidity)</b> | <b>No data on frequency of use</b><br><b>Collecting information for 2004 Health Determinants (annual)</b><br><b>Indicators developed by the World Health Organisation</b><br><b>Data collected in Capricornia District &amp; Rockhampton District – Rockhampton, Livingstone, Mt Morgan, Fitzroy shires</b><br><b>Not statistically valid to use smaller groups</b><br><b>Reports available on internet – data presented by key population groups (children, young/old, Indigenous), not by district</b><br><b>Health district profiles – socio-demographic data &amp; health status estimates using synthetic estimation models. Indicators consistent with national &amp; state &amp; criteria for indicator selection used.</b><br><b>See Health Determinants: Queensland 2004 report (incl. methodology)</b><br><b>No monitoring system for algae health effects. Record of community complaints</b><br><b>Hospital data on health of people</b><br><b>Records on visitor numbers –</b> |   |

| Impact details                          | Social impacts  |   |  |  |  |  |
|---|---|---|--|--|--|--|
|   | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)   | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)  | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment  | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)   | Resource accessibility and use affected by crocodiles above barrage  |
|   |   |   |  |  | <p><b>regional activity monitor to track occupancy rate but voluntary submission of figures by operators (8/60)</b><br/> <b>ABS only now includes accommodation with less than 15 rooms</b><br/> <b>Visitor survey at Yeppoon &amp; Great Keppel in 2003. ABS conducts Survey of Tourist Accommodation &amp; Holiday Tracking Survey.</b><br/> <b>Indigenous social impacts known from anecdotal evidence/story telling &amp; observation</b><br/> <b>Qld &amp; national Indigenous Tourism information available from Tourism Qld website (incl. regional summaries of Central Qld, Gladstone &amp; Calliope)</b></p> |  |
| Mitigation strategies to manage impacts | <p><b>- (draft) Stormwater Quality Management Plan to manage storm/floodwater quality &amp; quantity</b><br/> <b>-Installation of gross pollutant traps in town centre and Civil Operations Dept analyses material from pollutants traps – no monitoring of material collected</b><br/> <b>- Forestry operations in Waterpark Creek modified practices of clearing to protect habitat along waterways</b></p> | <p><b>- No action by local council</b><br/> <b>- Restocking of barramundi &amp; Golden Perch in Upper Fitzroy by Fitzroy River Fish Stocking Group due to inability of fish to migrate upstream above barrage (no commercial fishing in freshwater section of river)</b><br/> <b>- fish restocking in water storages to provide fish for recreational fishers in rivers</b><br/> <b>- Fish ladders on the barrage but not used by barramundi. Smaller</b></p> | <p><b>- Drought management plans being developed – determine limit to environmental flows with respect to urban water supply needs</b><br/> <b>- propose pipeline from Fitzroy River to supply Livingstone Shire</b></p> | <p><b>- Working Group formed in Fitzroy in Aug 2004; Consists of Darumbal &amp; Woppa Burra TOs, with support from GBRMPA &amp; EPA;</b><br/> <b>- Working to manage change in Indigenous community due to change in the environment, preserve &amp; maintain cultural practices, &amp; educate the wider community</b><br/> <b>- Developing a legal Traditional Use of Marine Resources Agreement (TUMRA)</b></p> | <p><b>- (draft) Stormwater Quality Management Plan to manage storm/floodwater quality &amp; quantity</b><br/> <b>-Installation of gross pollutant traps in town centre and Civil Operations Dept analyses material from pollutants traps – no monitoring of material collected</b><br/> <b>- Coordinator to implement stormwater quality controls</b><br/> <b>- new urban development at Causeway Lake is environmentally friendly subdivision, due to water quality concerns</b><br/> <b>- Erosion control regulations for</b></p>  | <p><b>- Management plan for removal of crocodiles over 3 metres in length for human safety reasons</b></p> |

| Impact details | Social impacts   |  |   |   |  |   |
|----------------|--|--|---|---|--|---|
|                | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)  | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing) | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation  | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae) | Resource accessibility and use affected by crocodiles above barrage |
|                | <p><b>species use fish ladders</b></p> <ul style="list-style-type: none"> <li>- Some studies on the use of fish ladders on the barrage</li> <li>- Fish ladder maintained by local council</li> <li>- Commercial ability to catch fish reduced due to marine park zoning – program will monitor the effects of marine park management</li> <li>- prohibited to build ponded pastures in intertidal areas (old structures maintained)</li> <li>- Sunfish populating Fitzroy River with barramundi fingerlings due to barrage stopping freshwater movement</li> </ul> |  |   | <p><b>development needed</b></p> <p><b>Maintain riparian vegetation</b></p> <ul style="list-style-type: none"> <li>- cost of removing sediment &amp; pollutants from the water (indicator)</li> <li>- Monitoring of leaching from landfill &amp; input into creeks (EPA &amp; RCC)</li> <li>- discharge licenses restrict contaminated runoff from coal mines &amp; cotton farmers</li> <li>- new development requires urban sensitive design with retention basins &amp; sediment ponds</li> <li>- Removal of riparian weeds by local council</li> <li>- Algal blooms managed by Fitzroy River Water.</li> <li>- Visual monitoring upstream &amp; sampling regime when needed &amp; different levels of community warning.</li> <li>- Fitzroy River water monitor discharges from wastewater treatment plants</li> <li>- Fitzroy River Water monitor inflows &amp; outflows from the barrage &amp; monthly water quality samples from inflow, outflow &amp; storage water. Monitor condition of river banks (bank slumping), erosion &amp; changes over time at key sites (video footage starting</li> </ul> |  |   |

| Impact details                   | Social impacts  |  |   |  |   |   |
|----------------------------------|---|--|---|--|---|---|
|                                  | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality) | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing) | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)  | Resource accessibility and use affected by crocodiles above barrage |
|                                  |   |  |   |  | <p><b>July 2004). Information sent to DNRMWW</b></p> <ul style="list-style-type: none"> <li>- Fitzroy River Water submit water quality reports to Rockhampton City Council – public information</li> <li>- QLD Health offer recommendations to other govt agencies to minimise adverse impacts &amp; encourage positive impacts</li> <li>- involved in impact assessment processes – health component of impacts &amp; determining health status</li> <li>- QLD Health investigating development of water quality management plans by drinking water providers</li> <li>- EPA require point source monitoring of wastewater at – inflow to the barrage, Wattle Bank Station 70km upstream, two sites inside the barrage storage, outflow of barrage (pH, temperature, nutrients)</li> <li>- Weed infestation requires upstream involvement to prevent reinfestation.</li> <li>- 4 bores constructed at Woorabinda to supply Indigenous community</li> </ul> |   |
| Information on impact monitoring | - Litter traps cleared by local council   | Suntag provides regular reports to the stocking group<br>Monitored through fish  |   | - Working Group to monitor social impacts of strategies<br>- Difficult to monitor                                  | - No monitoring of water quality in creeks flowing into the Fitzroy.<br>- Local Council monitors sewage discharge into river to meet EPA  | No monitoring   |

| Impact details                                      | Social impacts  |  |   |   |   |   |
|---|---|--|---|---|---|---|
|   | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality)   | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing) | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation  | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae)  | Resource accessibility and use affected by crocodiles above barrage |
|   | <p><b>tagging &amp; collecting data on tagged fish caught</b></p> <p><b>Monitoring of ponded pastures difficult due to obtaining access to private land</b></p> <p><b>DPI&amp;F don't include rainfall as factor affecting fish catch</b></p> |  | <b>social change &amp; identify social benefit</b>  | <p><b>licensing requirements (basic parameters only)</b></p> <ul style="list-style-type: none"> <li>- Algal bloom events documented by media releases &amp; information on Fitzroy River Water website</li> <li>- health impact assessments within EIA process</li> <li>- Litter traps cleared by local council</li> <li>- Fitzroy River water keep records on cost of water treatment for clean drinking water – cost depends on turbidity, weather etc.</li> <li>- Indigenous public health coordinator taking random water samples from swimming pools &amp; bores (ad hoc sampling regime, no standardized methods &amp; information in non-technical reports)</li> <li>- complaints from community about taste &amp; smell of bore water</li> <li>- Woorabinda Water Office (Woorabinda Council) take weekly samples &amp; analysed by CQU laboratory</li> </ul> |   |   |
| Associated social impacts of mitigation strategies? | - Pollution reducing mechanisms (litter traps, street sweepers) positive impacts on community well-being & health of local environment  | - Positive impacts from fish stocking benefit recreational fishers & tourists  |   | <ul style="list-style-type: none"> <li>- Better relationships between group members</li> <li>- TUMRA will reinstate 'eldership' &amp; social roles within Indigenous communities</li> <li>- Advance employment opportunities (e.g. rangers)</li> <li>- Expect greater capacity of Indigenous people to</li> </ul>   | <ul style="list-style-type: none"> <li>- Effluent reuse reduces impact on river &amp; is a beneficial social impact but grey water use viewed negatively</li> <li>- Pollution reducing mechanisms (litter traps, street sweepers) positive impacts on community well-being &amp; health of local environment</li> <li>- maintenance of water quality in bores for Indigenous community</li> </ul> |   |

| Impact details         | Social impacts  |  |   |  |  |   |
|------------------------|---|--|---|--|--|---|
|                        | Polluted river and estuaries impact on fishery resource affecting human health (incl. fish kills due to poor water quality) | Resource extraction affected by barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing) | Equitable allocation of water use amongst competing users – urban, industry, agriculture, and environment | Indigenous peoples' dependency on the river changes due to fishery resource and habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impact on:<br>(1) visual appearance of river<br>(2) human use & consumption (e.g. blue green algae) | Resource accessibility and use affected by crocodiles above barrage |
|                        |   |  |   | <p><b>participate in NRMW</b><br/>                     - wider community not familiar with Native Title<br/>                     - impact of traditional hunting by South Sea Island Group</p> |  |   |
| Sources of information |   |  |   | <p><b>Social plan in preparation by local government</b><br/>                     LGAQ conduct satisfaction survey of community</p>  |  |   |

## Appendix I (Part 1)

### *Social impacts from reduced fishery due to altered river flows and associated biophysical changes in the coastal zone – Fitzroy Catchment*

| Impact details                     | Social impacts   |  |   |
|------------------------------------|--|--|---|
|                                    | Polluted river & estuary impact on fishery resource affecting human health (incl. fish kills due to poor water quality)  | Resource extraction affected by the barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)   | Conflict between commercial and recreational fishers over reduced fishery resource  |
| Geographical/spatial scale         | <ul style="list-style-type: none"> <li>- <b>No specific location</b></li> <li>- <b>WaterparkCreek – major supply of water for Livingston Shire</b></li> <li>- <b>Soil migration to inshore reefs in Keppel Bay</b></li> <li>- <b>health of coast &amp; Fitzroy river linked-weirs, Cario bay, Fitzroy River, Fig Tree Creek, Ross Creek for fish kills</b></li> </ul>  | <ul style="list-style-type: none"> <li><b>Upper &amp; lower Fitzroy River</b></li> <li><b>Lower streams &amp; creeks</b></li> <li><b>Areas along the coast &amp; inland used for ponded pastures – sand flats, mangrove areas</b></li> </ul>   | <ul style="list-style-type: none"> <li><b>Lower Fitzroy Catchment – river, estuary, Keppel Bay &amp; Capricorn Coast</b></li> </ul>   |
| Temporal aspects                   | <ul style="list-style-type: none"> <li>- <b>Heavy rain after dry period causes greater problem due to lack of vegetation cover</b></li> <li>- <b>Weirs – annual event</b></li> <li>- <b>Pollutant levels high after rain</b></li> </ul>  | <ul style="list-style-type: none"> <li>- <b>Steady reduction in fish catch since 1997 for all recreational species (except barramundi - stable)</b></li> <li>- <b>Mud crabs impacted by delayed release of water</b></li> </ul>  | <ul style="list-style-type: none"> <li>- <b>No correlated data for fish stock &amp; rainfall - Dept Primary Industry (Fisheries)</b></li> </ul>                               |
| Magnitude and frequency of problem | <ul style="list-style-type: none"> <li>- <b>Coral bleaching or high turbidity levels affect coral, seagrass &amp; marine life</b></li> <li>- <b>Direct impact on seafood stock &amp; marine habitat</b></li> <li>- <b>Resident &amp; migratory recreational &amp; commercial fish stock impacted</b></li> <li>- <b>Causeway Lake shallower over time causing habitat &amp; fish species changes</b></li> </ul>   | <ul style="list-style-type: none"> <li>- <b>Water quality problem</b></li> <li>- <b>Unregulated access &amp; harvesting of groundwater</b></li> <li>- <b>Issue of grasses blocking waterways &amp; access for recreational use (fishing, boating, water skiing)</b></li> <li>- <b>Spread of pest grasses/weeds to surrounding areas</b></li> <li>- <b>Fish movement impeded</b></li> <li>- <b>Biodiversity affected as new habitat only supports certain species</b></li> </ul>  | <ul style="list-style-type: none"> <li>- <b>Ongoing conflict between recreational &amp; commercial fishers over impact on fish stocks &amp; access to resource</b></li> </ul> |
| Data sources available             | <ul style="list-style-type: none"> <li>- <b>Livingstone Shire tested local streams (upper catchment, major creeks – Waterpark Creek, Corio Bay, and Keppel Sands) to determine pollution levels. Found heavy sediments &amp; high nitrogen from urban runoff. Data in Stormwater Quality Management Plan</b></li> <li>- <b>No hard evidence of reduced fish stock/catch for waterways due to soil</b></li> </ul> | <ul style="list-style-type: none"> <li>- <b>Commercial &amp; recreational catch data documented in diary system – (10 yrs of data)</b></li> <li>- <b>Recreational data collected through Recreational Fishing Information System (RFISH)</b></li> <li>- <b>Suntag data for Qld from 1996/1997 (catch per effort &amp; monitoring data for all recreational fish species) Suntag monitor growth &amp; movement of stocked fish, &amp; mixing with wild stock</b></li> <li>- <b>Coastal CRC studying fish stock quantity &amp; environmental flows</b></li> <li>- <b>CQU research on fish breeding habits in Fitzroy River show the</b></li> </ul> | <ul style="list-style-type: none"> <li>- <b>Media &amp; newspaper articles by recreational fishers blaming commercial fishers for overfishing</b></li> </ul>                  |

| Impact details                         | Social impacts   |   |  |
|--|--|---|--|
|  |  | Polluted river & estuary impact on fishery resource affecting human health (incl. fish kills due to poor water quality)   | Resource extraction affected by the barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)   |
|  | <b>migration.</b>  | <p><b>barrage is not the problem. Issue is survival of juvenile fish.</b></p> <ul style="list-style-type: none"> <li>- Evidence barramundi respond to flooding</li> <li>- monthly catch figures (East Coast Trawl Fishery Logbook for Rosslyn Bay, Reef Line Fishery Logbook for GBR)</li> <li>-Recreational Fishing Information System or RFISH &amp; DPI&amp;F for recreational fishing surveys</li> <li>- Commercial Fisheries Information System (CFISH) at DPI&amp;F &amp; Electronic Catch Effort Reporting System (ECERS) &amp; Species of Conservation Interest Logbook (QDPIF)</li> <li>- Research reports on impacts of ponded pastures on barramundi &amp; other fin fish populations in tropical coastal wetlands</li> <li>- Ponded Pastures Steering Committee (1997) Policy Options Paper &amp; Discussion Paper (1996)</li> <li>- Coastal CRC Fitzroy Estuary conceptual model (Barramundi &amp; prawns)</li> </ul>  |  |
| Stakeholders affected & type of impact | <p><b>Local community</b><br/> <b>Recreational fishers</b><br/> <b>Commercial fishers</b><br/> <b>Indigenous people</b><br/> <b>Recreational users of Causeway Lake</b></p> <ul style="list-style-type: none"> <li>- Aesthetics of beaches &amp; ocean, &amp; effect on marine flora &amp; fauna</li> <li>- Fishery resource affected by runoff into estuary impacting on fish habitat &amp; spawning</li> <li>- Reduced water supply impacts affect tourism, local community &amp; farms supplying local markets</li> <li>- Low water flows, stagnant water &amp; pollutants cause poor fish catch &amp; low fish meat quality</li> </ul> | <p><b>Local community</b><br/> <b>Recreational fishers</b><br/> <b>Commercial fishers</b><br/> <b>Indigenous community</b></p> <ul style="list-style-type: none"> <li>- Communities above the barrage negatively impacted by reduced opportunity to fish</li> <li>- Altered natural system favours less desirable fish species above the barrage &amp; they dominate</li> <li>- Significant change to amount of commercial fishing in marine park</li> <li>- Introduction of controls on access to fishing areas &amp; gear</li> <li>- Significant reduction in effort through management – bag &amp; size limits reduce the recreational fishers fish amount</li> <li>- Availability of mud crabs due to delayed environmental flows in dry years</li> <li>- Infrastructure (barrage, weirs) obstruct river flows affect fishery resource</li> <li>- Changed river structure affects waterholes for recreational</li> <li>- Barrage changed river used by Indigenous people for social gatherings – swimming &amp; fishing</li> <li>- Ponded pastures negatively impact barramundi consumers &amp; fish</li> </ul> | <p><b>Commercial fishers</b><br/> <b>Recreational fishers</b></p> <ul style="list-style-type: none"> <li>- Public perceive commercial fishers negatively – not all commercial fishers are large-scale operators</li> <li>- Trawl fishers blamed for reef damage</li> </ul> |

| Impact details                                     | Social impacts  |   |   |
|--|---|---|---|
|  |   | Polluted river & estuary impact on fishery resource affecting human health (incl. fish kills due to poor water quality)   | Resource extraction affected by the barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing)  |
|  |   | <b>retailers due to low supply</b><br><b>- Tourists / recreational fisher catch is low</b>  |   |
| Data sources available                             | <b>- Anecdotal evidence of impact on Indigenous people</b>  | <b>- Anecdotal information</b><br><b>- National recreational &amp; indigenous fishing survey cover fishers' attitudes &amp; awareness</b><br><b>- Reef CRC research on social issues of fishing</b><br><b>- Current research on social assessment of management changes in the GBR marine park by JCU &amp; GBRMPA</b>  | <b>- Anecdotal evidence</b>   |
| Mitigation strategies to manage impacts            | <b>- (draft) Stormwater Quality Management Plan to manage storm/floodwater quality &amp; quantity</b><br><b>- Installation of gross pollutant traps in town centre and Civil Operations Dept analyses material from pollutants traps – No monitoring of material collected</b><br><b>- Adoption of sustainable forestry practices in Waterpark Creek to protect habitat along waterways</b> | <b>- No action by local council</b><br><b>- Restocking of barramundi &amp; Golden Perch in Upper Fitzroy by Fitzroy River Fish Stocking Group due to inability of fish to migrate upstream above barrage (no commercial fishing in freshwater section of river)</b><br><b>- fish restocking in water storages to provide fish for recreational fishers in rivers</b><br><b>- Fish ladders on the barrage but not used by barramundi. Smaller species use fish ladders</b><br><b>- Some studies on the use of fish ladders on the barrage</b><br><b>- Fish ladder maintained by local council</b><br><b>- Commercial ability to catch fish reduced due to marine park zoning – program will monitor the effects of marine park management</b><br><b>- prohibited to build ponded pastures in intertidal areas (old structures maintained)</b><br><b>- Sunfish populating Fitzroy River with barramundi fingerlings due to barrage stopping freshwater movement</b> | <b>Reef fishery is limited to a set number of days</b><br><b>No restrictions in the Fitzroy River</b><br><b>Dept Primary Industry (Fisheries) track commercial fishing boat movements &amp; catch amounts</b><br><b>Commercial fishers have quotas (catch quantity &amp; no. of days)</b><br><b>Bag limit on recreational fishers (fisher limit not boat limit)</b> |
| Information on impact monitoring                   | <b>- Litter traps cleared by local council</b>  | <b>- Regular reports from Suntag to the stocking group</b><br><b>- Monitoring through data on tagged fish caught</b><br><b>- Monitoring of ponded pastures requires access to private land</b><br><b>- DPI&amp;F records don't include rainfall as factor affecting fish catch</b>  | <b>- Dept Primary Industry (Fisheries) monitor commercial &amp; recreational fishers through log books</b>  |
| Associated social impacts of mitigation strategies | <b>- Positive impacts on community well-being &amp; health of local environment from pollution reducing mechanism (litter traps, street sweepers)</b>   | <b>- Positive impacts from fish stocking benefit recreational fishers &amp; tourists</b>  | <b>- Many commercial fishers &amp; family operators forced to leave industry – - Recreational fishers buy larger commercial boats</b>   |
| Information  |   |   |   |

| Impact  | Social impacts  |  |  |
|---------|---|--|--|
| details | Polluted river & estuary impact on fishery resource affecting human health (incl. fish kills due to poor water quality) | Resource extraction affected by the barrage and other water storage infrastructure (incl. reduced opportunity for estuarine fishing) | Conflict between commercial and recreational fishers over reduced fishery resource |
| sources |   |  |  |

| Impact details                     | Social impacts   |  |  |   |  |   |
|------------------------------------|--|--|--|---|--|---|
|                                    | Conflict between fishers over reduced availability of fishery resource                                   | Erosion and sedimentation restrict access and use of recreational areas  | Water supplied to Capricorn Coast from the Fitzroy and effect on health of Fitzroy   | Water restrictions could cause social breakdown – alters social activities                        | Changed water management and regulation for communities (e.g. WAMP)  | Changed policy restricts access to fishery resource in GBRMP  |
| Geographical/spatial scale         | <b>Lower Fitzroy Catchment – river, estuary, Keppel Bay &amp; Capricorn Coast</b>                        | <b>Causeway Lake</b>   | <b>Fitzroy River Capricorn Coast Waterpark Creek</b>   | <b>Local towns in Fitzroy Catchment</b>   | <b>Fitzroy catchment</b>   | <b>Corio Bay, GBR Capricorn Coast</b>   |
| Temporal aspects                   | <b>Dept Primary Industry (Fisheries) graphs don't account for rainfall</b>                               | <b>Causeway Lake water levels changed over long time period Big tides between Nov-Feb</b>  |  |   | <b>Water harvested using licenses when flow exceeds 30 cubic metres per second</b>   | <b>Closures during various months of the year</b>   |
| Magnitude and frequency of problem | <b>Ongoing conflict between recreational &amp; commercial fishers over impact on fish stocks</b>         | <b>Infrastructure (road) was major impact on sediment build up</b>   | <b>Difficult to determine effects due to current drought. Reduction in water has lowered cattle stocking levels. Issue covers water quantity &amp; quality</b> | <b>Water restrictions may reduce interactions between community members e.g. hosing of garden</b> | <b>Water management affects volume &amp; changes timing of water flows through infrastructure development to control water flow (dams, weirs) Protected water allocation security – upheld the rights of the existing users &amp; set limits on additional development Big episodic flood events cause major infrastructure damage</b> | <b>Overfishing by commercial &amp; recreational fishers Ongoing problem</b>   |
| Data sources available             | <b>Media &amp; newspaper articles by recreational fishers blaming commercial fishers for overfishing</b> | <b>CQU engineering study of Causeway Lake indicate big tides deposit sand &amp; soil erosion from surrounding catchment Hydrodynamic, water level &amp; siltation changes recorded</b> | <b>Cardno MBK Report – 2005 Capricorn Coast Water Supply Sources Study – no social impacts covered</b>   | <b>Hard to measure</b>  | <b>General reports but no known social impact studies from environmental flow changes. Water Allocation Management Plan (WAMP) process examined effects on environmental flows only</b>  | <b>Commercial fishers not allowed to trawl along coast &amp; 5 miles out for banana prawns Reduced fish catch in the areas is noticeable in retail outlets Retailers must</b> |

| Impact details                           | Social impacts  |  |  |  |   |  |
|--|---|--|--|--|---|--|
|  | Conflict between fishers over reduced availability of fishery resource  | Erosion and sedimentation restrict access and use of recreational areas  | Water supplied to Capricorn Coast from the Fitzroy and effect on health of Fitzroy | Water restrictions could cause social breakdown – alters social activities | Changed water management and regulation for communities (e.g. WAMP)   | Changed policy restricts access to fishery resource in GBRMP   |
|  |   | <b>Information on impacts on recreational activities gathered through informal discussions with local community &amp; recreational fishers</b> |  |  |   | <b>source fish products from elsewhere to maintain their stock &amp; satisfy customers</b>   |
| Stakeholders affected and type of impact | <p><b>Commercial fishers</b><br/><b>Recreational fishers</b></p> <p><b>Public perceive commercial fishers negatively – not all commercial fishers are large-scale operators</b><br/><b>Trawl fishers blamed for reef damage</b></p> | <p><b>Community Recreational fishers</b></p> <p><b>Shallow water levels prevent boating</b></p>  | <b>Capricorn Coast community</b>   | <b>Community Retired/elderly community</b>                                 | <p><b>Rockhampton community</b><br/><b>Environmental community</b><br/><b>Agricultural industry</b><br/><b>Indigenous community</b><br/><b>Urban communities (Capella, Clermont, Blair Ethel)</b></p> <p><b>Barrage provided reliable water supply</b><br/><b>Environment above Fitzroy barrage changed</b><br/><b>Agriculture benefited with regular water supply</b><br/><b>Water resource plan doesn't have an impact but the limits of the resource</b><br/><b>Licenses have low flow conditions on them</b><br/><b>Development impacts on resources, employment, traditional laws &amp; culture of Indigenous people</b><br/><b>Water supply for agriculture sector &amp; urban areas affected</b></p> | <p><b>All fishers but more effect on commercial fishers</b><br/><b>Small commercial fishers &amp; family owned businesses</b><br/><b>Local community</b><br/><b>Fish/seafood retailers</b></p> <p><b>Fish cooperative sold out &amp; local buyers affected</b><br/><b>Big commercial fishers at an advantage – export to overseas markets</b><br/><b>Fishing closures for 2.5 months affects prawn fishers</b><br/><b>Commercial fishers required to look for second jobs</b><br/><b>Fish effort into catching fish shows fisheries in decline</b></p> |

| Impact details                          | Social impacts   |  |   |  |  |   |
|---|--|--|---|--|--|---|
|   | Conflict between fishers over reduced availability of fishery resource   | Erosion and sedimentation restrict access and use of recreational areas  | Water supplied to Capricorn Coast from the Fitzroy and effect on health of Fitzroy  | Water restrictions could cause social breakdown – alters social activities | Changed water management and regulation for communities (e.g. WAMP)  | Changed policy restricts access to fishery resource in GBRMP  |
| Data sources available                  |  | <b>Causeway Lake – CQU study</b>   | <b>Cardno MBK report examines future water supply options for the Capricorn Coast – Sandy Creek, Fitzroy &amp; desalinisation options</b> |  | <b>Hard to identify cause-effect link &amp; a number of other factors impact on social change</b><br><b>CQ regional water supply study</b><br><b>Water quality &amp; quantity continuously monitored &amp; information available on government web site</b><br><b>1998 WAMP for the Fitzroy Basin Catchment: Indigenous Consultation (Progress Report)</b> | <b>Hard to quantify the recreational fishers catch amount, easier to assess commercial fishing</b><br><b>Fishing shops – useful to gather data</b><br><b>Data not easily monitored because it relies on voluntary people</b><br><b>Assess the buy-back scheme take-up</b><br><b>Retailers/licensed buyers maintain records on local product: amount of product, type, value to fisherman/wholesale price, date, name of operator, location caught</b> |
| Mitigation strategies to manage impacts | <b>Reef fishery is limited to a set number of days</b><br><b>No restrictions in the Fitzroy River</b><br><b>Dept Primary Industry (Fisheries) track commercial fishing boat movements &amp; catch amounts</b><br><b>Commercial fishers</b> | <b>No regulated management of erosion &amp; access to area. Dune stabilisation using fencing &amp; boardwalks restrict access to beach</b> | <b>Sandy Bay option has major environmental concerns</b><br><b>Fitzroy option has issues of water quality &amp; quantity</b>              |  | <b>Build big dam to address Fitzroy WRP (Water Resource Plan) to be finalised in July 2005 will address groundwater &amp; control of overland flow water. 2001 Information Report for the Fitzroy Water Resource Plan (WRP) proposes a Community Reference Panel &amp; Indigenous</b>  |   |

| Impact details                                      | Social impacts  |  |  |  |   |  |
|---|---|--|--|--|---|--|
|   | Conflict between fishers over reduced availability of fishery resource  | Erosion and sedimentation restrict access and use of recreational areas                  | Water supplied to Capricorn Coast from the Fitzroy and effect on health of Fitzroy | Water restrictions could cause social breakdown – alters social activities | Changed water management and regulation for communities (e.g. WAMP)   | Changed policy restricts access to fishery resource in GBRMP   |
|   | <b>have quotas (catch quantity &amp; no. of days)<br/>Bag limit on recreational fishers (fisher limit not boat limit)</b> |  |  |  | <b>Working Group for consultation about water allocation &amp; management</b>   |  |
| Information on impact monitoring                    | <b>Dept Primary Industry (Fisheries) monitor commercial &amp; recreational fishers through log books</b>                  | <b>Livingstone Shire Council responsible for maintaining boardwalks on the foreshore</b> |  |  | <b>Annual monitoring &amp; evaluation of the WRP but no social impacts monitored</b>  | <b>No specific monitoring<br/>Use of census, projective population trends (unemployment, population migration)<br/>Monitoring depends on government funding<br/>Monitoring is only a snapshot</b>  |
| Associated social impacts of mitigation strategies? | <b>Many commercial fishers &amp; family operators forced to leave industry – recreational fishers buy the boats</b>       | <b>None – but requires Ongoing maintenance of boardwalks</b>                             |  |  | <ul style="list-style-type: none"> <li>- use of effluent or recycled water to conserve water</li> <li>- restrained development around the catchment – protected the water allocation of existing owners</li> <li>- social impacts raised are social impacts with not being able to undertake an activity which wasn't feasible anyway</li> <li>- if science incorrect in water allocations then changing the rules would</li> </ul> | <ul style="list-style-type: none"> <li>- economic impact from reduction in commercial fishers due to new management plans – translate into social impacts (poverty, family problems)</li> <li>- fishing businesses/operators can't sell due to uncertainty in industry</li> <li>- commercial fishing dominated by big companies &amp; loss of</li> </ul> |

| Impact details         | Social impacts   |   |  |  |  |  |
|------------------------|--|---|--|--|--|--|
|                        | Conflict between fishers over reduced availability of fishery resource | Erosion and sedimentation restrict access and use of recreational areas | Water supplied to Capricorn Coast from the Fitzroy and effect on health of Fitzroy | Water restrictions could cause social breakdown – alters social activities | Changed water management and regulation for communities (e.g. WAMP)  | Changed policy restricts access to fishery resource in GBRMP   |
|                        |  |   |  |  | <p><b>be unfair on current licenses</b><br/>                     - Development proposals not rejected based on environmental flows but due to impacts on water entitlement security objectives of existing entitlement owners.<br/>                     - Pre-WRP people affected by unreliable water supply caused by usage upstream (entitlements downstream eroded). - Under WRP no impacts due to realistic goals.<br/>                     - Positive effects for recreational fishing due to fish stocking &amp; greater environmental awareness by fish stocking groups</p> | <p><b>smaller companies affects local community</b><br/>                     - loss of family fishing traditions<br/>                     - movement of people from local community to get work<br/>                     - long term impact on sustainability<br/>                     - impact on community due to presence of major fishing industry<br/>                     - tourist industry relies on local seafood from local commercial fishing</p> |
| Sources of information |  |   |  |  |  |  |

## Appendix I (Part 2)

### *Potential social indicators for monitoring the effects of reduced fish and seafood availability and consumption – Fitzroy Catchment*

| <b>Social impact</b>   | <b>Potential indicators</b>  | <b>Data sources</b>   | <b>Limitations</b>   |
|--|--|---|--|
| <b>Pressure/Driving Force</b>  |  |   |  |
| Environmental health<br>- water quality decline from reduced water flows & flushing of system  | No. & frequency of fish kills<br>No. & frequency of blue-green algae outbreaks   | EPA Fish kill data & reports – regional information available<br>EPA water quality testing  | No data on contaminant or cause of death   |
| <b>Impact</b>  |  |   |  |
| Public health<br>- effect on human health from fish & seafood consumption  | Notification rates for microbial contamination conditions (seafood poisoning)<br>Emergency/out-patient admissions for gastrointestinal illness<br>No. outbreaks which exceed health standards<br>Toxin level in seafood, fish & marine vertebrates<br>Exceedence of pollution guidelines<br>Incidence of health problems with traditional food sources (turtle, dugong, oysters)<br>No. marine wildlife deaths | Hospital admitted patient data<br>Fisheries retailer & commercial fishing data<br>Food contamination data may be a surrogate for water contamination<br>Government department statistics on Indigenous community health<br>EPA water quality testing<br>Community health water quality testing<br>EPA database & statistics in tri-annual report on marine wildlife mortality | Health data limited to hospitals & does not include GP patient data<br>Does not account for lost work days & medical costs<br>No regular testing of fish & seafood for contaminants & residual levels<br>Relies on public reporting of outbreaks   |
| Natural resource condition<br>- demand for quality/healthy fishery resource<br>- effect on pricing<br>- effect on fish availability<br>- effect on fish species available<br>- effect on catch effort & location | Commercial catch per unit effort<br>Commercial fishery biomass<br>Seafood wholesale price<br>Fisheries closure periods – No of days  | Release of environmental flows & timing from barrage<br>Local & migratory fish catch data – commercial & recreational catch data in diary system<br>Monthly commercial logbook catch figures<br>Fish & seafood retailers & licensed buyers records on local product supply  | Relies on voluntary reporting by fish & seafood retailers & recreational fishers<br>Estimation of recreational fish catch is difficult<br>Other factors may cause changes in fish availability, pricing, etc., other than polluted river & estuary |
| Natural resource availability<br>- availability of fishery resource for extraction   | Seafood catch per unit effort<br>Cost of accessing alternative fishing locations   | Recreational fish data collected through Recreational Fishing Information System (RFISH), Suntag & diary system   | Relies on voluntary reporting by recreational fishers  |
| Social cohesion<br>- management of conflict over resource access & sustainability  | Level of conflict<br>Frequency of media articles<br>Reports of measures to manage conflict   | Anecdotal evidence<br>Media articles  | Difficult to determine extent of conflict due to reporting bias  |

| Social impact   | Potential indicators   | Data sources   | Limitations  |
|---|--|--|--|
| Cultural traditions & areas<br>- Indigenous water resource access & use<br>- Indigenous traditional resource access respected (respect ownership & use rights to resource)        | No. of accessible public recreational amenities/opportunities<br>No. protected Aboriginal sites along waterways<br>No. agreements to access areas on private property<br>Retention of Aboriginal oral history  | Anecdotal evidence on usage from Aboriginal people<br>Record of Native Title claims & agreements between Traditional Owners and private landholders  | No visitor numbers on usage of Indigenous meeting/recreation places along waterways<br>Inadequate data & data only on sites where development is occurring<br>Need to capture amount, location & quality of open space<br>Difficult to measure impact on Aboriginal oral history – use of process indicator needed   |
| Quality of life<br>Community amenity to water-based recreation (access & use)<br>- recreational access<br>- recreational opportunity<br>- perceived quality of recreational space | Transport cost of accessing alternative locations to recreate<br>No of closure of waterways & recreational areas<br>Usability of public waterway areas – access, location & quality of surrounding environment<br>No. & quality of public coastal & waterway recreational areas (accessible with & without boat) | Local government & Dept of Natural Resources & Mines public notice reports<br>Local government public recreational space data on usage   | Requires specific data on types of recreational space affected & how accessibility for different groups is changed.<br>Data on waterway closures due to safety reasons is limited<br>Lack of data on visitor use of recreational areas, especially for water-based activities<br>Subjective rating on usability<br>Only anecdotal information on impact on Indigenous communities<br>Original survey data needed on recreational needs & uses of local recreational facilities – Sports & Recreation QLD |
| Community values<br>- visual aesthetic value of polluted beaches & waterways  | No. & frequency of fish kills<br>No & frequency of blue-green algae outbreaks  | Local government complaints data<br>EPA Fish kill data & reports – regional information available<br>EPA water quality testing   | Difficult to measure visual aesthetics & rely on indirect indicators   |
| <b>Response</b>   |  |  |  |
| Community perceptions of waterway/river health & water quality  | Institutional response<br>- Implementation of stormwater quality & quantity control measures<br>- Adoption of sustainable forestry practices to protect waterways  | Percentage of control measures implemented to manage stormwater<br>Gross pollution trap monitoring data<br>Percentage of waterways protected under sustainable practices – forestry plans            | Require community survey to determine success of mitigation strategies to manage stormwater  |
| Tourism maintenance & growth  | Satisfaction level for quality of destinations in GBR<br>Incidences of conflict of use<br>Fish biomass & diversity<br>Level of retail fish supply  | GBRMPA Tourist visitor survey to GBR Recreational Fishing Information System (RFISH) data & recreational fisher diary /personal logbook<br>Fish buyer & retailer records on fish biomass & diversity | Require survey data for visitor satisfaction & to disaggregate to local level<br>Difficult to determine visitor consumption of fishery resource<br>Fish catch data based on voluntary reporting<br>Difficult to access individual retailer records on fish supply  |
| Recreational fisher satisfaction  | Resource availability – catch effort & location  | Suntag monitoring data on fish stocking  | Relies on indirect measure of stocking levels to   |

| <b>Social impact</b>   | <b>Potential indicators</b>  | <b>Data sources</b>   | <b>Limitations</b>   |
|--|--|---|--|
| <p>Management of resource availability<br/>                     - Limits on access &amp; extraction<br/>                     - Compliance with management plans &amp; rezoning regulations</p> | <p>Fish restocking biomass</p> <p>Catch per unit effort<br/>                     Satisfaction with availability &amp; size of target species<br/>                     Recreational fisher uptake of bag &amp; size limits - No. fines for exceeding limits<br/>                     Fish restocking numbers in Upper Fitzroy<br/>                     No. recreational fishers involved in voluntary reporting<br/>                     Amount of commercial fisher quotas/total allowable catch, no. of fishing days &amp; license buyback<br/>                     Level of unemployment within commercial fishery</p> | <p>levels</p> <p>DPI Fisheries data on fines<br/>                     National recreational &amp; Indigenous fishing survey of fisher attitudes &amp; awareness<br/>                     Recreational fisher diary system/ personal logbook<br/>                     DPI Fisheries data on commercial fish quotas, effort units &amp; buyback, fisher licenses<br/>                     Government department provide statistics on unemployment<br/>                     Commercial boat registration &amp; licensing from Dept of Transport<br/>                     Maritime Safety Qld biannual survey of boat owners</p> | <p>determine fisher satisfaction</p> <p>Limited to prosecution data<br/>                     Survey data may not disaggregate down to local level<br/>                     Costly to monitor fishing activities &amp; enforcement of rules<br/>                     Difficult to monitor commercial fishers when accessing non-local resources<br/>                     Quotas &amp; effort units are transferable &amp; traded<br/>                     Necessary to distinguish between fishery groups as differential effects across groups<br/>                     Difficult to identify the effects of GBR zoning plan, such as potential loss of ability to catch fish in areas closed to fishing &amp; availability of local alternative areas<br/>                     Low response rate to biannual survey &amp; limited information</p> |

## Appendix J (Part 1)

### *Social impacts on Indigenous hunting and fishing activities due to altered river flows and associated biophysical changes in the coastal zone – Fitzroy Catchment*

| Impact details                     | Social impacts   |   |
|------------------------------------|--|---|
|                                    | Indigenous peoples' dependency on the river changes due to fishery resource & habitats affected by sedimentation   | Increased pollutants, sediment & nutrients impacts on:<br>(1) visual appearance of the river,<br>(2) human use & consumption (e.g. blue-green algae)  |
| Geographical/spatial scale         | <ul style="list-style-type: none"> <li>- Mangrove habitat destruction displaced fish population from river</li> <li>- Sedimentation in Keppel Bay</li> <li>- Fitzroy River changes affect connected coastal environments</li> <li>- Environment above the Fitzroy barrage</li> </ul> | <ul style="list-style-type: none"> <li>- Upper Fitzroy, above barrage &amp; Rockhampton river part</li> <li>- Fitzroy River</li> <li>- Waterpark Creek catchment supplying Capricorn Coast</li> <li>- Woorabinda Aborigine Community – Mimosa Creek &amp; lagoon</li> </ul>   |
| Temporal aspects                   | <ul style="list-style-type: none"> <li>- Reef recovering from 1992 flood event</li> <li>- Periodic big tides</li> <li>- Upstream activities have delayed impact on estuary &amp; coast (spatial influence)</li> <li>- River flows declining each year</li> </ul>                     | <ul style="list-style-type: none"> <li>- Periods of low &amp; high rainfall</li> <li>- High flow events after high rainfall, esp. after dry period - Water temperature increases after long periods without rain</li> <li>- Large flows move weeds to river mouth</li> <li>- Water quality decline in creek at Woorabinda after dam built in 1980s</li> </ul>   |
| Magnitude and frequency of problem | <ul style="list-style-type: none"> <li>- Ongoing sedimentation &amp; episodic flood events</li> <li>- Source of the sediment unknown</li> </ul>  | <ul style="list-style-type: none"> <li>- Water quality affects many biophysical responses in the river &amp; under certain conditions the water becomes unusable</li> <li>- Wet season coincides with high tourist season &amp; negative perceptions by tourists &amp; local community</li> <li>- Visual appearance of the water</li> <li>- Unknown impact of stormwater on the river</li> <li>- Major Ongoing sedimentation problem</li> <li>- Algae outbreaks are serious problem for water users (e.g. recreational &amp; agricultural)</li> <li>- Areas cleared closer to waterways will have greater impact &amp; high rainfall causes sediment along coast</li> </ul>       |
| Data sources available             | <ul style="list-style-type: none"> <li>- Commercial &amp; recreational crab numbers decline</li> <li>- Sediment &amp; deposition build up</li> <li>- Anecdotal evidence from Indigenous Elders &amp; crab catchers</li> </ul>  | <ul style="list-style-type: none"> <li>- Coastal CRC research on water quality in the Fitzroy</li> <li>- Community aware of direct results of soil migration – discoloured beaches &amp; ocean, impact on marine flora &amp; fauna</li> <li>- Livingstone Shire pollution level testing of local streams found high sediments &amp; nitrogen from urban runoff. Information in Stormwater Quality Management Plan.</li> <li>- Livingstone Shire water quality study of social impacts of sedimentation informed by community consultation</li> <li>- Algal blooms information held by Fitzroy River Water</li> <li>- Community complaints to Local Council about weeds</li> </ul> |

| Impact details                         | Social impacts  |  |
|--|---|--|
|  | Indigenous peoples' dependency on the river changes due to fishery resource & habitats affected by sedimentation  | Increased pollutants, sediment & nutrients impacts on:<br>(1) visual appearance of the river,<br>(2) human use & consumption (e.g. blue-green algae)   |
|  |   | <ul style="list-style-type: none"> <li>- Anecdotal evidence/storytelling &amp; observation by Indigenous community</li> <li>- Qld Health information on human exposure to polluted water (potable or otherwise). Notification rates for conditions associated with microbiological contaminants.</li> </ul>  |
| Stakeholders affected & type of impact | <p><b>Indigenous people &amp; communities</b><br/> <b>Other stakeholder groups due to established access &amp; lack of understanding of traditional hunting &amp; fishing rights</b></p> <ul style="list-style-type: none"> <li>- Cultural connection &amp; identity to food source</li> <li>- Social &amp; economic reliance on marine wildlife (e.g. fish, turtle, dugong)</li> <li>- Traditional food part of staple diet</li> <li>- Indigenous people perceive risk to consuming river fish</li> <li>- Taste of freshwater fish from above the barrage affected</li> <li>- Negative impacts on condition of resource influences shift from traditional country</li> <li>- Community affected through health, breakdown in social structures, relationships with other stakeholders &amp; TO groups</li> <li>- Displacement of fisheries influences migration to access alternate resource</li> <li>- Shift of activities puts increased pressure on other resource areas</li> </ul> <p><b>Indigenous people</b></p> <ul style="list-style-type: none"> <li>- GBRMPA rezoning displaced commercial &amp; recreational fishers resulting in conflict over reduced fish stock</li> </ul> | <p><b>Local community</b><br/> <b>Recreational users of the river</b><br/> <b>Irrigators</b><br/> <b>Indigenous community</b><br/> <b>Tourists</b><br/> <b>Tourism operators/small businesses</b><br/> <b>Woorabinda Aborigine Community</b></p> <ul style="list-style-type: none"> <li>- Change in frequency of use (indicator)</li> <li>- Change in aesthetics of beaches &amp; ocean, &amp; effect on marine flora &amp; fauna (incl. seagrass areas)</li> <li>- Accessibility to river &amp; boat launching affected</li> <li>- Dead coral affects the visual aesthetics for divers</li> <li>- Urban development reduces vegetation filtering of stormwater flows</li> <li>- Impacts on water for human consumption negligent due to water treatment, but increased cost to treat water</li> <li>- Blue-green algae impacts on treatment process, cost of treatment &amp; ability to treat available water</li> <li>- Fish kills from algae outbreaks</li> <li>- Water high in nutrients &amp; sediment effects estuary &amp; river resources (e.g. altering prawn inshore fishery)</li> <li>- Water quality impact on tourism</li> <li>- GBR assets threatened by high sediment loads in Fitzroy River &amp; estuary due to muddy water appearance</li> <li>- Pollution from yachts, tankers impact creeks &amp; beaches</li> <li>- Weeds stop access for fishing, kayaking &amp; hazard for water skiers</li> <li>- Indigenous people have limited recreational access &amp; use of waterways &amp; loss of meeting places</li> <li>- Indigenous public health issue – children get sore eyes &amp; ears from swimming in creek &amp; water not good for human consumption or use</li> </ul> |

| Impact details                          | Social impacts   |  |
|---|--|--|
| Data source information                 | <p>Indigenous peoples' dependency on the river changes due to fishery resource &amp; habitats affected by sedimentation</p> <ul style="list-style-type: none"> <li>- <b>Statistical data from QLD Health Hospital Admitted Patient Data Collection – hospitalisation rates only</b></li> <li>- <b>Statistical information on incidence rates, links &amp; comparisons to non-Indigenous people.</b></li> <li>- <b>Towards a Queensland Aboriginal and Torres Strait Islander Environmental Health Strategy – A Scoping Paper (1999)</b></li> </ul> | <p>Increased pollutants, sediment &amp; nutrients impacts on:</p> <p>(1) visual appearance of the river,<br/>(2) human use &amp; consumption (e.g. blue-green algae)</p> <ul style="list-style-type: none"> <li>- <b>No data on frequency of use</b></li> <li>- <b>Annual information collected for Health Determinants Queensland report</b></li> <li>- <b>Data presented by key population groups (children, young/old, Indigenous), not by district</b></li> <li>- <b>No monitoring system for algae health effects. Record of community complaints</b></li> <li>- <b>Hospital data on health of people</b></li> <li>- <b>Records on visitor numbers – regional activity monitor to track occupancy rate (voluntary submission by operators) ABS conduct Survey of Tourist Accommodation &amp; Holiday Tracking Survey.</b></li> <li>- <b>Indigenous social impacts known from anecdotal evidence/story telling &amp; observation</b></li> </ul>  |
| Mitigation strategies to manage impacts | <ul style="list-style-type: none"> <li>- <b>Working Group formed in Fitzroy in Aug 2004 &amp; consists of Darumbal &amp; Woppa Burra TOs, with support from GBRMPA &amp; EPA</b></li> <li>- <b>Working to (1) manage change in Indigenous community due to change in the environment, (2) preserve &amp; maintain cultural practices, &amp; (3) educate the wider community</b></li> <li>- <b>Developing a legal Traditional Use of Marine Resources Agreement (TUMRA)</b></li> </ul>  | <ul style="list-style-type: none"> <li>- <b>(draft) Stormwater Quality Management Plan to manage storm/floodwater quality &amp; quantity</b></li> <li>- <b>Installation of gross pollutant traps in town centre &amp; analysis of material from pollutants traps, but no monitoring of material collected</b></li> <li>- <b>Implementation of stormwater quality controls</b></li> <li>- <b>Cost of removing sediment &amp; pollutants from the water (indicator)</b></li> <li>- <b>EPA &amp; RCC monitoring of leaching from landfill &amp; input into creeks</b></li> <li>- <b>Discharge licenses restrict contaminated runoff from coal mines &amp; cotton farmers</b></li> <li>- <b>New development requires urban sensitive design with retention basins &amp; sediment ponds</b></li> <li>- <b>Removal of riparian weeds by local council</b></li> <li>- <b>Algal blooms managed by Fitzroy River Water. - Visual monitoring upstream &amp; sampling regime when needed</b></li> <li>- <b>Fitzroy River Water monitor discharges from wastewater treatment plants</b></li> <li>- <b>Fitzroy River Water monitor inflows &amp; outflows from the barrage &amp; monthly water quality samples from inflow, outflow &amp; storage water. Monitor condition of river banks (bank slumping), erosion &amp; changes over time at key sites (video footage starting July 2004)</b></li> <li>- <b>Fitzroy River Water submit water quality reports to Rockhampton City Council &amp; public information</b></li> <li>- <b>QLD Health offer recommendations to other govt agencies to minimise adverse impacts &amp; encourage positive impacts</b></li> <li>- <b>EIS includes health component of impacts &amp; determining health status</b></li> <li>- <b>QLD Health investigating development of water quality management plans by drinking water providers</b></li> <li>- <b>EPA require point source monitoring of wastewater at – inflow &amp; outflow sites at barrage (pH, temp, nutrients)</b></li> <li>- <b>Weed infestation requires upstream involvement to prevent reinfestation.</b></li> <li>- <b>4 bores constructed at Woorabinda to supply Indigenous community</b></li> </ul> |

| Impact details                                      | Social impacts   |   |
|---|--|---|
| Information on impact monitoring                    | Indigenous peoples' dependency on the river changes due to fishery resource & habitats affected by sedimentation<br><br><b>- Working Group to monitor social impacts of strategies</b><br><b>- Difficult to monitor social change &amp; identify social benefit</b>  | Increased pollutants, sediment & nutrients impacts on:<br>(1) visual appearance of the river,<br>(2) human use & consumption (e.g. blue-green algae)<br><br><b>- No monitoring of water quality in creeks flowing into the Fitzroy.</b><br><b>- Local Council monitors sewage discharge into river to meet EPA licensing requirements (basic parameters only)</b><br><b>- Algal bloom events documented by media releases &amp; information on Fitzroy River Water website</b><br><b>- Health impact assessments within EIA process</b><br><b>- Litter traps cleared by local council</b><br><b>- Fitzroy River water keep records on cost of water treatment for clean drinking water</b><br><b>- Random water sampling by Indigenous public health coordinator of swimming pools &amp; bores</b><br><b>- Complaints from community about taste &amp; smell of bore water</b><br><b>- Woorabinda Council take weekly water samples</b> |
| Associated social impacts of mitigation strategies? | <b>- Better relationships between group members &amp; TUMRA will reinstate 'eldership' &amp; social roles within Indigenous communities</b><br><b>- Advance employment opportunities (e.g. rangers)</b><br><b>- Expect greater capacity of Indigenous people to participate in NRMW</b><br><b>- Wider community not familiar with Native Title</b><br><b>- Impact of traditional hunting by South Sea Island Group</b> | <b>- Effluent reuse reduces impact on river &amp; is a beneficial social impact but community view grey water use negatively</b><br><b>- Pollution reducing mechanisms (litter traps, street sweepers) have positive impacts on community well-being &amp; health of local environment</b><br><b>- Maintenance of water quality in bores for Indigenous community improve community health</b>  |
| Sources of information                              | <b>- Social plan in preparation by local government</b><br><b>- LGAQ community satisfaction survey</b>   |   |

## Appendix J (Part 2)

### *Potential social indicators for monitoring the effects of changed flows on Indigenous hunting and fishing – Fitzroy Catchment*

| <b>Social impact</b>   | <b>Potential indicators</b>   | <b>Data sources</b>  | <b>Limitations</b>  |
|--|---|--|---|
| <b>Pressure/Driving Force</b>  |   |  |   |
| Resource demand  | <ul style="list-style-type: none"> <li>- Changes in land use – % loss of mangroves in fish habitat areas</li> <li>- Water demand - % water provision for environmental flows</li> <li>-Nutrient load from diffuse &amp; point source pollution</li> </ul> | Qld Dept NRMW<br>Coastal CRC baseline mangrove survey, aerial surveys & archival data<br>QLD Dept NRMW Water Resource Plans, Water Allocation Management Plans, Resource Operation Plans, M&E of WRP/ROP objectives<br>EPA water quality data<br>Fitzroy River Water data on treatment costs | While it is a direct measure of the pressure, it relies on GIS & spatial habitat models. Provides temporal data   |
| Environmental health – water quality decline linked to reduced water flows & nutrients | Number & frequency of fish kills<br>Number & frequency of blue-green algae outbreaks  | EPA fish kill data & reports – regional information available<br>EPA water quality testing   | No data on contamination or cause of death  |
| <b>Impact</b>  |   |  |   |
| Cultural vitality - Cultural & spiritual values  | Frequency of use of aquatic recreation areas (fishing, swimming, boating)<br>Number of access areas for traditional use (fishing)<br>Visitation to sites  | Anecdotal evidence only<br>Indigenous survey required  | No primary data. Requires data collection through survey triggered by development or policy change  |
| Waterway development (infrastructure)  | Number of cultural heritage sites damaged or destroyed<br>Species diversity – Number of fish species  | Cultural heritage register<br>DPI Fisheries commercial & recreational fisher catch data  | Hard to link loss of biodiversity & Country to loss of traditional cultural & hunting opportunities, along with social problems of dispossession & discrimination |
| Traditional food resource availability & access  | Commercial & recreation crab numbers<br>Level of traditional hunting & fishing  | DPI Fisheries commercial & recreational fisher catch data<br>Anecdotal evidence  | Requires the use of indirect measures & anecdotal evidence<br>Requires primary data collection using survey   |
| Recreational amenity of waterways & coast  | Perception of health of the resource in waterways & coastal areas   | Anecdotal evidence only<br>Indigenous survey required  | Quality of the waterway or coastal for use is a subjective measure. Perceptions change & costly to monitor  |

| <b>Social impact</b>  | <b>Potential indicators</b>   | <b>Data sources</b>   | <b>Limitations</b>  |
|---|---|---|---|
| Indigenous health   | Prevalence of health problems associated with poor diet   | QLD Health statistical data from hospital admitted patient data collection & statistical information on incidence rates & comparison to non-Indigenous people   | Disaggregating effect of diet from other factors difficult<br>Data accessibility & geographical location may be hard  |
| Cultural harmony over access to resource                      | Incidence of conflict over migration to access alternate fishery  | Anecdotal evidence<br>Media reports   | Difficult to measure, highly subjective & reporting bias  |
| Community identity  | Rates of in-migration & out-migration of local Indigenous community   | Secondary data available from QLD statistical agencies & community profiles   | Indirect measure of social cohesion but not satisfactory for social pathologies. Requires longitudinal study  |
| Human health  | Number of times exceedence of drinking water quality guideline<br>Notification rates for conditions associated with microbiological contaminants<br>Cost of removing pollutants & sediment from water<br>Number of disease outbreaks per year associated with contaminated marine water, fish & other species | Local government water monitoring data<br>Fitzroy River Water data on algal blooms & water treatment<br>Fitzroy water monitoring data<br>QLD Health data on human exposure to polluted water in hospital records<br>Record of community complaints. | Some data available. Need to correlate incidences of water quality decline with human health statistics. Data for different geographical areas required to identify Indigenous communities at risk. No monitoring system for algae health effects |
| Attractiveness/amenity of resource & area                     | Number of complaints (smell, visual, usage)<br>Frequency of waterway & beach use for recreation   | Local government record of complaints & meeting minutes   | No data on Indigenous peoples' perceptions of waterways & coastal health & changed behaviour/use  |
| <b>Response</b>   |   |   |   |
| Recognition of cultural practices by non-Indigenous community | Establishment of agreements to secure access to resource<br>Level of conflict between Indigenous & non-Indigenous communities   | Native Title or agreements to secure access   | Difficult to determine extent of conflict due to reporting bias   |
| Cultural education & awareness                                | Level of public education on Indigenous culture & traditional practices   | Media reports<br>QLD Education programs<br>Requires community survey  | No direct relationship between attitudinal & behavioural change. Requires primary data collection   |

| Social impact   | Potential indicators  | Data sources  | Limitations  |
|---|---|---|--|
| Environmental health<br>- point source contaminants<br>- diffuse source contaminants<br>- weed management | Level of implementation of stormwater quality controls<br>Cost of removing pollutants & sediment from water<br>% landholders implementing catchment management programs to control sediment & water quality<br>% catchment area under catchment management programs<br>Amount of funds & volunteer time for waterways weed eradication<br>Level of implementation of water quality management plans | Local government data<br>Fitzroy River Water treatment costs, Fitzroy River Water sampling & visual monitoring data on algae<br>Fitzroy River Water monitoring of inflow/outflow barrage water<br>EPA & RCC water monitoring records<br>QLD Dept NRMW & FBA records on landholder grants & catchment activities<br>QLD Health data on water quality plans implemented by drinking water providers | Level of uptake by community due to changes in behaviour needs survey data<br>Ad hoc & informal water sampling at waterways used by Indigenous people is limited |
| Change in community attitudes   | Perception of grey water<br>Waste water re-use -% of total waste water discharged   | Community survey needed<br>Local government & Fitzroy River Water data on re-use<br>EPA licenses  | Need to survey community for primary data on attitudes of grey water use before & after education./awareness campaign  |

## Appendix K (Part 1)

### *Social impacts from NRMW policy change to manage the Fitzroy waterways and coastal zone natural resources – Fitzroy Catchment*

| Impact details                                    | Social impacts   |   |
|---|--|---|
|   | Water management & regulation for communities & agriculture (e.g. WAMP)  | Effect on fishers of policy changes restricting access to GBRMP fishery resource after reduced flows negatively impact river & estuarine fishery resource   |
| <b>Geographical/spatial scale</b>                 | - Fitzroy catchment  | Corio Bay, GBR<br>Capricorn Coast   |
| <b>Temporal aspects</b>                           | - Licensed water harvesting when river flow exceeds 30 cubic metres per second   | - Closures during various months of the year  |
| <b>Magnitude and frequency of problem</b>         | - Water management affects volume & changes timing of water flows through infrastructure (dams, weirs)<br>- Secure water allocation with rights of the existing users upheld & limits on future development<br>- Big episodic flood events cause major infrastructure damage   | - Overfishing by commercial & recreational fishers<br>- Ongoing problem   |
| <b>Data sources available</b>                     | General reports but no known social impact studies from environmental flow changes.<br>Water Allocation Management Plan (WAMP) process examined effects on environmental flows only  | - Reduced fish catch noticeable in retail outlets<br>- Retailers source fish products from elsewhere to maintain their stock & satisfy customers  |
| <b>Stakeholders affected &amp; type of impact</b> | Rockhampton community<br>Environmental community<br>Agricultural industry<br>Indigenous community<br>Rural town communities (Capella, Clermont, Blair Ethel)<br><br>- Environment above Fitzroy barrage changed<br>- Agriculture benefited with regular water supply<br>- Water licenses have low flow conditions on them<br>- Development impacts on resources, employment, traditional laws & culture of Indigenous people<br>- Water supply for agriculture sector & urban areas affected | All fishers but more effect on commercial fishers - Commercial fishers not allowed to trawl along coast & 5 miles out for banana prawns<br>Small commercial fishers & family owned businesses<br>Local community<br>Fish/seafood retailers<br><br>- Fish cooperative sold & local buyers affected<br>- Big commercial fishers export to overseas markets<br>- Fishing closures for 2.5 months affects prawn fishers & need to supplement income<br>- Fish effort shows fisheries in decline |

| Impact details   | Social impacts   |   |
|--|--|---|
|  | Water management & regulation for communities & agriculture (e.g. WAMP)  | Effect on fishers of policy changes restricting access to GBRMP fishery resource after reduced flows negatively impact river & estuarine fishery resource   |
| <b>Data source information</b>                             | <ul style="list-style-type: none"> <li>- Hard to identify cause-effect link &amp; a number of other factors</li> <li>- CQ regional water supply study</li> <li>- Water quality &amp; quantity continuously monitored &amp; information available on government web site</li> <li>- 1998 WAMP for the Fitzroy Basin Catchment: Indigenous Consultation (Progress Report)</li> </ul>   | <ul style="list-style-type: none"> <li>- Recreational &amp; commercial fisher catch logbooks. Hard to quantify the recreational fishers catch amount, easier to assess commercial fishing records</li> <li>- Fish retailers&amp; licensed buyers maintain records: amount of product, type, wholesale price, date, operator, location caught</li> <li>- Reliance on voluntary data collection &amp; reporting for monitoring impacts Assess the buy-back scheme take-up</li> </ul>  |
| <b>Mitigation strategies to manage impacts</b>             | <ul style="list-style-type: none"> <li>- Build large water storage infrastructure (dam)</li> <li>- Fitzroy WRP (Water Resource Plan) to be finalised in July 2005 will address groundwater &amp; control of overland flow water.</li> <li>- 2001 Information Report for the Fitzroy Water Resource Plan (WRP) proposes a Community Reference Panel &amp; Indigenous Working Group for consultation about water allocation &amp; management</li> </ul>  |   |
| <b>Information on impact monitoring</b>                    | Annual monitoring & evaluation of the WRP but no social impacts monitored  | <ul style="list-style-type: none"> <li>- No specific monitoring</li> <li>- Use of census, projective population trends</li> <li>- Monitoring depends on government funding</li> <li>- Monitoring provides snapshot</li> </ul>   |
| <b>Associated social impacts of mitigation strategies?</b> | <ul style="list-style-type: none"> <li>- Altered &amp;/or delayed water flows impact on recreational fishing in upper catchment</li> <li>- Recreational opportunities with dam</li> <li>- Use of effluent or recycled water to conserve water</li> <li>- Restricted development around the catchment protects the existing water allocations</li> <li>- Development proposals not rejected based on environmental flows but due to impacts on water entitlement security objectives of existing entitlement owners.</li> <li>- Pre-WRP people affected by unreliable water supply caused by usage upstream (entitlements downstream eroded)</li> <li>- Positive effects for recreational fishing due to fish stocking &amp; greater environmental awareness by fish stocking groups</li> </ul> | <ul style="list-style-type: none"> <li>- Economic impact from reduction in commercial fishers due to new management plans &amp; associated social impacts ( family problems)</li> <li>- Industry uncertainty impedes sale of commercial fishing operations</li> <li>- Commercial fishing dominated by big companies &amp; loss of smaller companies affects local community</li> <li>- Loss of family fishing traditions</li> <li>- Migration of people from local community</li> <li>- Change to local economy &amp; community due to major fishing industry</li> <li>- Tourist industry relies on local seafood from local commercial fishing operations</li> </ul> |
| <b>Sources of information</b>                              |  |   |

## Appendix K. (Part 2)

### *Potential social indicators for monitoring the effects of NRMW policy change and the implementation of new management actions – Fitzroy Catchment*

| <b>Social impact</b>  | <b>Potential indicators</b>  | <b>Data sources</b>   | <b>Limitations</b>   |
|---|--|---|--|
| <b>Pressure/Driving Force</b>   |  |   |  |
| Level of commercial & recreational fishing  | Level of fisher activity   | DPI Fisheries data on commercial & recreational fishers – catch & effort log book, boat ramp survey, telephone survey etc   | Numerous factors may influence fishery resource & fisher activity  |
| Resource availability   | Total seafood catch<br>Catch per unit effort   | DPI Fisheries data on commercial & recreational fishing biomass volume, location etc. Disaggregate seafood catch<br>Records of fish retailers & licensed buyers   | Good data on commercial fish catch. Data on recreational fish catch reliant on voluntary reporting<br>No standard system for recording retail seafood data |
| Resource demand   | - Water demand - % water provision for environmental flows, % increase in water allocation overall & for individual catchments<br>- Level of development (mining, agriculture, industry)<br>- Degree in which environment flows over barrage meet critical fishery requirements<br>- Fish species biodiversity – Number of fish species available locally for retail | QLD Dept NRMW Water Resource Plans, Water Allocation Management Plans, Resource Operation Plans, M&E of WRP/ROP objectives<br>DPI Fisheries/Coastal CRC data<br>DPI Fisheries on status of individual fish species<br>Records of fish retailers & licensed buyers | Need greater information on water requirements & future planned expansions & development   |
| <b>Impact</b>   |  |   |  |
| Environmental health<br>- water quality decline from reduced water flows & flushing of system | Number & frequency of fish kills<br>Number & frequency of freshwater & marine algae outbreaks  | QLD state government monitoring data on water quality & quantity<br>EPA fish kill data & reports<br>EPA water quality testing data  | Need to link fish kills & algae to reduced water flow volumes  |
| Security of resource  | Level of use of buy-back scheme & quota transfers/trades   | DPI Fisheries data on commercial fishers (licenses, quotas)   |  |
| Natural resource sector viability   | Level of unemployment within commercial fishery<br>Number of family owned small business seafood retail outlets<br>Level of seafood product & price  | Government agencies have statistics<br>Records of fish retailers & licensed buyers  | Difficult to distinguish between types of commercial businesses. Need to define further  |

| <b>Social impact</b> | <b>Potential indicators</b> | <b>Data sources</b> | <b>Limitations</b> |
|----------------------|-----------------------------|---------------------|--------------------|
|----------------------|-----------------------------|---------------------|--------------------|

| <b>Social impact</b>           | <b>Potential indicators</b>  | <b>Data sources</b>  | <b>Limitations</b>  |
|--------------------------------|--|--|---|
| <b>Response</b>                |  |  |   |
| Development activities managed | Level of restriction on development in the region<br>% Approved development applications | Local government data  |   |
| Equity of resource allocation  | Projected % of economic value/cost to sector   |  | Difficult to measure & compare economic benefits across different sectors (& within sector) & process of determining benefits |
| Change in community attitudes  | Attitude to grey/recycled water<br>Waste water re-use -% of total waste water discharged | Community survey needed<br>Local government & Fitzroy River Water data on re-use<br>EPA licenses | Need to survey community for primary data on attitudes to grey water use before & after education./awareness campaign         |

## Appendix L

### *Targets and indicators the responsibility of the regional NRMW group*

| <b>Resource condition/<br/>management action<br/>for targets</b> | <b>Indicator</b>   | <b>Component<br/>indicator</b>                              |
|--|--|---|
| Inland aquatic ecosystem integrity (rivers & wetlands)           | Length of function riparian areas  | Length protected  |
| Critical Assets identified & protected                           | Critical assets register   |   |
| Improved land & water management practices adopted               | Adoption of sustainable management practices (mostly not measured)<br>- % of region covered by neighbourhood catchment planning<br>- No. neighbourhood catchment planning<br>- Networks established in key locations<br>- No. landholders implementing practices for increased groundcover<br>- % of landholders actively adopting Integrated Pest Management (IPM)<br>- % of local governments implementing IPM |   |
| Fire   | Fire management targets  |   |
| Salinity   | Extent of appropriate management practices on recharge areas   |   |
| Vegetation management  | - Area voluntarily protected<br>- Vegetation regeneration  |   |
| Species recovery & protection                                    | Species recover & habitat protection plans   |   |
| Riparian area management   | Kilometres of riparian area protected  |   |
| Wetland protection   | Area of wetlands protected   |   |
| Fish passage   | Barriers to migration  |   |
| Water quality  | Water quality targets set  |   |
| Business resilience  | Uptake of options to increase business resilience (not measured)   |   |
| Social viability   | Community participation  | Knowledge of groups & individuals recognised (not measured) |
| Regional coordination  | State of Region reporting developed & used   |   |

## Appendix M

### *Criteria to assess performance indicators and measures*

*(adapted from Armstrong and Francis 2002)*

| Criterion              | Definition  | Checklist  |
|------------------------|---|--|
| <b>Validity</b>        | The extent to which the indicator reflects the concept it is intended to  | Does the indicator behave the way it is expected in relation to the other variables in the model? (Construct validity)<br>Does the measure correctly predict some situations that would be caused by or coincide with the phenomenon being measures? (Predictive validity)<br>Do other measures of the construct move approximately in unison over time? (Convergent validity) |
|                        | A clear logical relationship between the indicator and the construct being measured                                       | Does face validity suggest that the indicator measures change in social and community health with resource change (use, condition, management)?  |
| <b>Relevance</b>       | Consistent  | Does the indicator measure the same activity – On each occasion? In all locations?   |
|                        | Clearly communicates what is being measured   | Can users understand and use the indicators?   |
| <b>Appropriateness</b> | Reflects the Government's (stakeholder's) priorities and allocation of resources  | Does indicator reflect Government (Stakeholder) priorities?<br>Outcomes inform programs?<br>Do the indicators provide a balanced view addressing different aspects of social and community health?   |
|                        | Relationships   | Do they reflect the constructs addressed in research questions and relationships hypothesised prior to analysis?   |
| <b>Robustness</b>      | Trend data over time  | Is data – Reliable? Available for more than a year? Stable over time?  |
|                        | Benchmark against others  | Are the variables - reported to other States (Stakeholders)? Comparable with other countries? Can reports be presented on whole-of-government programs (sectors)?  |
| <b>Manageability</b>   | The data are available and the research team has the capacity to analyse and report the data                              | Is infrastructure in place to collect/obtain/report the data?  |
|                        | The preparedness of departments to accurately measure and report their performance in relation to the indicators/measures | What multivariate statistical analysis is used to test?<br>Are controls in place to ensure data captured in information systems is accurate?<br>What reliance is place on information from external sources?   |
|                        | The capacity of the Government (Stakeholder) to implement the findings  | What communication is there with government and other stakeholders?  |

## Appendix N

### *Bibliography of social impact assessment studies for NRMW*

#### **Fisheries**

Bradshaw, M., Wood, L. and Williamson, S. 2001. Applying qualitative and quantitative research: a social impact assessment of a fishery. *Applied Geography*, 21(1): 69–85.

Increasingly, human geographers are being encouraged to combine qualitative and quantitative research approaches. The combination involves more than simply juxtaposing approaches; instead, some of the barriers between them need to be removed. This, however, is often easier said than done. Here we address the issue of combining qualitative and quantitative research approaches through a concrete example: a **social impact assessment** of the rock lobster fishery in Tasmania, Australia. In addition, we discuss how the research was applied politically by people outside the academy.

Harris, C. C., Nielsen, E. A., McLaughlin, W. J. and Becker, D. R. 2003. Community-based social impact assessment: The case of salmon-recovery on the lower Snake River. *Impact Assessment and Project Appraisal*, 21(2), 109-118.

This paper presents a process for gathering and using data for socio-economic indicators in a community-based impact assessment conducted in 1999 across a three-state area. It assessed community-level impacts of alternative Federal actions to recover salmon runs, ranging from maintaining the existing hydro system to breaching four dams on the lower Snake River. Residents from 27 diverse communities participated in structured, interactive forums that sought to empower them with an understanding of the results of concurrent biological, economic and physical impact studies as the basis for making more informed judgments. This approach raises significant issues for developing and applying socio-economic indicators to a highly controversial effort to sustain endangered species across a large landscape.

NMFS. *Guidelines for assessment of the social impact of fishery management actions*. Accessed -[http://www.nmfs.noaa.gov/sfa/reg\\_svcs/social\\_impact\\_assess.htm](http://www.nmfs.noaa.gov/sfa/reg_svcs/social_impact_assess.htm)

Wilson, D., McCay, B. J., Ester, D., Perez-Lugo, M., LaMarque, J., Seminski, S. and Tomczuk, A. 1998. *Social and cultural impact assessment of the Highly Migratory Species Fisheries Management Plan and the Amendment to the Atlantic Billfish Fishery Management Plan*. New Brunswick, New Jersey: The Ecopolicy Centre for Agriculture, Environmental and Resource Issues, Rutgers University. July 1998. Accessed - <http://www.st.nmfs.gov/st1/econ/cia/hms.pdf#search='fisheries%20and%20social%20impact%20assessment'>.

#### **Forestry**

Gale, R. P. 1991. Forest resource-dependent communities and the new forestry: how wide the welcome mat in the Pacific Northwest? *Northwest Environmental Journal*, 7(1), 7–33.

Lugg, A. 1996. Social impact assessment and forestry. *Australian Forestry*, 59(3), 146–150.

In NSW, environmental impact assessment through the *Environmental Planning and Assessment Act 1979* clearly entreats consideration of social impacts as well as the traditional 'physical' environmental considerations. Social impact assessment is an important component of environmental impact assessment and is seen as a step that acknowledges the interrelationship between physical and social environments. Public participation is recognised as an essential ingredient of social impact assessment. Environmental impact assessment, by way of its main instrument—the environmental impact statement, requires further development of social considerations including an examination of the impacts on less tangible forest values and quality of life indicators.

- Mercer, E. and Aruna, P. B. 2000. Assessing the impacts of forests on human welfare: Preliminary results from the Mid-Atlantic Integrated Assessment. *Environmental Monitoring and Assessment*, 63(1), 43–63.

This paper presents results from the first phase of the socio-economic assessment of forest ecosystems in the Mid-Atlantic Integrated Assessment (MAIA). First, we present results of the analysis of changes in the distribution of human population and forest land use in the region. Then, trends in wood products employment and income between 1975 and 1995 are used to examine the economic contributions of forest-based industries in the Mid-Atlantic region. Between 1970 and 1990 the population of the MAIA region increased by 14% (4.3 million people) resulting in the average population density increasing by 25 people per square mile from 179 to 204 people per square mile. Nevertheless, population density was lower in large parts of the region in 1990 than in 1950. Although forests dominate the MAIA landscape, the trend is toward more people owning smaller forest land holdings, with developed lands increasing by 21% and rural lands decreasing by 2.64% between 1982 and 1994. All of this suggests increasing forest fragmentation in all states of the region except New York, Pennsylvania, and West Virginia. Forest industry has been an important contributor to the economy of the MAIA region, producing an average of a quarter million jobs (2.03% of all wage employment) and generating \$4.5 billion in wages and salaries each year between 1975 and 1995. If recent trends continue, forest industry will continue to be an important source of employment and income for parts of some states in the MAIA region; however, the forest industry's importance relative to the entire mid-Atlantic economy will likely continue to decline in the 21st century.

### **Agriculture**

- Chamala, S. 1990. Social and environmental impacts of modernization of agriculture in developing countries. *Environmental Impact Assessment Review*, 10(1–2), 219–231.

In the early 1950s many developing countries lacked indigenous research and technology capability. In their desperate attempts to modernize traditional agriculture they selectively borrowed technology and strategies of development from the West. Green revolution technology produced some impressive results in food production but also increased poverty and caused deterioration of the environment. It is easier to be critical than to find universal solutions to solve complex problems of development in diverse agro-climatic and socio-political systems. This paper examines the external megafactors, namely international agricultural centres, trade, bilateral aid, and international organizations affecting modernization of agriculture in developing countries, and provides a balanced critique on positive and negative impacts of modernization in these countries. General trends of social and environmental impacts are briefly summarized. New approaches undertaken by international centres and by some developing countries to overcome social and environmental impacts of modern agriculture are reviewed. Mechanisms to generate appropriate agricultural technology development and management of delivery services are suggested to achieve integrated socio-economic welfare of the people and sustainable environment.

### **Mining**

- Joyce, S. A. and McFarlane, M. 2001. *Social impact assessment in the mining industry: Current situation and future directions*. Mining, Minerals and Sustainable Development Project for the International Institute for the Environment and Development. Report No. 46. Accessed - [http://www.natural-resources.org/minerals/cd/docs/mmsd/topics/social\\_impact\\_assessment.pdf#search='mining%20and%20social%20impact%20assessment'](http://www.natural-resources.org/minerals/cd/docs/mmsd/topics/social_impact_assessment.pdf#search='mining%20and%20social%20impact%20assessment').

### **Urban regeneration**

Sairinen, R. and Kumpulainen, S. 2005. Assessing social impacts in urban waterfront regeneration. *Environmental Impact Assessment Review* [In Press – available on-line].

The authors identify the social impacts of urban waterfront regeneration. For this purpose, four different dimensions of social impacts in urban waterfront planning are presented: resources and identity, social status, access and activities and waterfront experience. The four social dimensions refer to the different ways of experiencing and using the edges of the sea, lake or river to make an understanding of their qualities to the community.

### **Port development/infrastructure**

Marx, A. 2002. Uncertainty and social impacts: A case study of a Belgian village. *Environmental Impact Assessment Review*, 22(1), 79–96.

The paper discusses social impacts in a village in Flanders resulting from the construction of a container terminal near the port of Antwerp. First of all, attention will be paid to the research design (key experts, public hearing, information centre, and survey) and the main research results. It will be shown that the social impact will be very significant. Then the paper explains this impact by focusing on the importance of uncertainty. It will be argued that uncertainty plays an important role in the decision-making process of households in the predevelopment and development stage. In this case and context, this means that uncertainty results in people leaving the village. These micro decisions will result in larger macro effects due to a decrease in the community's social cohesion (a decrease in the importance of one of the possible motives of staying) and a change in the system of interaction. The latter creates a crowding-out effect by means of what could be labelled Schellings' interaction mechanism.

### **Water infrastructure development**

Équr , D. and Sen cal, P. 2003. Social impact assessments of large dams throughout the world: Lessons learned over two decades. *Impact Assessment and Project Appraisal*, 21(3), 215–244.

The dams reviewed in this paper - Three Gorges in China, Ilisu in Turkey and Urra in Colombia - are controversial and the assessment of their social impacts represents a challenge. This paper emphasizes the complexity of the institutional setting and social impacts of these projects as well as the specific problems raised by their assessment, which result from the magnitude, intensity and visibility of these impacts. The paper draws lessons from these projects on SIA methods, impact perception, the analysis of project alternatives, the design of mitigation and compensation measures, social monitoring and follow-up, as well as ethical boundaries.

Becker, D. R., Harris, C. C., Nielsen, E. A. and McLaughlin, W. J. 2004. A comparison of a technical and a participatory application of social impact assessment. *Impact Assessment and Project Appraisal*, 22(3): 177–189.

Results of independent applications of a technical and a participatory approach to SIA are compared for an assessment of impacts of the proposed removal of hydroelectric dams to recover threatened and endangered salmon in the Pacific Northwest of the United States. The analysis focuses on empirical differences and similarities between the technical social analysis report (SAR) and the participatory interactive community forum (ICF) in terms of indicators used, projection of impacts, and types of social impacts identified in two communities. The SAR used a more homogeneous set of social structures and indicators to make expert-based projections. The ICF did not limit indicators to those aggregated across the region, but revealed residents' perceptions of impacts to their communities. A combination of the two approaches would provide robust findings of social impacts.

Lerer, L. B. and Scudder, T. 1999. Health impacts of large dams. *Environmental Impact Assessment Review*, 19(2), 113–123.

Large dams have been criticized because of their negative environmental and social impacts. Public health interest largely has focused on vector-borne diseases, such as schistosomiasis, associated with reservoirs and irrigation projects. Large dams also influence health through changes in water and food security, increases in communicable diseases, and the social disruption caused by construction and involuntary resettlement. Communities living in close proximity to large dams often do not benefit from water transfer and electricity generation revenues. A comprehensive health component is required in environmental and social impact assessments for large dam projects.

Walker, A. 2003. Restoring flows on Australia's Snowy River: Assessing the impacts on local amenity. *Impact Assessment and Project Appraisal*, 21(2), 119–124.

This paper outlines the assessment of local amenity benefits arising out of increased flows along Australia's Snowy River. The assessment used indicators of river condition to address the amenity issues raised by local residents. An expert panel provided information on how these indicators would respond to increased flow and catchment-management scenarios. The key finding of the assessment was that catchment management measures were likely to have a more substantial impact on amenity than increased flow.

## **Cultural**

Chase, A. 1990. Anthropology and impact assessment: Development pressures and indigenous interests in Australia. *Environmental Impact Assessment Review*, 10(1-2), 11–23.

In Australia's remote areas there has been considerable recent growth in development projects and plans. These mostly relate to extraction of natural resources and tourism. This situation has placed considerable pressure on resident Aboriginal groups that claim traditional attachment to the land affected. This article discusses the Australian situation, and examines a silica sand mining proposal in northern Queensland, where a local Aboriginal group claimed attachment to the proposed site. The article examines the shortcomings in the impact assessment process for that project, and then discusses the nature of consulting firms in Australia and the engineering perspective as it is increasingly brought to bear on the field of social impact assessment and analysis, through the historic growth of private consulting firms.

Jobes, P. C. 1986. Assessing impacts on reservations: A failure of social impact research. *Environmental Impact Assessment Review*, 6(4), 385–394.

This paper addresses the failure of the social impact assessment process (SIA) used to analyze the effects of recent energy development near the Northern Cheyenne Reservation in Montana. Research conducted under the auspices of state and federal agencies to assess the impacts of coal development adjacent to the reservation has neglected to consider the potential negative consequences on the social interaction and organization of the Northern Cheyenne. The focus here is on one reservation, but the findings may be applicable to development near other reservations with similar demographic, social, and jurisdictional characteristics. Another important similarity includes the relationship between the reservations and persons and organizations outside them. An ideal model for analyzing reservations is described.

- Lane, M. B., Ross, H., Dale, A. P., and Rickson, R. E. 2003. Sacred land, mineral wealth, and biodiversity at Coronation Hill, Northern Australia: Indigenous knowledge and SIA. *Impact Assessment and Project Appraisal*, 21 (2), 89–98.

This paper is concerned with the role of social impact assessment (SIA) in the resolution of an environmental conflict involving demands for the conservation of an ecologically significant area, a proposal to exploit mineral wealth, and the concerns of indigenous custodians who feared damage to sacred lands. This is a case in which the knowledge claims of key protagonists were deeply politicized and contested, and in which the process of decision-making was itself the subject of controversy and debate. The paper reviews the case, emphasizing the roles of western and indigenous epistemologies in decision-making. It presents an approach to SIA that addresses these epistemological issues and ensures the articulation of indigenous knowledge to governmental decision-makers.

- Ross, H. 1990. Community social impact assessment: A framework for indigenous peoples. *Environmental Impact Assessment Review*, 10(1–2), 185–193.

A community social impact assessment framework for indigenous peoples has been developed on the basis of a study conducted with a group of East Kimberley Aboriginal communities in Western Australia. The framework involves community control, with emphasis on community values, perspectives, and social context. It requires research methods that Aboriginal people feel comfortable using and that represent their viewpoints effectively. It incorporates a cumulative regional and historical view, and takes a social developmental approach.

### ***Resource development***

- Walker, J. L., Mitchell, B. and Wismer, S. 2000. Impacts during project anticipation in Molas, Indonesia: Implications for social impact assessment. *Environmental Impact Assessment Review*, 20(5), 513–535.

Important impacts can emerge regarding biophysical, economic, social, political/legal, cultural, and psychological aspects during the anticipation stage of a project, as confirmed by a study of impacts during anticipation of proposed tourism developments in the village of Molas, in North Sulawesi, Indonesia. The main findings were that during the anticipation phase both the quantity and quality of agriculture production on land acquired by speculators and developers decreased, individuals used the income from the sale of their land to build new homes or improve existing ones or to invest in new occupations, exposure to new values and lifestyles made younger people in the village less interested in maintaining traditional values and culture, the local community became marginalized related to planning and development decisions, and considerable fear and anxiety were created for many villagers due to the uncertainty generated by the proposed tourism development. Many of these impacts will not be documented in any environmental impact statement related to the proposed development, because the EIS will be conducted well after the anticipation stage. These findings, and other studies, suggest that SIA is one of the most poorly handled aspects of impact assessment in Indonesia.