

# **SUMMARY STATEMENT OF THE REEF SCIENCE PANEL**

## **Regarding water quality in and adjacent to the Great Barrier Reef**

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## Abstract

This paper summarises the Report and recommendations of a Panel of Scientists formed to provide advice to be used in the development of a Water Quality Protection Plan for the Great Barrier Reef (the Reef), which will focus on land-sourced pollutants. The Panel considered nine terms of reference related to the evidence and impact of any decline in water quality entering the Reef from river catchments, advising on capabilities, gaps and priority research needs to achieve water quality improvements (including commenting on the *Great Barrier Reef Catchment Water Quality Action Plan* [GBRMPA Action Plan], and on practical options for reducing water quality impacts on the Reef.

The Panel found that there are clear indications that major land use practices in the Reef catchment have led to accelerated erosion and greatly increased the delivery of nutrients over pre 1850 levels. The reasons for this decline are varied but relate to activities within the river catchments, such as the extensive grazing practices in the drier catchments and overgrazing in general, urban development, agricultural production, water use practices, extensive vegetation clearing and wetland drainage on coastal plains and development on acid sulphate soils.

The Panel found that there is clear evidence of the effect of these practices on some rivers, estuaries and inshore areas. Reefs at a number of inshore locations along the coast have been disturbed and have remained in a disturbed state. These reefs exhibit characteristics consistent with altered ecological function due to enhanced nutrient availability or sedimentation. Evidence of impacts on offshore areas of the Reef is not well understood, however information from overseas shows that by the time such effects are obvious the system would be almost irreparably damaged. In light of the above factors the Panel confirmed that there is a serious risk to the long term future of at least the inshore reef area and that action is necessary to avoid such damage.

The Panel believes that an integrated resource management approach to dealing with the issue is the best approach and supports the concepts of risk assessment and target setting. To this end the Panel found that the GBRMPA Action Plan has value on a broad basis, but requires significant refinement, particularly at a sub-catchment level. The future development of water quality targets and risk classification must include community input and would best be achieved through existing regional structures using specific local water quality data. The Panel proposes that such development should be initiated through a two day dedicated multi-disciplinary workshop providing a values-objectives-indicators-measurements decision tree for the Reef, involving representatives of all relevant stakeholders and experts in the field of water quality and taking account of State of the Environment reporting.

The Report identifies gaps in current knowledge and provides advice on tools and methods to improve water quality and how adverse water quality impacts on the Reef might be reduced. The Panel believes that its advice, which necessarily invokes the precautionary principle, should form an integral part in the development of an effective Reef Water Quality Protection Plan.

## **Introduction**

Through a Memorandum of Understanding announced on 13 August 2002, the Federal Government and the Queensland Government have undertaken to develop a Reef Water Quality Protection Plan with the goal of stabilising and reversing the decline in water quality entering the Great Barrier Reef as soon as practicable. The following statement summarises the report of a Panel of Scientists, (see Attachment 1 for membership), which was established to provide advice to facilitate the development of that Plan. The Terms of Reference that the Panel was asked to address are noted throughout the document, and are included in full as Attachment 2. Important terms used in this summary report are explained in Attachment 3.

The Panel met on seven occasions and interviewed marine scientists, managers of Reef Agencies, representatives of major "User groups", and representatives of Non-Government Organisations. Written submissions were received, having been invited from all local authorities and universities in the Great Barrier Reef region. A total of 459 references were sighted or cited in the report.

As scientists, the Panel is acutely aware of the changes that occur over various timeframes from decades to thousands of years. For example profound changes have occurred in the scales of thousands of years, with respect to the existence of the Great Barrier Reef, and the impact of a 40 metre sea level rise from about 18,000 years ago to about 8,000 years ago.

We are not, however, reporting on the time scale of thousands of years.

In this summary report, we are concerned with what has happened over the very short (geological) decadal time period of a maximum of about 200 years or so. Although humans have not been systematically monitoring events in the Reef for anything like the necessary length of time to be confident of fully understanding the impact of any changes in conditions (such as that of water quality), some of the Reef organisms (such as the hard corals), and some of the sediments in the Reef region, may well have retained "signals" or "indicators" of these recent events. These signals can now be accessed and evaluated using accepted scientific methodologies.

The Terms of Reference have set out that the Panel must focus on land-sourced pollutants, and it is recognised that this is not the only source of pressure on the Reef. Our aim has been to be as definitive about the level of these pollutants and the extent of their impact as is practicable, and to clearly describe the boundaries of uncertainty within which we have operated. This summary should be read with this in mind, and is discussed in detail in the full report.

The Panel also recognises that several other studies related to the issue of Reef water quality are planned or already in progress, and that these studies will further our knowledge beyond what we have at our disposal at this time. This however is the nature of science. If we wait for all the relevant research to be completed before making a decision on the level of risk then we run the risk of making those decisions too late.

## **Summary responses to the Terms of Reference**

Term of Reference 1. *Review existing evidence for any decline in water quality of catchments draining to the Reef, and*

Term of Reference 2. *Review existing scientific evidence of the presence of land-based pollutants in Reef waters and of the nature and extent of the existing and potential impacts of any such land-based pollution.*

The Panel has found that major land use practices in the Reef catchment have led to accelerated soil erosion, as well as increased fertiliser and pesticide application, with consequent increases in sediment, nutrients and pesticides in waterways flowing to the Reef. While these factors are known to have harmful effects on the health of tropical marine ecosystems, the spatial extent of impacts and the resilience of the Reef's systems to sediments, nutrients and pesticides is not as well understood.

Scientific measurements, calculations and predictive modelling of water quality conducted over the past 15 years consistently indicates that there has been at *least* a four-fold increase in sediment and nutrient delivery to rivers discharging to the Reef.

Current estimates of average annual sediment runoff in rivers draining to the Reef range between 10 and 15 million tonnes per year, while estimates of pre-1850 inputs fall between 1 and 5 million tonnes per year. Sediment increase factors of 4, 15 and 4 for rangelands, cropping lands and urban areas respectively, may often be conservative. Current estimates suggest that annual nitrogen (N) exports from catchments bordering the Reef have increased at least 2-fold (22,000 to 43,000 tonnes per year) since 1850. Annual phosphorus (P) exports have increased at least 3-fold (2,400 to 7,000 tonnes per year) since 1850.

Soil P levels in most sugar cane production lands and in soils used for vegetable production are nowadays well above those deemed as critical to achieve maximum yields indicating that improved fertiliser efficiencies are possible.

Inputs of fertilisers (chiefly N & P) and other chemicals for agricultural production in cropping systems of the Reef catchment have steadily risen.

Nitrogen budgets for cropping lands consistently indicate that a significant proportion (ca. 30-50%) of the N input is lost to the surroundings through gaseous transformations, surface runoff and leaching to groundwater. Between 80 and 90% of the P lost to waterways and the sea is attached to suspended sediments derived from eroded soil.

Because of the large area of land use involved, most of the sediments, N and P that moves from catchments to the Reef are sourced from extensive grazing lands in the drier catchments (Burdekin and Fitzroy Rivers). However, there is evidence from a number of catchments (Haughton, Johnstone, Herbert and Tully Rivers) that nitrate-N concentrations in river waters increase as water passes through intensive sugarcane growing areas. For example, in the Johnstone Catchment, sugarcane occupies around

12% of the catchment yet contributes close to 50% of the nitrate exported. In contrast, rain forest, which occupies >50% of the catchment, contributes little more than 10% of the nitrate load. Sugar cane farming also contributes a disproportionate percentage of the total P transported from the catchment to the sea (>30%).

Time series sampling of nutrients in the perennially flowing lower Tully River show evidence for a steady increase in dissolved nitrate and phosphate concentrations and more frequent episodes of enhanced suspended sediment concentrations due to up-catchment erosion. This upward trend began in the early 1990's when a significant change in land use occurred within the Tully River catchment.

There is evidence from Bassett Basin (Pioneer Catchment) of elevated levels of ammonia/ammonium and oxides of N in water and pore-water, suggestive of point-source pollution from the nearby sewage treatment plant.

There is evidence of a significant build-up of nitrate below the root zone in highly weathered soils, particularly under sugarcane at Tully, Johnstone and Burnett catchments. A change in land management or cropping regime that changes soil pH is likely to release large quantities of this nitrate, which will then move to groundwater and appear as baseflow in streams. At present, there is no certainty when and to what extent this "sink" will overflow into adjacent waterways.

Livestock numbers in Queensland are as high as they have ever been, resulting in considerable and increasing pressure on grazing lands where grass/tree cover is <25-30%.

Human population and land use pressures in Reef catchments vary widely, with population density unrelated to catchment size. Extensive grazing is the major land use and occupies around 83% of the Reef area between Cape York and the Mary River (94% of land use in the Dry Tropics; 52% of land use in the Wet Tropics). Urban [sub-urban and semi-rural] areas occupy 1.6% of the catchment, cropping 1.13% (dominated by sugarcane), while protected (pristine or minimally disturbed) areas (includes military lands) and forestry occupy the remainder. Land use pressure (impact per unit area) is highest in catchments where sugarcane is grown.

Construction of dams and weirs, development of extensive surface drainage networks and increasing extraction of water for irrigation and urban use have significantly altered the flow regime of some of the Reef rivers (eg. Burnett, Fitzroy, Pioneer, Burdekin, Barron), in some instances reducing overall flow or resulting in changes from seasonal flow to perennial flow and the transformation of ephemeral wetlands in irrigation drainage areas of the Lower Burdekin into permanent wetlands. This probably has (and definitely will have) effects on ecosystem health and water quality that as yet have not been fully quantified.

Extensive vegetation clearing and drainage works on coastal plains have significantly reduced the extent of riparian vegetation and wetlands (permanent and seasonal) and significantly degraded remnant habitats through weed infestations and loss of fringing vegetation.

Drainage and Land developments and drainage schemes on low lying coastal lands comprising a high proportion of acid sulphate soils (ASS), or potential acid sulphate soils (PASS) such as those at Trinity Inlet, have locally resulted in strong acidity, causing the mobilisation of aluminium and iron, increasing chemical demand for dissolved oxygen (DO) in waterways, and consequent harm to local aquatic biota. Although in open waters the acid is diluted when good mixing occurs, and slowly neutralised by seawater, the release of acid may occur over many years, effectively continuously, if only slowly. The extent of any indirect effects on coral reefs, fish and other biota is uncertain. However this is one specific example where the adage for chemical contamination should be heeded - that is, "dilution is not the solution".

Sugar cane juice and billets lost during mechanical cane-harvesting operations can contribute to very low DO in nearby waterways when the sugars and other soluble organics move off-site in runoff or in irrigation tail water. Contemporary research has confirmed that five-day biochemical oxygen demand (BOD<sub>5</sub>) levels many times higher than the upper limit of 20 mg O<sub>2</sub>/L permitted in municipal effluent can develop under wet field conditions.

While implications for local fish stocks are obvious, information on the effects on fish that interact between coastal waterways and "reef" waters is lacking.

Episodically depleted concentrations of dissolved oxygen (DO) to levels unhealthy to fish have been recorded in coastal waterways of the Lower Herbert following runoff events and for several weeks in a lagoon in the Lower Burdekin after mechanical removal of aquatic weeds.

Comprehensive audits of pesticide applications are lacking for uses other than for sugarcane, which is a prominent user of herbicides such as atrazine, diuron, 2,4-D, glyphosate, ametryn, and paraquat, and an emerging user of new products such as Flame (imazapic), Confidor (imidacloprid), and Balance (isoxaflotol).

There are several reports of detections of atrazine, 2,4-D, ametryn and diuron in coastal waterways, including atrazine in groundwaters of the Burdekin Delta. For example, diuron residues have been detected in the Johnstone River, in agricultural drains in the Lower Burdekin, upstream of Mackay in the Pioneer River, in sediments of Bassett Basin in the Pioneer River estuary, and in downstream locations of the Mary River.

There is a recent Pioneer Catchment Report ("River Water Quality in the Pioneer Catchment on February 14-15, 2002", DNRM, July 2002) that states that 470 kg of diuron entered the Dumbleton Weir during this single flood event. This is a substantial and significant amount.

In summary, all of the above factors are very strong indicators of a decline in water quality in Reef catchments. In some catchments (Herbert, Tully, Johnstone) such changes are clearly demonstrated by the results of various extensive water quality monitoring programs in river networks. In many catchments, trends in water quality and nutrient

exports are obscured by very high natural seasonal and inter-annual variations in river flow and nutrient concentrations. In such catchments we infer from the well-studied catchments and the factors listed above that there is a high likelihood of similar decline. This general pattern is also corroborated by the findings of the National Land and Water Resources Audit.

The second part of Term of Reference 2 requires the Panel to *"Review existing scientific evidence .... on the nature and extent of the existing and potential impacts of any such land based pollution"*.

This is a very broad challenge, and the Panel advises that:-

1. Reefs at a number of locations along the coast have been disturbed and have remained in a disturbed state. These reefs exhibit characteristics consistent with altered ecological function due to enhanced nutrient availability or sedimentation. These effects include: local reductions in biodiversity, reduced or failed coral recruitment, enhanced mortality of juvenile corals, reduced photosynthetic performance of corals and the replacement of reef-building hard corals by space-occupying algal communities.
2. Nearshore coral reefs in the Reef are influenced by increased sediment and nutrients in runoff from catchments with significant land clearing and fertiliser utilisation on a recurrent basis ranging from intervals of a decade or longer in the southern Reef to near-annually in sections of the central Reef (16°-19°S) coast bordering the wet tropics
3. River plumes following periods of heavy rainfall are observed well into the Reef lagoon. Apart from the mass of freshwater entering the coastal waters, turbidity has a major impact on available light and coral photosynthesis and coral death has been observed in a range of experimental conditions. Concentrations of nutrients in river runoff plumes reflect increased concentrations in river waters due to land use in catchments. This level of concentrated nutrients gives potential for harm.
4. Detectable concentrations of herbicides (principally diuron) have been found in coastal and intertidal sediments and seagrasses at a number of sites along the coast in close proximity to catchments with substantial sugarcane farming.
5. Elevated concentrations of fat-soluble pesticide residues have been found in dugongs and other marine mammals within the Reef, suggesting that land-based pollutants are finding their way into the food chain of biota associated with the Reef.
6. There is a significant body of well-documented evidence regarding coral reef systems outside of Australia demonstrating harmful effects of excess nutrient availability (eutrophication) and excess sedimentation. The principal effects of excess sedimentation and/or nutrient availability are through disruptions to normal ecological processes in reef systems, especially the capacity of coral-dominated reef communities to recover from natural disturbance events and to maintain naturally biodiverse communities.

Term of Reference 3. *Advise on methodology for developing scientifically sound, effective and measurable end-of-river targets to achieve the goals.*

An adaptive management framework that provides processes for participatory determination of water quality objectives and targets, catchment objectives and targets across social, economic and environmental indicators is needed. Such a process provides effective multi-stakeholder and multi-objective decision making as part of the plan making phase, and for these decisions to be based on a scientific conceptual understanding of the processes and drivers. Capacity and skills would be identified following a process to build a common understanding of the threats and consequences of various actions. The process recommended follows the National Water Quality Management Strategy but with specific science inputs.

End-of-catchment objectives and targets need to be translated to upstream reaches and associated properties, so that there are measurable targets at the point where land use change can be observed and measured and consequent changes in water quality measured over a shorter time period than end of catchment targets.

Steps in the methodology to set effective targets includes; set water quality values and objectives, set targets, set indicators of water quality, assess appropriate measurements and technologies and techniques to identify progress towards the targets, set time periods for expected response of the system, set interpretive tools to account for episodic events and impacts of multiple stressors. That is, a hierarchy of indicators are required from the individual parameter level to the more ecologically integrated indicators, so that multiple factors occurring at once can be separated and adverse trends in selected indicators directly related to causal mechanisms.

This process should be facilitated by a multi-disciplinary Workshop providing a values-objectives-indicators-measurements decision tree for the Reef.

The methodology proposed is one that involves "user groups" from the outset, and builds on systems already adopted by "user groups", such as the COMPASS concept of sugar cane growers, which would be adaptable to other users.

Measures warranting serious consideration to resolve environmental concerns are not restricted to end-of-river targets and should continue to include existing measures imposed on the industrial sector (including sugar mills and the mining sector) to limit point-source pollution and free rider behaviour. The measures to control diffuse sources of pollution should embrace enhanced management and monitoring of inputs, soundly-based physico-chemical performance targets; fiscal controls; economic instruments; incentive structures; standards and voluntary agreements; and information and awareness campaigns.

Recalling that the MOU states "an initial goal for a Reef Protection Plan to halt the decline in the water quality of catchments draining to the Reef caused by land-based pollution and a long-term goal of reversing the trend in declining water quality", and



noting that environmental systems represent complex networks of interactions amongst physical, biological and social entities making it difficult to fully define damage functions and assimilatory capacities, while simultaneously isolating background sources of the same pollutants, the Panel recognises that any measures introduced will only succeed if they lead to a net reduction in the pollution risk.

Moreover, this may take many years as the environmental response to a lowering of some fertiliser application rates or the withdrawal of a herbicide such as diuron will be slow. Those measures "owned" or respected by the landholder or land manager are the most likely to be effective. Ideally, the benefits should not be outweighed by the costs imposed on businesses, the public or individuals. Typically, tradeoffs may need to be negotiated between resource managers and resource users, taking account of benefits, costs and risks.

In recognition of the complexity of the source and of the fate of catchment waters, including groundwater, and floodplain interactions during peak rainfall events, the Panel suggests that a two day Workshop be conducted at the earliest practicable time to review the most relevant measurements that should be made in catchment, in-river, end-of-river and in-reef-waters to allow assessment over time of any changes in water quality, and of the sources of any materials associated with any change in water quality.

In determining the measurements to be made, recognition should be given to the Indicators used in National and Queensland State of the Environment (SoE) reports, to ensure compatibility and comparability with other coastal aquatic systems, and to facilitate incorporation of Reef water quality results into State and National SoE reports in the future.

Consideration should also be given to the application of the Condition-Pressure-Response model (or similar model) to allow future recommendations to be made on modification of human behaviour to minimise adverse impacts on river, estuary, and reef waters.

The Workshop should take into account the draft document "National Framework for Natural Resource Management Standards and Targets" (2001) which has been prepared as part of the Inter-government Agreement for the National Action Plan (NAP). The framework sets aspirational targets - a vision by the community for a region, achievable resource condition targets, the desired outcomes in the medium term of 10-20 years and management action targets for the short term of 1-5 years.

For NAP, targets should be:

- Based on best available science;
- Benchmarked against current natural resource condition and trend;
- Capable of being linked to management actions;
- Defined at appropriate scales and set in specific locations;
- Able to take account of cumulative impacts of actions and the dynamic nature of natural systems;
- Meaningful and achievable, reflecting the agreed natural resource outcomes sought;
- Measurable so outcomes can be quantified; and

- Time-bound, with targets moving progressively towards agreed outcomes.

Term of Reference 4. *Evaluate the methodology and data used to set end-of-river targets contained in the GBRMPA Water Quality Action Plan; and*

Term of Reference 5. *Assess whether these targets are valid and appropriate for the above goals.*

The Panel supports the concept of target setting to achieve the goal of stabilizing and reversing the decline in water quality entering the Reef. The Panel is aware that the 2001 *GBR Catchment Water Quality Action Plan* (the Action Plan) was the first step in a proposed staged approach at setting priorities and targets for addressing water quality issues and defining requirements for water quality monitoring and reporting. The Panel is also aware that the Action Plan did not involve public consultation and underwent only limited peer-review.

The Panel also considers that the Action Plan has value on a broad basis, but requires significant refinement at a sub-catchment level. It will be essential for the development of water quality targets to include community input in order to foster community ownership. The use of the most contemporary water quality data available is also fundamental to the broad acceptance of such targets. These aims can effectively be achieved through the involvement of existing regional structures and seeking specific local information and input.

These, and other points can be captured through the Workshop we have suggested in response to ToR 3, above. The Panel also suggests that end-of-river targets are not the only targets that should be considered in the holistic management of river catchments draining to the Reef.

Term of Reference 6. *Assess whether the catchment risk classification contained in the GBRMPA Water Quality Action Plan is valid and appropriate for the above goals.*

The Panel believes that the Commonwealth and the State Governments should accept the concept of risk assessment and work to refine the classification procedure, in collaboration with regional NRM bodies, by jointly engaging a recognised risk analysis specialist(s) to review and assist in updating the proposed end-of-river sediment and nutrient and AgVet chemicals reduction targets, and to achieve desired water quality goals, as part of a process of continuous improvement.

The specific issues could be further addressed at the proposed Workshop.

Term of Reference 7. *Evaluate current research, and advise on capabilities, gaps and priority research needs, to:*

- *assess water quality impacts;*
- *quantify acceptable levels of pollution;*
- *locate and quantify the sources of pollution;*
- *reduce pollution from key sources; and*
- *assess the effectiveness of actions to reduce pollution.*

The Panel believes that:-

1. A water quality and sediment pore-water survey should be commissioned in Reef catchments, targeting the discharge zone in coastal estuaries of municipal sewage treatment plants, with an emphasis on nutrients, including the levels of ammonia/ammonium, nitrate and total N, primarily to independently ascertain the “quality” of the discharge and its potential to promote or damage nearby aquatic fauna and flora.
2. Appropriate bio-physical, social and economic research should be undertaken to identify opportunities for improvement and barriers to the adoption and implementation of land and water management practices beneficial to catchment water quality. For example, measures to minimize the mobilization of sediments can be expected to include the avoidance of overgrazing, maintenance of around 25-30% plus of land cover across grazing lands, and attention to roadways, headlands and stream-banks in cropping areas where improved soil conservation measures have already been implemented. Collection/removal of cane trash as a possible green power fuel source, particularly in erosion prone areas, will need to be monitored carefully for impact.
3. All current fertiliser recommendations applicable in “reef” catchments (particularly those for sugarcane, vegetables, bananas and dairy pastures) should be reviewed, modified as necessary, and implemented as a matter of priority, with the goal of optimising for the lowest possible application rate to just achieve the maximum yield or production plateau. This may require a new series of experiments containing sufficient fertiliser rates to fit multiple parameter linear-plateau yield models. Alternatively and expeditiously, the data for sugarcane might be generated from modeled simulations. Moreover, soil test recommendations should be discontinued that encourage additional fertiliser input when specified soil test levels exceed values known to be sufficient for maximum yield. This will, for example, require a change to Table 1 of Schedule 1 of the *Code of Practice for Sustainable Cane Growing in Queensland*, which presently specifies the use of 20 kg P/ha for plant cane at all soil P fertility levels above 40 mg/kg of air dry soil.
4. Research and development should be undertaken to produce and implement cost-effective monitoring technologies to ensure autonomous, wide-spread, long-term and consistent monitoring of key or proxy water quality parameters in the Reef and waterways of the Reef catchment. (This monitoring and the application of the results from the research would also be expected to provide methods to detect the origin of specific contaminants and pollutants transferred to streams and rivers, and/or to the Reef). In addition, the State and Commonwealth governments should establish a joint working group of experts to review and audit the outcomes and effectiveness of water quality monitoring programs on a regular and ongoing basis.
5. Technical (whole-of-system), institutional and social mechanisms for improving water quality in the Reef catchment and reducing contaminated runoff to the Reef should be trialed and demonstrated with a suitable level of support in a number of key

or representative catchments (e.g. Fitzroy, Pioneer, Burdekin, Johnstone, Daintree) as a mechanism for encouraging wider adoption of effective approaches to improving water quality and reducing runoff to the Reef.

6. A concerted R&D effort should be undertaken to develop robust and effective modelling tools to support target setting processes and trade-off analysis of land management options in support of planning, policy formulation and implementation of improved land use. This would need to include:
  - Targeted data acquisition to validate and make the current sediment and nutrient delivery models more robust and scaled to information available in the various Reef catchments;
  - Additional process studies to improve our understanding of water quality effects and habitat modification on health of freshwater ecosystems in Reef catchments, and the resulting flow-on effects for marine environments;
  - Application of the refined modelling tools to determine the benefit of targeted intervention within key sediment and nutrient source areas in Reef catchments;
  - Application of the refined modelling tools to assist in options analysis at sub-catchment to local scales to identify priority actions for communities and industry.
7. While accepting that the sugar industry should move as quickly as possible to minimize or prevent the movement to waterways of sugars and other forms of highly labile carbon during and soon after mechanical cane harvesting operations, the Panel believes research is needed to assess the effects of acute and sustained levels of low DO in fresh waters on fish and crustaceans that interact between coastal waterways and reef waters, particularly to assess the consequences for biodiversity and population dynamics.

Term of Reference 8. *Advise on the most practical options for improving catchment water quality; and*

Term of Reference 9. *Advise on the most practical options for reducing water quality impacts on the Reef.*

The Panel has grouped these two Terms of Reference, because so many of the considerations will relate both to catchment water quality and to water quality impacts on the reef.

The Panel believes that Governments, and where appropriate industry and the general community engaged in the process of developing the Reef Water Quality Protection Plan, should consider the following options:

1. Undertaking a review of policies (including NRM policy) and legislation in 2002-2003 with a view to removing, by 30 June 2005, perverse incentives for activities or environmental outcomes contrary to the goal of improving water quality within the Reef and Reef river catchments.

2. Federal and State agencies jointly endorsing the 6 key principles in designing incentives to address water quality in Reef catchments. (*user pays; polluter pays; cost sharing; sense of community, ownership, and stewardship; adaptive systems; ecosystem approach*).
3. Federal and Queensland governments enhancing their support, including incentives, for industry specific initiatives aimed at improving water quality performance, and to industries promoting development and adoption of codes of practice and guidelines for all operations and industries within Reef catchments, and to consider legislation to ensure adherence, where necessary.
4. Commissioning an independent review of options for implementation of enhanced incentives for improving water quality in Reef catchments.
5. Undertaking an urgent review of current legislation and commissioning an intergovernmental working party to explore options for legislative reform aimed at integrating and streamlining legislation relevant to water quality issues in Reef catchments.
6. Recommending on ways that industry and regional communities can be assisted in accessing key R&D resource products to assist in the implementation of water quality objectives.
7. Recommending on ways that Commonwealth and State agencies can develop strategic alliances with industry, regional communities and R&D providers to establish "demonstration sites" in the Fitzroy, Pioneer, Burdekin, Johnstone and Daintree (ie Douglas Shire) catchments to provide a focus for innovation in water quality management in Reef catchments.
8. Implementation of an ongoing system to assist industry and regional communities in data collection, data collation and analysis data integration, information access and use of the outputs of current/future R&D.
9. Investigation of the options, costs and benefits of establishing a Reef Catchments Commission based on the successful NSW Healthy Rivers Commission model, such investigation to include an analysis of whether any existing Agency, Ministerial Council or other body could assume this function.
10. At a whole-of-Reef level, developing a policy and planning framework to enable a whole-of-government approach to improve water quality. A core element should be the development of a whole-of-government service delivery model based on strong regional arrangements underpinned by meaningful and functional partnerships with industry and the wider community, with a panel to monitor and correlate performance across regions.
11. Putting in place adaptive management processes, consistent with best practice Integrated Resources Management (INRM) and at the scale of individual catchments draining into the Reef, to enable government, industry and community participation and partnerships.
12. Formal endorsement of INRM as the conceptual underpinning for water quality management in Reef catchments by industry, regional community and Government organisations and their representatives.

13. Explicit consideration of INRM principles and practices when evaluating the acceptability of policy, planning and management actions that are proposed and developed to address water quality objectives and targets in Reef catchments.
14. With respect to pesticides, intensify efforts to:
  - (i) continue to accredit, reaccredit and further train primary producers on responsible and environmentally sound use of AgVet chemicals;
  - (ii) develop and train people in the use of a spatially-referenced decision support tool to assess local risk of off-site pesticide movement in "reef" catchments and to provide guidance on appropriate strategies and practices to lessen risks of pesticide loss at the individual farmer level; and
  - (iii) conduct research into alternatives to pesticides or on pesticides less prone to contaminate aquatic environments.
15. With respect to fertilisers, all intensively farmed coastal catchments draining to the Reef being classified as Nutrient Sensitive Zones (NSZs) with the following requirements:
  - (i) purchase of fertiliser permitted only if there is a Nutrient Management Plan (NMP) for the block or property as part of an accredited Property Management Plan;
  - (ii) NMPs supported by contemporary soil and/or plant testing of the area/farm in question, using approved sampling and analytical methods and undertaken by providers deemed to be proficient by the Australian Soil and Plant Analysis Council Incorporated; and
  - (iii) records of all fertiliser inputs, including other materials used as an alternative to commercial fertiliser (eg. mill mud, biosolids) being maintained for a minimum of five years, and made available for annual collation by an authorised department or agency.
16. Federal and State agencies, with relevant Local Government involvement, developing a joint service delivery model for water quality management in Reef catchments, where service delivery is achieved in a way that supports community and industry networks, partnership and capacity.
17. Relevant personnel in Federal, State and Local government agencies responsible for water quality management in Reef catchments:
  - (i) receiving adequate formal training in participatory processes, relationship management, service delivery and ethics; and
  - (ii) when trained, be "accredited", to an appropriate national standard, to deliver participatory processes in regional communities.
18. Governments introducing accountability for the processes by which relevant personnel in Federal, State and Local government agencies responsible for water quality management in Reef catchments interact with communities and ensure Agency accountability for community capacity building with respect to improving water quality outcomes.

19. Federal and State agencies jointly supporting programs in each Reef catchment to:

- (i) provide information to and engage stakeholders in consultations over water quality management, with an emphasis on regional and industry-by-industry approaches;
- (ii) undertake economic and socio-economic assessment of catchment water quality management options;
- (iii) develop tools and methods to enable the assessment of the benefits and costs of specific water quality management actions;
- (iv) ensure cooperation in the assessment of options for short, medium and long-term actions to address water quality issues, including the environmental, social and economic benefits and costs of those actions, and implementation through the regional NRM planning processes;
- (v) enable negotiation and implementation of local water quality improvement actions that are accredited in regional NRM plans;
- (vi) provide financial, policy and project management assistance to implement priority actions co-operatively with regional communities;
- (vii) provide assistance to industry to refine and encourage industry adoption of current recommended best practice in the use of AgVet chemicals;
- (viii) develop an independently assessable water quality audit system for each Reef catchment, that includes audits of inputs (eg. people, land uses, fertilisers, pesticides, heavy metals, and persistent organics).

20. Amending the State Coastal Management Plan to require any approvals under the Coastal Protection and Management Act 1995 to include the submission of an accredited Property Management Plan, including a Nutrient Management Plan (NMP).

21. Regional Coastal Management Plans (RCMPs) spatially identifying constraints to development so that these are comparable with basic land information. (This information to be incorporated into Local Government plans )

22. Federal and State Government agencies jointly providing financial, technical and project management assistance to Local Government, industry and the community in the support of Reef Catchment Plans and RCMPs to implement priority actions for water quality management co-operatively, including a whole-of-system approach (eg. soil types/fertility, inputs, riparian and in-stream condition, land and water management, etc.).

### **Conclusions**

The Panel has recognised that the science related to the extent and impact of increases in the level of sediments, nutrients and pesticides is incomplete. Indeed the Panel has identified a range of monitoring, as well as biophysical, social and economic research,

that should be undertaken to improve the basis of this knowledge. These suggestions range from ways to improve the identification of pollutant sources and of monitoring their impacts, to reviewing recommended fertiliser application rates and identifying barriers to the adoption of land and water management practices beneficial to water quality.

The Panel has also acknowledged that the Reef is spatially and temporally complex with various regional feedback mechanisms, such that a pressure in one part may not be evident in another part. In short, the Reef is not a homogeneous feature and it is subject to multiple and often coincident pressures making the clear identification of contributing factors and their relative importance difficult to quantify. This complicates interpreting pressure and risk.

This notwithstanding, there are very strong indicators of a decline in the water quality in Reef catchments. In some catchments this change is borne out by the results of extensive water quality monitoring programs. In many catchments however, trends are obscured by very high natural seasonal and inter-annual variations in river flow and nutrient concentrations. In such catchments we infer from the well-studied catchments and other relevant factors that there is a high likelihood of similar decline. This general pattern is also corroborated by the findings of the National Land and Water Resources Audit.

The Panel found that there is clear evidence that land practices are impacting some rivers, estuaries and inshore areas. Coral reefs at a number of inshore locations along the coast have been disturbed and have remained in a disturbed state. These reefs exhibit characteristics consistent with altered ecological function due to enhanced nutrient availability or sedimentation. Evidence of impacts on offshore areas of the Reef is not well understood, however information from overseas shows that by the time such effects are obvious the system would be almost irreparably damaged. In light of the above factors the Panel confirmed that there is a serious risk to the long term future of at least the inshore reef area, and that action is necessary to avoid such damage.

The Panel believes that an integrated resource management approach to dealing with the issue is the best approach and supports the concepts of risk assessment and target setting. To this end the Panel found that the GBRMPA Action Plan has value on a broad basis, but requires significant refinement, particularly at a sub-catchment level. The future development of water quality targets and risk classification must include community input and are best achieved through existing regional structures using specific local water quality data.

In conclusion the Panel believes that a precautionary approach needs to be used. The precautionary principle should be applied to both the Reef and to human based activities in the catchments so that the major impacts of human disturbance are identified. From this, changed management practices can be implemented that will make a substantial improvement to water quality of streams discharging to the reef, rather than changes which will have limited impact on the reef but may significantly affect the livelihoods of many people and industries.



The Panel believes that the report sets forward a suitable process that sets ecological health and water quality objectives for both terrestrial activities and for the Reef based on scientific knowledge that is 'socially robust', and whose production can be seen by society to be both transparent and participative. This process utilises a multi-disciplinary workshop providing a values-objectives-indicators-measurements decision tree for the Reef, involving representatives of all relevant stakeholders and experts in the field of water quality and taking account of State of the Environment reporting. The Panel has also set out a number of practical options for improving water quality and reducing water quality impacts on the Reef that can be considered as Governments, industry and the general community as they are engaged in the development of the Reef Water Quality Protection Plan.