5.5. REEF 2050 WATER QUALITY IMPROVEMENT PLAN SUBMISSION TO EHP

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RECOMMENDATION

That Council resolves to support and submit the attached Reef 2050 Water Quality Improvement Plan 2017-2022 to the Department of Environment and Heritage Protection.

EXECUTIVE SUMMARY

The Department of Environment and Heritage Protection (EHP) invited Douglas Shire Council to provide a submission on the draft Reef 2050 Water Quality Improvement Plan 2017-2022.

BACKGROUND

The 2017 Scientific Consensus Statement was released in conjunction with the Reef 2050 Water Quality Improvement Plan 2017-2020 (draft Plan). The consensus statement was produced by a multidisciplinary group of scientists, with oversight from the Reef Independent Science Panel and supported the development of the draft Plan.

The overarching scientific consensus is:

Key Great Barrier Reef ecosystems continue to be in poor condition. This is largely due to the collective impact of land run-off associated with past and ongoing catchment development, coastal development activities, extreme weather events and climate change impacts such as the 2016 and 2017 coral bleaching events.

Current initiatives will not meet the water quality targets. To accelerate the change in on-ground management, improvements to governance, program design, delivery and evaluation systems are urgently needed. This will require greater incorporation of social and economic factors, better targeting and prioritisation, exploration of alternative management options and increased support and resources.

The draft Plan ***(Attachment 1)*** builds on previous water quality plans developed in 2003, 2009 and 2013 and aligns with the Reef 2050 Long-Term Sustainability Plan. It presents several important advances in the management of water quality on the Great Barrier Reef (GBR). It addresses all land-based sources of water pollution (agricultural, urban, public lands and industrial) and includes social, cultural and economic values for the first time. It also updates water quality targets and presents individual targets for reducing water pollution from the 35 GBR catchment areas.

Despite the improved targets and management framework for reducing land-based pollution outlined in the draft Plan, it does not respond to a key concern raised in the 2017 Scientific Consensus Statement ***(Attachment 2)*** that 'Current initiatives will not meet the water quality targets'. This is because the draft plan does not provide any major additional funding, legislation or other initiatives to improve the health of the GBR.

COMMENT

Council has prepared a submission to EHP ***(Attachment 3)*** on the Reef 2050 Water Quality Improvement Plan 2017-2022. The submission answers fourteen questions and will be submitted to EHP through the online survey process.

PROPOSAL

That Council resolves to support and submit the attached Reef 2050 Water Quality Improvement Plan submission to EHP.

FINANCIAL/RESOURCE IMPLICATIONS

There are currently no additional financial or resource implications for Council in making a Reef 2050 Water Quality Improvement Plan submission to EHP.

SUSTAINABILITY IMPLICATIONS

Economic: The contribution of the GBR to the Queensland and Australian economy is estimated to be close to $6 billion a year, generating over 69,000 jobs across the tourism, recreation, commercial fishing, scientific research and management industries.

Environmental: The GBR contains the world's largest collection of coral reefs, with 400 types of coral, 1,500 species of fish and 4,000 types of mollusc (invertebrate animals). The purpose of the draft Plan is to build on the Reef 2050 Long-Term Sustainability Plan, to improve the health of the GBR.

Social: More than one million people live in the GBR catchment, the draft Plan recognises the social and cultural values that rely on a healthy GBR.

CORPORATE/OPERATIONAL PLAN, POLICY REFERENCE

This report has been prepared in accordance with the following:

Corporate Plan 2014-2019 Initiatives:

Theme 4 - Engage, Plan, Partner

4.2.2 - Provide leadership to secure beneficial social, environmental and economic outcomes for the Shire.

4.2.3 - Work with regional, state, national and international stakeholders to promote beneficial partnerships to support strong, resilient and sustainable communities.

Operational Plan 2015-2016 Actions:

COUNCIL'S ROLE

Council can play a number of different roles in certain circumstances and it is important to be clear about which role is appropriate for a specific purpose or circumstance. The implementation of actions will be a collective effort and Council's involvement will vary from information only through to full responsibility for delivery.

The following areas outline where Council has a clear responsibility to act:

Advocate	Supporting communities and groups by advocating for certain actions from other organisations (usually other levels of government)

CONSULTATION

Internal: Consultation has taken place within the Sustainable Communities Team.

External: EHP

COMMUNITY ENGAGEMENT

This is an EHP led engagement activity, EHP is providing the opportunity for wider public comment via its website.

ATTACHMENTS

1. Reef 2050 Water Quality Improvement Plan 2017-2022 **[5.5.1]**
2. 2017 Scientific Consensus Statement **[5.5.2]**
3. Douglas Survey - Reef 2050 Water Quality Improvement Plan **[5.5.3]**

Australian Government

Queensland Government

Reef 2050 Water Quality Improvement Plan

2017-2022

Aboriginal and Torres Strait Islander peoples are the Traditional Owners of the Great Barrier Reef area and have a continuing connection to their land and sea country.

Foreword

The Great Barrier Reef is precious to all Australians as well as to citizens across the globe who recognise its scale, beauty and biodiversity. For Australia's Traditional Owners, it is an integral part of their culture and identity. The Reef's economic social value, and its value as an iconic global asset is estimated at $56 billion. It supports 64,000 jobs and contributes $6.4 billion annually to the Australian economy.[1]

Scientific evidence shows the reef is under threat from a range of sources, including climate change, causing coral bleaching and more severe cyclones. This means that now more than ever it is important to reduce the pressures on the Reef and poor water quality is chief among them. Sediments, nutrients and pesticides flowing to the Reef through our waterways affect the health of the coral and seagrass habitats, making the Reef less able to withstand or recover from events like the coral bleaching we have witnessed over the past two years.

This new Reef 2050 Water Quality Improvement Plan 2017-2022 builds on almost 15 years of efforts by governments at all levels working in partnership with landholders, natural resource managers, industry, research and conservation groups. Much has already been achieved by landholders and the community to change and improve their practices to protect the Reef.

The Australian and Queensland governments have committed over $2 billion over the next ten years to protecting the Reef, with an unprecedented level of investment into improving water quality.

We can still do more. We must accelerate our collective efforts to improve the land use practices of everyone living and working in the catchments adjacent to the Reef. A step change is needed. The Reef 2050 Water Quality Improvement Plan now directly aligns with our Great Barrier Reef 2050 Long-Term Sustainability Plan. It has expanded its scope and now addresses all land-based sources of water pollution, including from urban, industrial and public lands. It now recognises the importance of people in creating change and includes our social, cultural and economic values. Targets for improving water quality have been set for the catchments flowing to the Reef, for the six regions and for the whole Reef.

It is imperative that we continue to work in partnerships to achieve the targets set in this Plan. This means governments working together. It means land managers working together—whether they be farmers, residents, industry or public authorities. Through our partnerships, we can all improve the water quality flowing onto the Great Barrier Reef. In this way, we help ensure the Reef is more resilient to the effects of climate change and will remain a site of economic, social and natural resource value into the foreseeable future.

Hon Dr Steven Miles MP
Minister for Environment and Heritage Protection and Minister for National Parks and the Great Barrier Reef

Hon Josh Frydenberg MP
Minister for the Environment and Energy

[1] Deloitte Access Economics 2017. At what price? The economic, social and icon value of the Great Barrier Reef

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Summary

The UNESCO World Heritage listed Great Barrier Reef is a place of superlative natural beauty, valued by its Traditional Owners along with all Australians and the international community. One of the biggest threats to the health of the Reef is climate change, which causes coral bleaching and more severe cyclones. Improving the quality of the water flowing from the land to the Reef is critical for the Reef's health and therefore its ability to withstand and recover from climate change events.

The new five-year Reef 2050 Water Quality Improvement Plan (the plan) now aligns with the Australian and Queensland governments' Great Barrier Reef 2050 Long-Term Sustainability Plan (Reef 2050), agreed in 2015. In particular, it seeks to improve the water quality flowing from the catchments adjacent to the Reef. The plan builds on previous water quality plans developed in 2003, 2009 and 2013 by:

- including all sources of land-based water pollution: agriculture, industry, urban and public lands, while recognising that the majority of water pollution still arises from agricultural activities
- incorporating the human dimensions of change: our social, cultural and economic values and how they drive our adoption of actions to improve water quality
- setting individual targets for reducing water pollution from the catchments, enabling better prioritising where the most management action is needed.

The plan is based on the best available independent scientific advice, as provided by Scientific Consensus Statement 2017. The multidisciplinary team responsible for this Statement found that key Great Barrier Reef ecosystems continue to be in poor condition. This is largely due to the collective impact of land run-off associated with past and ongoing catchment development, coastal development activities, extreme weather events and climate change impacts such as the 2016 and 2017 coral bleaching events. The scientists agreed that current initiatives would not meet water quality targets and that on-ground changes in practices need to be accelerated and supported.

Partnerships across all sectors at all levels continue to be the key to success in reaching water quality targets. This includes governments working together and working with agricultural, industry, conservation, community and natural resource management stakeholders.

The plan recognises that governments and stakeholders have made significant achievements in improving the water quality reaching the Reef. Most of these achievements have been realised through partnerships. The Smartcane and Grazing Best Management Practice programs are examples of strong partnerships that improve the productivity, profitability and sustainability of farm enterprises. However, more needs to be done to expand adoption of these practices.

The outcome of the Reef 2050 Water Quality Improvement Plan is '**Reef water quality supports the outstanding universal value of the Great Barrier Reef, builds resilience, improves ecosystem health, and benefits communities**.'

Our scientific understanding of Reef water quality issues has been improved by research setting new water quality targets for reducing nutrients and sediments in waterways. The new targets define the reductions needed for each of the catchments by 2025. This is a new level of specificity from the

Reef 2050 Long-Term Sustainability Plan targets that commit to achieving reductions of up to 80% in dissolved inorganic nitrogen and 50% in sediments (refer Appendix 2 & 3). Sophisticated water quality modelling and other scientific information have been used to ensure that these targets are based on what the Reef needs to be healthy.

The Reef 2050 Water Quality Improvement Plan is implemented using an adaptive management approach where actions are regularly monitored to see how well they are working. In this way, our actions can be continuously adapted and improved. This approach recognises the importance of applying scientific evidence to management responses.

The Reef 2050 Water Quality Improvement Plan meets the water quality challenge by:

- applying minimum practice standards across all industries and land uses
- supporting industries and communities to build a culture of innovation and stewardship that takes them beyond minimum standards
- restoring catchments through works to improve or repair riparian vegetation, streambanks, gullies, waterways and wetlands.

Reef 2050 Water Quality Improvement Plan 2017-2022

In 2015, the Australian and Queensland governments released the Reef 2050 Long-Term Sustainability Plan (Reef 2050). Reef 2050 has seven themes (ecosystem health, biodiversity, heritage, water quality, community benefits, economic benefits and governance) for managing the Great Barrier Reef World Heritage Area.

The Reef 2050 Water Quality Improvement Plan 2017-2022 (the plan) is a nested plan under the water quality theme of Reef 2050. It is a joint commitment of the Australian and Queensland governments to address all land-based run-off flowing from the catchments adjacent to the Great Barrier Reef.

The plan contributes to delivering a net benefit for the Reef ecosystem and the social, cultural, environmental and economic values it provides (see Figure 2 on page 8-9).

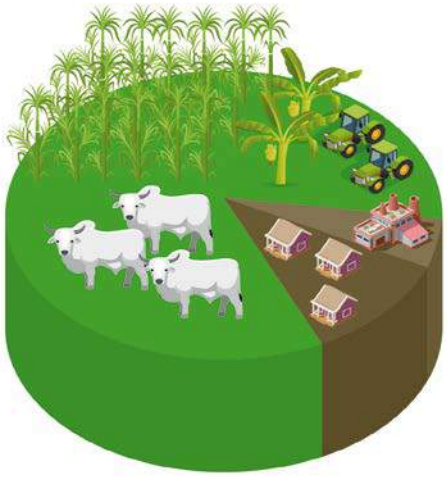
The plan sets the strategic priorities for the whole Reef catchment. The regional Water Quality Improvement Plans, developed by regional natural resource management bodies, support the plan in providing locally relevant information and guiding local priority actions within regions.

The plan links to environmental, social, cultural and economic values

The Reef Water Quality Protection Plan was originally released in 2003 and was updated in 2009 and 2013 (see Appendix 1 for a history timeline).

The name has now changed to Reef 2050 Water Quality Improvement Plan. This reflects its alignment with Reef 2050, which uses a holistic approach to address pressures on the Reef. For the first time, the plan addresses all land-based sources of water pollution, expanding to include urban, industrial and public lands. While the main sources of water pollution from the Reef catchments continue to be from agriculture, the plan recognises that urban and industrial areas can create concentrated pollution that has important local impacts (see Figure 1).

Figure 1. Sources of water pollution to the Reef



The plan now also includes consideration of the human dimension: our social, cultural and economic values that drive our adoption of actions to improve water quality.

The plan sets targets for reducing water pollution at the catchment, regional and whole-of-Reef scale, which means actions can be prioritised by catchments.

Balkanu supported to improve water quality affecting tidal wetlands

The Australian Government is supporting Balkanu Cape York Development Corporation and their partnership with James Cook University to improve Great Barrier Reef water quality by reducing impacts to tidal wetland habitats in Princess Charlotte Bay, located at the base of Cape York Peninsula.

The Mangrove Watch Eastern Normanby Basin project directly engages Traditional Owners in tidal wetland assessments, and to undertake systems repair activities that improve the quality of water entering the Great Barrier Reef. Impacts from agricultural, urban and industrial areas are addressed through direct action to protect and restore vegetation, contain and manage weeds and targeted control of pest animal species.

The project also contributes to scientific understanding of tidal wetland systems in Northern Australia to address ongoing and emerging natural resource management issues that threaten the health and resilience of the Great Barrier Reef.

Water quality critical to Reef's survival in the face of climate change

The Great Barrier Reef—of value for all people, but under threat

Australia is the custodian of the Great Barrier Reef, which is included in the UNESCO World Heritage list for being one of the most remarkable places on earth. It is a place of superlative natural beauty with unique habitats rich in biodiversity.

Aboriginal and Torres Strait Islander peoples are the First Australians and the Traditional Owners of the land and sea. Traditional Owners have cared for and used the natural resources of this land and sea country for thousands of years. Their heritage lives on through their practices, use of resources and their knowledge, which is expressed through their traditional lore, cultural and identity. The water quality and management of our waterways and the Great Barrier Reef has direct impacts on the traditional use of land and sea country resources for Traditional Owners.

The Reef is under increasing pressure from the cumulative effects of climate change, land-based run-off of sediments and pollutants, increasing coastal development and direct use from tourism, fishing and shipping. These pressures affect the health of the Reef and its ability to recover after disturbances such as cyclones or coral bleaching.

When water flowing from land catchments into the Reef carries significant amounts of sediment and pollutants, this damages the Reef directly and adversely affects its ability to recover from disturbances.

We all need to engage in conversations, cooperation, partnerships and consultation to better manage and monitor the land and sea country. This in turn will help on-ground delivery to improve water quality outcomes for the Great Barrier Reef.

Everyone has a role to play in managing the land in Reef catchments and improving the quality of water entering the Great Barrier Reef.

The Great Barrier Reef receives run-off from 35 major catchments, from Cape York in the north to the Burnett Mary in the south, an area larger than the size of Japan. Grazing is the dominant agricultural land use (77%), particularly in the Burdekin and Fitzroy regions. Sugarcane (1.4%) and horticultural crops (0.2%) occur on the coastal floodplains where there is high rainfall and/or irrigation. Grain crops and irrigated cotton occur in inland areas of the Fitzroy region.

Tackling both climate change and water quality is vital for Reef's future

The 2014 Great Barrier Reef Outlook Report identified climate change as the biggest threat to the Great Barrier Reef. Climate change resulting from the build-up of carbon pollution is affecting our weather pattern (increasing intensity of cyclones and storms), increasing sea temperatures resulting in bleaching, and rising sea levels. Also, oceans are absorbing more carbon from the air making it more acidic. More acidic oceans affects the ability of marine animals, including corals, to form skeletons or shells. These changes are affecting coastal, estuarine and marine ecosystems the world over.

In 2017, mass coral bleaching occurred on the Great Barrier Reef for the second consecutive year, caused in large part by higher than normal ocean temperatures. We need to reduce our greenhouse gas emissions to help address this primary threat to the Great Barrier Reef.

The Australian and Queensland governments are committed to responding to the climate change challenge. Under the 2015 United Nations Framework Convention on Climate Change's Paris Agreement, Australia will reduce its emissions by 26–28% of 2005 levels by 2030.

The Australian Government is implementing its National Climate Resilience and Adaptation Strategy and continues to invest in the Emissions Reduction Fund, which supports businesses and households to take direct action to reduce their emissions. In 2017, the Australian Government commenced a review of its climate change policies to make sure they were effective in achieving our international commitments. The Emissions Reduction Fund is also funding vegetation management activities in Reef catchments, which will store carbon in the land and, in some cases, benefit Reef water quality.

In July 2017, the Queensland Government released its climate change response comprising two complementary strategies - the *Queensland Climate Transition Strategy* and *Queensland Climate Adaptation Strategy*. These strategies set a vision for a zero net emission economy by 2050 and an innovative and resilient Queensland that addresses the risks and harnesses the opportunities of a changing climate.

There are considerable ongoing efforts by all governments and sectors of our community to reduce the impacts of climate change. But we also need to maintain our focus on dealing with the other significant threats to the Reef, such as water pollution, so that we have the best chance of helping the Reef adapt to and recover from the impacts of climate change.

Water quality pollution is also a major threat to the Reef. The Scientific Consensus Statement 2017 concludes that the greatest water quality risks to the Reef are from water containing too much nitrogen and fine sediment running off in our waterways from the land to the Reef. Other pollution such as pesticides, plastics and other toxicants also impact the Reef and its biodiversity.

Too much nitrogen in Reef waters is associated with crown-of-thorns starfish outbreaks. Crown-of-thorns starfish are a natural part of the reef ecosystem but when their numbers are boosted as a result of too much nitrogen, they can eat the coral too fast for it to recover. Excess nitrogen can also cause algae blooms, which block light to seagrass and corals. Fine sediment reduces the light available to the seagrass and coral reefs, affecting their growth and health. Pesticides affect the health of animals and plants in our freshwater ecosystems as well as some inshore and coastal habitats. Plastics directly harm iconic species like dugongs, turtles and seabirds as plastics do not break down after being ingested.

Improved water quality will build the resilience of the Reef and give it the best chance to recover from the current and future impacts of climate change.

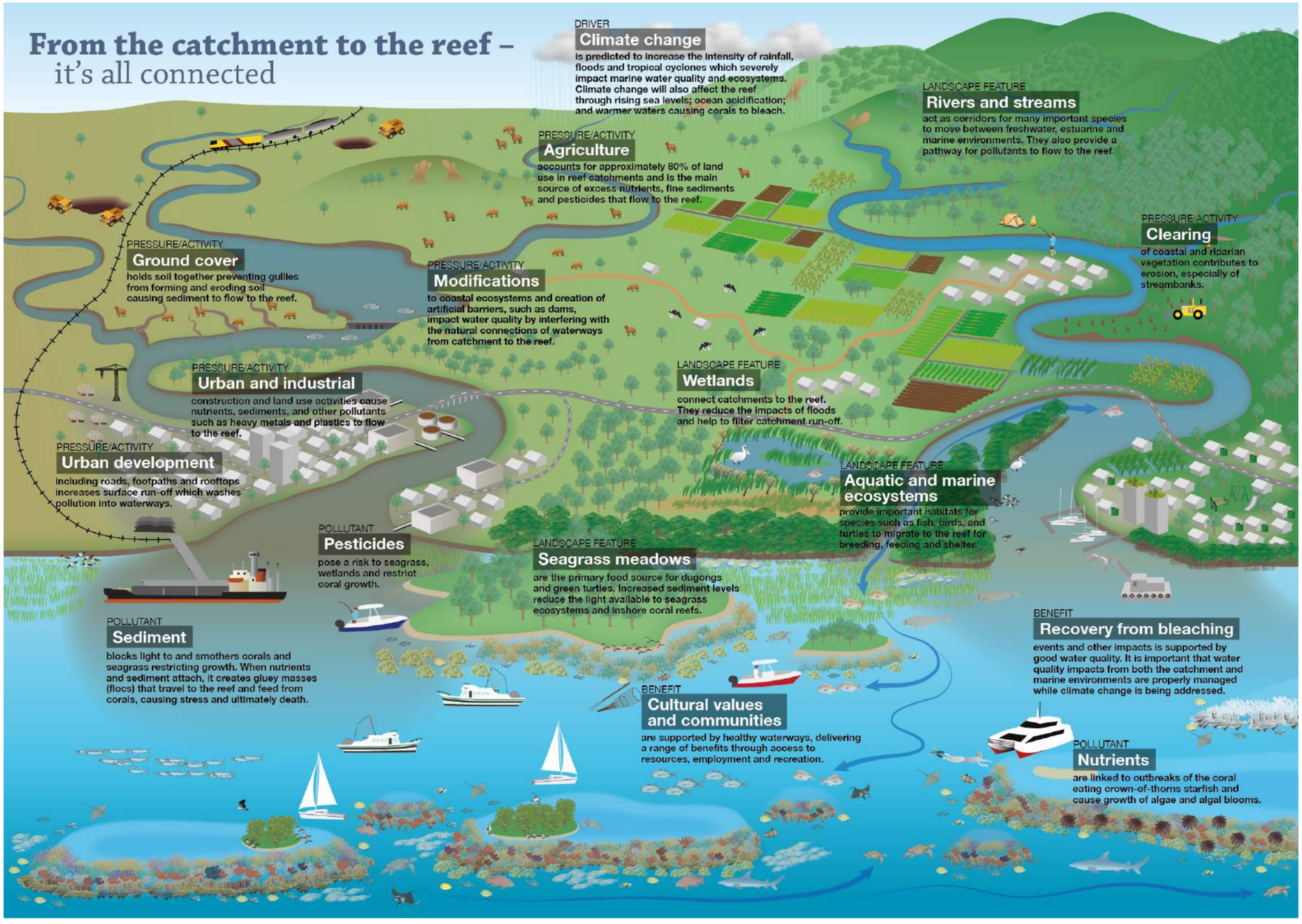
Climate change makes the task of improving the water quality in our rivers, streams, wetlands and estuaries even more challenging. More extreme weather events such as floods, droughts and cyclones means there is also more potential for soil to erode from the land and streambanks into our waterways. More rainfall means an increased amount of water and pollutants washing into the rivers and out to the Reef. All of this means it is much harder for us to manage our land and remain productive in a more extreme environment.

Our successful implementation of the Reef 2050 Water Quality Improvement Plan 2017-2022 will assist the Reef's resilience while the world works to address climate change. The primary aim of the plan is to improve water quality to improve Reef health. However, actions to improve water quality can also help to mitigate climate change impacts. For example, restoring and protecting the vegetation along waterways or in wetlands reduces run-off and erosion into rivers and streams and increases the amount of carbon stored in the landscape.

Since the first Reef Water Quality Protection Plan was released in 2003, actions to improve the water quality in our waterways have substantially increased.

Scientists agree that improving water quality improves the resilience of the Reef to the pressures from climate change by reducing the recovery time after catastrophic events such as cyclones and coral bleaching and increasing the tolerance of species to rapid fluctuations in water temperature.

Figure 2. The connections between the catchments and the Reef



Reef 2050 Water Quality Improvement Plan 2017-2022 builds on a decade of achievements

Government, industry, agriculture and community investment in improving the water quality leaving Reef catchments is reducing pollution of our waterways. This is a result of land managers changing the way they use the land, including farmers leading innovative management practices.

The momentum is building and needs to continue. Adoption of practices to stop pollution is not widespread or rapid enough. And there is a time lag between these changes happening on land and seeing the results in the marine environment.

This plan builds on our achievements to date (see Figure 3 on page 11).

Industry leads with best management practices

The Smartcane Best Management Practice (BMP) and Grazing BMP programs for farm management are examples of strong partnerships across the agricultural industry, natural resource management bodies, landholders and governments to improve productivity, profitability and sustainability of farm enterprises.

Indigenous Land and Sea Rangers increase participation in environmental management

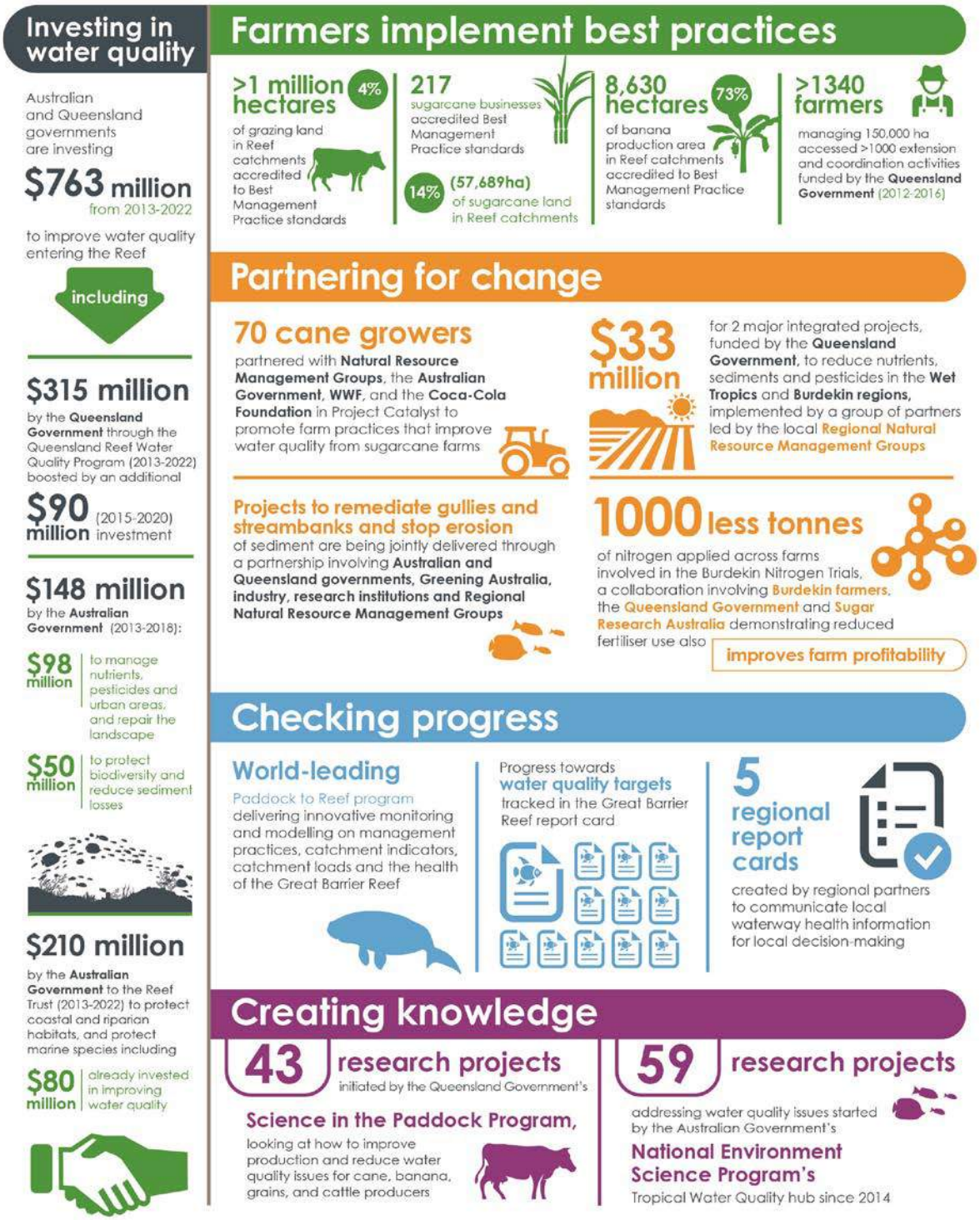
The Queensland Indigenous Land and Sea Ranger program is a successful initiative that cares for land and sea country and increases Indigenous participation in environmental management. It is a unique community ranger program that funds local community host organisations to employ rangers who develop a sense of ownership and worth by undertaking on-country projects.

Yuku Baja Mulika rangers look after country for water quality benefits

Yuku-Baja-Muliku Land Owner and Reserves Limited in Cape York established the Yuku Baja Mulika (YBM) Ranger Program in 2008. Rangers undertake a wide range of activities including weed and feral animal control, fire management, wetland and land restoration, erosion mitigation, water quality monitoring, wildlife management and recovery, community education and visitor management. These activities have direct water quality benefits and also help prevent wildfires, reduce carbon emissions, and maintain biodiversity.

YBM rangers currently undertake water quality and sediment monitoring in partnership with South Cape York Catchments and private consultancies. Water quality monitoring using diodes is done in Oakey Creek and the Annan River, and sediment level monitoring using transects is carried out from Endeavour River to Boulder Reef. YBM rangers are continuously building their capabilities through training and negotiating additional water quality monitoring sites on country through existing partnerships.

Figure 3. The plan builds on our collective achievements in improving water quality



Plan builds on ongoing evaluation of water quality programs

The Reef 2050 Water Quality Improvement Plan 2017-2022 responds to the government's ongoing commitment to and evaluation of water quality programs.

Office of the Great Barrier Reef established to coordinate Queensland's Reef efforts

In 2015, funding for Reef water quality was fragmented and needed more accountability for expenditure on programs and activities. In response, the Office of the Great Barrier Reef was established to coordinate Queensland's Reef management strategies and programs. Additionally, the Queensland Reef Water Quality Program was established within the Office of the Great Barrier Reef to coordinate the annual funding to implement Reef 2050 and the funding over five years to implement the Great Barrier Reef Water Science Taskforce recommendations.

Great Barrier Reef Water Science Taskforce provides best advice possible

In 2015, the Queensland Government convened the Great Barrier Reef Water Science Taskforce to provide advice on the best possible approach to achieving the water quality targets. The Taskforce evaluated water quality programs and produced a report in 2016 recommending a mix of policy, regulation and investment to accelerate progress towards Reef water quality targets. The Taskforce particularly noted that existing initiatives are not bringing about rapid or widespread enough changes to water quality to achieve the targets. The Taskforce's recommendations were accepted in-principle by the Queensland Government and are incorporated into this plan and its actions.

Australian Government's Reef Trust making a difference

In 2016, Reef Trust was audited to assess the effectiveness of the program design and implementation. The audit found that the Reef Trust was largely effective and had incorporated the lessons learned from previous Reef programs. To assess the progress of Reef Trust, and its effectiveness and efficiency in delivering outcomes, a mid-term evaluation will be undertaken in 2017-2018.

Testing the logic to achieve action

A program logic process brought together science, government and stakeholder knowledge to identify how our actions will lead to desired water quality outcomes. This process also identified where new knowledge was needed to create change.

Principles, Partnerships and best available science

Plan guided by agreed principles

The plan is guided by the following principles:

Human dimension: Understand what motivates people to engage in water quality actions to implement this plan more effectively.

Best available science: Base decisions on the full range of knowledge, including scientific understanding and Traditional Owner, stakeholder and community knowledge.

Adaptive management: Identify and respond to any changes to maximise outcomes from water quality actions over time.

Partnerships: Involve all levels of government, industry, business and community by working together to improve water quality.

Innovative: Identify and implement sustainable and innovative best management practices that will deliver substantial decreases to nutrient, sediment and pesticide run-off along with financial benefits to land managers.

Holistic/systems approach: Recognise that actions need to address the connections between land, stream, rivers, estuaries, wetlands and marine environments to protect the whole Reef ecosystem.

Targeted: Identify and prioritise sources of pollution that pose the highest risks from land-based activities to the Reef and identify key priorities and effort to deliver reductions.

Investment: Prioritise investment with the key priorities and ensure that funded actions are effective and cost-efficient.

Plan built on the best available science

The plan is based on the best available science, brought together through a Scientific Consensus Statement written by a group of reputable multidisciplinary scientists. This builds on the body of scientific evidence informing the previous 2003, 2009 and 2013 plans.

The overarching consensus in the Scientific Consensus Statement 2017 is that key Great Barrier Reef ecosystems continue to be in poor condition. This is due to land run-off associated with past and ongoing catchment development, coastal development activities and climate change impacts such as the recent coral bleaching events. Collectively, these pressures impact on water quality and the health of marine and coastal ecosystems.

Current initiatives will not meet water quality targets. To accelerate the change in on-ground management, improvements to program design, delivery and evaluation systems are urgently needed. This will require greater incorporation of governance, social and economic factors; better targeting and prioritisation; exploration of alternative management options and increased support and resources.

Plan relies on partnerships across sectors for success

Partnerships across government, industry, research, Traditional Owners, agriculture, business and community are required to coordinate projects to improve water quality in the Great Barrier Reef and adjacent catchments.

Governments working together

The *Great Barrier Reef Ministerial Forum* of Australian and Queensland government Ministers oversees Reef decision-making. The forum takes advice from government agencies, science experts and stakeholder advisory committees.

The *Executive Steering Committee* coordinates implementation of the plan across the Australian and Queensland governments and the Great Barrier Reef Marine Park Authority.

Reef Guardian Councils (local councils along the Great Barrier Reef coast) have an important role in planning for sustainable population growth, approving environmentally sound developments and preparing the community for climate change impacts.

Working with stakeholders

The *Reef 2050 Advisory Committee* provides advice from representatives of agricultural and industry groups, conservation and community organisations, natural resource management groups, Traditional Owners and local government.

The *Partnership Committee* provides water quality advice from stakeholders and links to management to guide the delivery of the plan.

The *Reef Alliance* is a partnership led by the Queensland Farmers' Federation, which includes members from industry, regional natural resource management bodies and the conservation sector. The alliance works to deliver on-ground actions across Reef catchments against this plan and regional Water Quality Improvement Plans.

Regional partnerships have formed to provide local communities with information on the health of their waterways and to guide implementation of this plan and regional Water Quality Improvement Plans. Current partnerships include the Gladstone Healthy Harbour Partnership, the Mackay Whitsunday Healthy Rivers to Reef Partnership, the Wet Tropics Healthy Waterways Partnership and the Fitzroy Partnership for River Health**.** New partnerships are being formed to cover other Reef regions.

Working with communities

The Great Barrier Reef Marine Park Authority's *Reef Guardian Schools* program creates awareness, understanding and appreciation for the Reef and its connected ecosystems among teachers, students and broader school communities. This fosters stewardship and promotes a community culture of custodianship for Reef protection. Stewardship continues and builds with Landcare groups and other volunteer programs.

Hotspot water quality monitoring in Sandy Creek – RP144C

This project established multiple water quality monitoring sites in Sandy Creek to identify hotspots that are responsible for high levels of pesticides in waterways. The monitoring aimed to show where the problems existed so that growers could make informed decisions about their land management practices. The project was led by the sugar industry from concept development, to sampling design, sample collection and interpretation of results, and planning of management actions to address off-farm losses of pesticides.

The monitoring was primarily conducted by local cane growers that were formally trained by Queensland Government Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) staff. These growers were coordinated by regional industry representative organisations, Farmacist and Mackay Area Productivity Services (MAPS). The strong evidence of the origin and fate of pesticides in samples provided certainty about the impact of particular practices and ownership of the problem and its mitigation.

The leadership shown by the sugar industry and commitment of all participating growers underpins the successes of this project in advancing understanding of the water quality in Sandy Creek. The approach encouraged the growers involved in the project to improve their local waterways by changing their land management practices as they have become aware of the run-off from their paddocks. A further project is now building on this work in Sandy Creek to link farm practice to in-stream water quality and direct extension activities for growers to change practices in sub-catchments where water quality exceeds set guidelines.

Independent scientific advice for adaptive management

The *Reef Water Quality Independent Science Panel* provides scientific advice to inform adaptive management decisions and provides independent oversight of the Great Barrier Reef Report Card and the science underpinning it. The Independent Science Panel provides management advice to the Executive Steering Committee and feeds strategic advice through the Independent Expert Panel to the Great Barrier Reef Ministerial Forum.

A number of working groups have been established to coordinate technical aspects between researchers and managers:

- Paddock to Reef Coordination and Advisory Group
- Research, Development and Innovation Coordination Group
- Sediment Working Group
- Nutrient Use Efficiency Working Group
- Pesticides Working Group
- Human Dimensions Working Group
- Reef Urban Stormwater Management Group.

Reef 2050 Water Quality Improvement Plan 2017-2022: Our desired future

Outcome

The plan focuses on land actions as part of the theme of water quality in Reef 2050. The plan seeks to achieve the water quality outcome that contributes to the protection of the Reef's outstanding universal values (Figure 4).

The plan connects improved water quality with social, cultural, environmental and economic community benefits. The new outcome is:

Reef water quality supports the outstanding universal value of the Great Barrier Reef, builds resilience, improves ecosystem health and benefits communities.

Objectives

The objectives of the plan align with the themes of Reef 2050 and emphasise that good water quality alone will not improve the condition and resilience of the Great Barrier Reef. The plan will contribute to the improved condition of coral, seagrass, wetlands and mangroves and to biodiversity such as dugongs, turtles and fish. Such improvement in ecosystem condition is supported by good water quality through better land management and governance, and an increased culture of stewardship where everyone understands their responsibility to look after the Reef.

Targets

Targets are set for reducing water pollution and managing the land, catchment and human dimensions affecting water quality.

Past water quality improvement plans set whole-of-Reef water quality targets

In 2015, Reef 2050 set ambitious whole-of-Reef targets to be achieved for water quality improvement by 2025 in priority areas, including up to 80% reduction in nitrogen, up to 50% reduction in sediment, at least 20% reduction in particulate nutrients and at least 60% reduction in pesticides.

With each iteration of the Reef Water Quality Protection Plan, water quality targets were revised based on improved scientific knowledge and monitoring and modelling technology. When targets were originally set in 2009, they were based on the best available evidence at the time and designed as ambitious, whole-of-Reef targets. In 2013, an ambitious target for nitrogen was set while targets for sediment and pesticides were based on the estimated load reductions that could be achieved by 2018 through delivery of best management practice systems. A water quality relative risk assessment was undertaken to determine the priority regions for

Catchment water quality targets set to reduce pollutants

The new water quality targets for nutrients and sediments are based on the Great Barrier Reef Marine Park Authority's Reef water quality guidelines and set as end-of-catchment load reductions for the catchments that flow into the Great Barrier Reef (Appendix 3). The catchment targets are combined to provide targets by region (Appendix 2) and for the whole of the Great Barrier Reef

(Figure 4). This differs to past Reef Water Quality Protection Plans, which only set whole-of-Reef targets. It is a new level of specificity from the Reef 2050 targets that commit to achieving reductions of up to 80% in dissolved inorganic nitrogen and 50% in sediments in priority areas. The catchment targets take into account local situations for areas of the reef affected by each river. This will support better targeting and prioritisation of on-ground management and investment.

The targets were set by using a combination of catchment modelling, to estimate reductions from improved land management practices, and eReefs marine water modelling, to calculate how pollutants impact the Reef and ensure that the targets are based on what the Reef needs to be healthy. Expert science advice and technical knowledge complemented the outputs of the modelling.

The pesticide target has been changed to align directly with the outcome of the plan with greater ecological relevance for protecting aquatic ecosystems of the Great Barrier Reef from pesticide risk, and to be compatible with the Australian and New Zealand Water Quality Guidelines. It has been changed from a measurement of annual loads of pesticides transported to the Great Barrier Reef, to a target based on the level of ecosystem protection we want to achieve. That is, we want to ensure that at least 99% of species in the aquatic ecosystems of the Great Barrier Reef are protected from the impacts of all pesticides, which is determined based on pesticide concentrations.

There is insufficient science to set quantitative targets for other pollutants, including plastics, at this time, but the science does show that these other pollutants have local impacts. As the science is refined over time, quantitative measures will be developed.

Increasing the area of land under improved management will benefit water quality

Improving water quality depends on expanding the area of land under improved management. The land management target for agriculture is based on the area of land rather than on the number of farmers. Work will continue to develop quantitative targets for other land uses that are new to the plan, such as urban areas.

Managing the catchments improves water quality

Good ground cover and riparian vegetation help to minimise erosion. Riparian vegetation and healthy wetlands assist with filtering pollutants from the water. Catchment management targets aim to increase ground cover and riparian vegetation and prevent further loss of wetland extent.

The ground cover target continues to focus on grazing lands and late dry season ground cover levels when water quality risk is generally at its greatest with the onset of the wet season. In this plan, the target has been refined to incorporate an area-based component (i.e. 90% of grazing lands will have achieved the target level of ground cover), while still providing for natural variability in ground cover levels. Research still supports a target level of ground cover of 70% to minimise erosion.

The wetlands target has been revised to focus only on wetland extent. The target has changed from ‘no net loss’, to ‘no loss’ of natural wetlands. The condition of Reef wetlands is now captured as an objective of improved water quality and is included under the theme of ecosystem health in Reef 2050.

The riparian vegetation target has not changed from the previous plan and still focuses on extent.

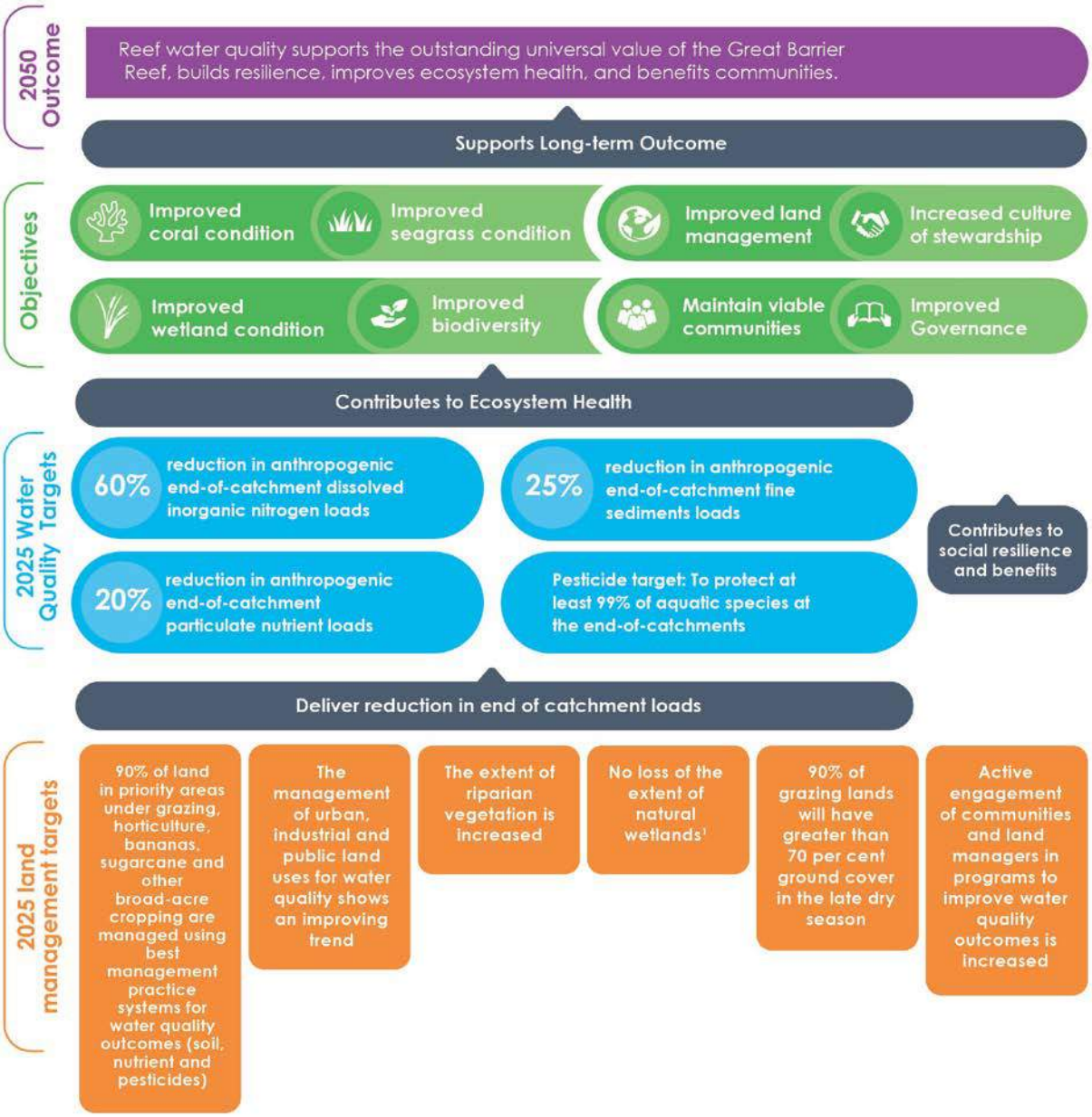
Human factors shape social, economic and environmental outcomes

Human dimensions are defined as the human factors that exist at all social scales (from the individual through to society-wide) and play a role in shaping social, economic, cultural and environmental outcomes associated with the Great Barrier Reef.

People's practices, behaviours, attitudes, relationships and governance have a direct or indirect impact on the quality of water entering the Reef.

The human dimension target is new to the plan and will be refined towards becoming a more quantitative target/s in future plans.

Figure 4. Summary of outcomes, objectives and targets



Best management practices are defined by this Reef 2050 Water Quality Improvement Plan's water quality risk frameworks priority areas as defined in Appendix 3

[1] *Natural wetlands include lakes, swamps and estuarine wetlands.*

Using adaptive management approaches

This plan is built on an adaptive management approach and adopts the outcomes focus of program logic. The outcomes and actions of the plan are captured in two work areas: responding to the challenge and enabling delivery (see Figure 5).

This new approach to the delivery of the plan aligns our actions with outcomes identifying *how* and *why* a desired change is expected to happen in a particular context. Achieving the outcomes will progress us to reaching the 2025 land and catchment targets and water quality targets.

Each section under the work areas identifies upfront the end-of-plan outcome to be achieved and the land and catchment management targets the outcome contributes to. Tables 1 to 3 that support each work area explain the intermediate outcomes, the pathways to the outcomes and the actions to achieve the outcomes. Additionally, how we will measure the success of the actions is identified under measuring impact.

How the actions will be implemented is identified in Appendix 4. The implementation schedule will be developed in consultation with stakeholders and be included in the final plan released later in 2017.

Adaptive management is where management actions are regularly monitored to gain new knowledge about how well these actions are working, so they can be continuously modified and improved.

1. Responding to the challenge includes all our on-ground delivery actions to implement the changes required to make progress towards the targets. This is divided into three simultaneously implemented sections:

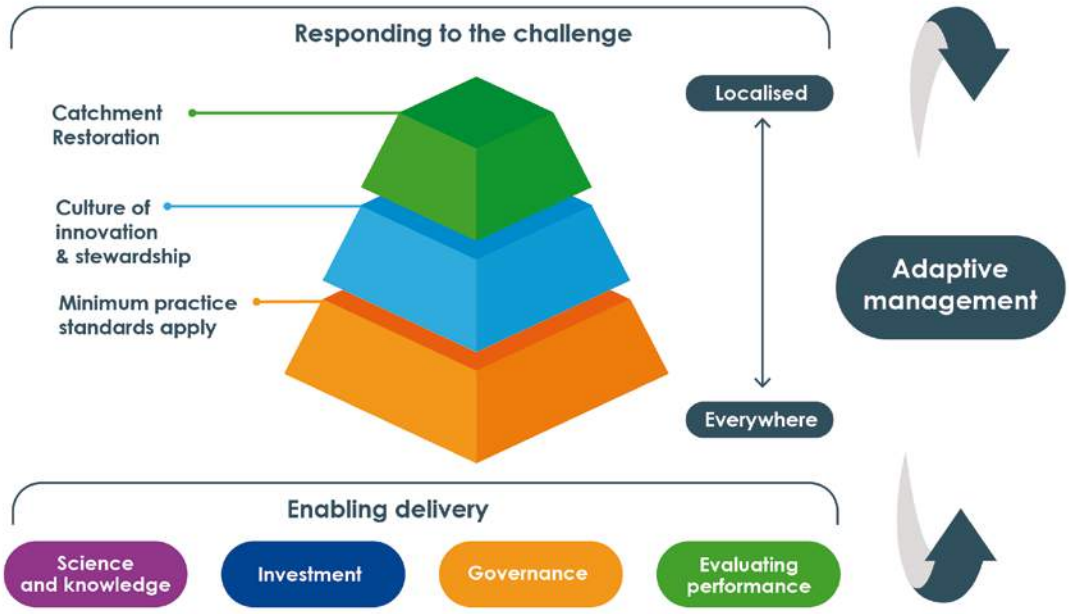
- *Minimum practice standards* will be applied across all industries and land uses. Achieving this will remove the highest risk practices to deliver a step-change in progress towards the water quality targets across all catchments.
- Industries and communities will be supported to build a *culture of innovation and stewardship*. This will build on the improvements to water quality achieved by exceeding minimum practice standards and engage land managers in implementing innovations and best practices to maintain viable communities and further reduce water quality risk.
- *Catchment restoration* will address legacy issues of land development and past practices. Targeted restoration of riparian vegetation, streambanks, gullies, waterways and wetlands is needed to meet the targets, it will also slow the movement of water over land and to the Reef, and improve biodiversity and the natural environment for all to enjoy.

2. Enabling delivery includes the activities that support on-ground delivery, divided into four sections:

- *Science and knowledge* provide a foundation for on-ground responses.
- *Investment* is coordinated, prioritised based on risk to the Reef and supported by local decision-making.

- *Governance* ensures accountability of investments to the actions and outcomes of the plan.
- *Evaluating performance* tracks progress towards the targets and evaluates the effectiveness of our activities to feed into our adaptive management of responding to the challenge.

Figure 5. Responding to the challenge and enabling delivery



Responding to the challenge: Actions to progress towards targets

Minimum practice standards everywhere

Minimum practice standards will be applied across all industries and land uses. All land managers and communities will adhere to minimum practice standards, reducing the risk to water quality. Achieving this will deliver a step-change in progress towards the water quality targets across all catchments.

Table 1. Achieving minimum practice standards

Outcomes	Pathway to outcomes	Actions	Measuring impact
Minimum practice standards are in place for all industries and activities.	Minimum practice standards are set based on reducing risk to water quality.	1.1 Include minimum water quality practice standards for agricultural practices in regulation.	• Measure reduction in water quality risk due to standards • Evaluate standards to ensure continuous improvement
		1.2 Maintain existing standards, regulations and planning frameworks and refine where required as new information improves knowledge for all industries.	
Achieve uptake of the standards.	Build capacity and capability of industry and public land management to uptake standards.	1.3 Encourage land managers and communities to be aware of the standards and their obligations.	• Rate of environmental compliance • Capacity and capability of compliance providers is adequate • Best management practice adoption rates • Ongoing evaluation of extension and education approaches and adaptive management where required
		1.4 Deliver communications, education and best practice guidance to build capability.	
	Industry-led accreditation schemes achieve voluntary uptake of standards.	1.5 Support industry-led best management practice programs to engage farmers in water quality modules.	
		1.6 Support development and implementation of industry-led best management practice programs to engage urban and industrial land managers in water quality improvement.	
	Government compliance programs ensure uptake of standards.	1.7 Support local government capacity and capability to undertake compliance activity.	
		1.8 Deliver targeted environmental regulations compliance and enforcement.	

Ensuring minimum practice standards are applied everywhere will contribute to achieving the following land and catchment management targets:

- 90% of agricultural land managed using best management practice for water quality outcomes
- 90% of grazing lands with greater than 70% ground cover in the late dry season
- increase in riparian vegetation
- no loss of natural wetlands
- improving management of urban, industrial and public land uses.

Culture of innovation and stewardship

Industries and communities will be supported to build a culture of innovation and stewardship through the outcomes and actions identified in Table 2. This will build on the improvements to water quality achieved by exceeding minimum practice standards and engage land managers to participate in implementing innovations and best practices to further reduce water quality risk. A culture of stewardship will result in lasting change and continuous water quality improvement.

Table 2. Supporting a culture of innovation and stewardship

Outcomes	Pathway to outcomes	Actions	Measuring impact
Reef communities and industries are engaged and empowered to improve practices and behaviours beyond minimum standard practice for water quality improvement.	Land managers are informed and acknowledge the benefits of improved practices including economic, productivity and water quality improvement.	2.1 Communicate the benefits of improved practices and water quality outcomes. 2.2 Facilitate local leadership and opportunities through various mechanisms such as peer to peer. 2.3 Build extension and education provider motivation, capacity and capability. 2.4 Support land managers with extension, education and awareness programs to increase capacity for practice change.	• Determine the human dimensions baseline through ongoing project investigations and surveys to understand motivations and barriers • Track change in knowledge, attitudes, skills and aspirations through project and program monitoring and evaluation strategies to measure extent of increase in participation and knowledge
	Barriers to participation and change are reduced or removed.	2.5 Identify and address barriers to change and practice improvement uptake through programs and policy. 2.6 Conduct economic evaluations to inform decisions about tools and to advise programs about land management practices that improve water quality and business profitability. 2.7 Enhance use of decision support tools and databases in on-ground management for water quality. 2.8 Provide incentives to support land managers with	• Collate evidence of barriers being addressed • Tracking change in behaviours to measure the extent of barriers reduced or removed • Measure the enhanced use of decision support tools and databases in on-ground management for water quality

Outcomes	Pathway to outcomes	Actions	Measuring impact
		practice change and further build their capacity.	
		2.9 Trial and implement innovation in technologies for on-ground management, water treatment and monitoring.	
		2.10 Use applied science to test on-ground management practices and implement projects to build on successful trials.	

A culture of innovation and stewardship will contribute to achieving the following land and catchment management targets:

- 90% of agricultural land managed using best management practice for water quality outcomes
- 90% of grazing lands with greater than 70% ground cover in the late dry season
- increase in riparian vegetation
- improving management of urban, industrial and public land uses
- increase in active engagement of communities and land managers in programs to improve water quality.

Catchment restoration

Catchment restoration addresses legacy issues of land development and past practices. Targeted restoration of riparian vegetation, streambanks, gullies, waterways and wetlands is needed to meet the targets, it will also slow the movement of water over land and to the Reef, and improve biodiversity and the natural environment for all to enjoy.

Table 3. Restoring catchments

Outcomes	Pathway to outcomes	Actions	Measuring impact
On-ground interventions are targeted.	Information supports intervention locations and methods.	3.1 Map gullies, soil and land types, land uses, water courses and at-risk streambanks.	• Collated information has improved decision-making for future interventions.
		3.2 Use guidelines and other decision support tools to design and inform interventions.	
	Innovative on-ground approaches are used to continuously improve catchment repair for water quality improvement and other ecosystem benefits.	3.3 Trial and implement innovation in catchment repair.	Relates to on-ground delivery: • Were the interventions effective? What outcomes did they provide? • Were the tools/ science and knowledge used in investment programs?
		3.4 Deliver catchment restoration projects including riparian revegetation, gully repair, streambank stabilisation and coastal wetlands rehabilitation.	
		3.5 Modify existing urban area stormwater management and rehabilitate urban waterways.	
On-ground organisations, land managers, Indigenous groups and voluntary stewardship groups implement catchment restoration.	Strong and collaborative partnerships are developed to deliver on-ground catchment repair interventions.	3.6 Partner with voluntary stewardship groups, Traditional Owner groups, Indigenous Land and Sea Rangers and other organisations to deliver catchment repair projects.	• Was investment coordinated and aligned? What leverage was achieved? • Evaluate collaboration and engagement through projects and initiatives and what co-benefits were achieved • Evaluate partnerships formed and outcomes achieved
		3.7 Support the development of ground up, multi-stakeholder programs for the delivery of catchment repair projects.	
		3.8 Identify on-ground leaders and assist them in the establishment of partnerships and collaborations.	

Restoring catchments contributes to achieving the following land and catchment management targets:

- increase in riparian vegetation
- improving management of urban, industrial and public land uses
- increase in active engagement of communities and land managers in programs to improve water quality.

Enabling delivery

Science and knowledge drive the implementation of the plan

The best available science, along with management, Traditional and community knowledge, drives our decision-making and informs on-ground actions to meet water quality improvement outcomes. Building on the Scientific Consensus Statement, this section is the cornerstone of the plan.

Table 4. Applying the best available science and knowledge

Outcomes	Pathway to outcomes	Actions	Measuring impact
Science and knowledge is utilised to fill gaps and inform improvement in on-ground action at local, regional and whole-of-Reef scale.	Research and knowledge generation are collaborative and targeted at addressing on-ground delivery knowledge gaps.	4.1 Identify and prioritise knowledge gaps through the Reef 2050 Water Quality Improvement Plan Research, Development and Innovation Strategy.	• Knowledge gaps identified are filled
		4.2 Capture, analyse and publish on-ground practice management knowledge and expertise to complement Scientific Consensus Statement 2017.	• Reef 2050 Water Quality Improvement Plan Science Synthesis workshop utilised to scope and evaluate on-ground practice management knowledge and expertise synthesis • On-ground practice management knowledge used to inform Scientific Consensus Statement
		4.3 Integrate forms of knowledge including science, policy, management, Traditional Owner and community through regular synthesis workshops and theme-specific working groups.	• Synthesis workshops regularly held and include stakeholders representing the forms of knowledge • Knowledge from working groups is integrated into projects and programs
Science and new knowledge are accessible and used to support policy, programs and practical on-ground management to improve water quality outcomes.	Science and knowledge are made available through a range of platforms.	4.4 Deliver science and knowledge communication and education products tailored to specific audiences.	• Communication strategies are evaluated to ensure that new science and knowledge is accessible and used
		4.5 Develop decision support tools for use in education, awareness and extension programs.	• Decision support tools and education, awareness and extension programs complement one another
		4.6 Improve data integration and access and increase useability.	• Project and program data is made accessible to decision-makers and the public

The science and knowledge work area focuses on identifying, prioritising and filling knowledge gaps to continuously improve our understanding of Reef water quality issues so that decision-making and on-ground action are based on the best available science.

Our existing knowledge base, built from an extensive amount of science and research, on-ground work, modelling and monitoring, will be drawn on to prioritise interventions and to ensure the greatest possible efforts are made to achieve the targets of the plan.

Science and knowledge inform investment in Reef activities and track the success of the plan through monitoring and evaluation. We use the best available science and knowledge to adaptively protect and manage the Great Barrier Reef.

Coordinated investment delivers water quality outcomes

Investment is prioritised, aligned and coordinated across all investment streams to deliver water quality improvements.

Table 5. Coordinating and prioritising investment

Outcomes	Pathway to outcomes	Actions	Measuring impact
Water quality activities are boosted beyond government funding.	Investment sources are expanded and diversified.	5.1 Identify opportunities for innovative financing mechanisms.	• Innovative finance mechanisms are being utilised to support further investment
Coordination and alignment of resources, funding and skills across all sources is improved to maximise co-benefits.	All sources of investment and new investment opportunities are identified.	5.2 Identify opportunities for co-investment or alignment of funds and resources with industry, research organisations, philanthropists, natural resource management groups, community and corporate organisations to achieve water quality objectives.	
Investment is prioritised to ensure interventions are effective and cost-efficient and delivery mechanisms are appropriate.	Decision support tool are used to prioritise investment locations, time frames and interventions.	5.3 Prioritise investment across Reef catchments according to the catchment management priorities and targets in Appendix 3 and using modelling scenarios, decision support tools and local and regionally developed plans.	• Investment has been prioritised across projects and programs and communicated to stakeholders
	A mix of investment mechanisms is used to achieve cost efficiencies.	5.4 Identify the benefits and appropriate applications of different investment mechanisms.	• The mix of investment mechanisms used within projects and programs is cost-efficient
		5.5 Trial innovative investment delivery mechanisms.	

Good governance supports responsive decision-making and accountability

Governance results in decision-making at appropriate levels and ensures accountability of investments with plan outcomes.

Table 6. Governance to support decision-making and accountability

Outcomes	Pathway to outcomes	Actions	Measuring impact
Governance arrangements are progressively and continuously adapted, improving coordination between partners and structures at all levels.	Roles, responsibilities and accountabilities within the governance framework are clear, defined and agreed.	6.1 Collaborate and coordinate between the Queensland and Australian governments using the Executive Steering Committee.	• Executive Steering Committee meetings held regularly and attended by representatives to ensure collaboration and coordination
		6.2 Ensure accountability of investment delivery and outcomes through annual reporting.	• Annual investment reporting conducted across programs
		6.3 Align research programs with the Reef 2050 Water Quality Improvement Plan Research, Development and Innovation Strategy through the Research, Development and Innovation Coordination Group.	
	There is alignment between policy, regulatory mechanisms, on-ground delivery and funding strategies.	6.4 Deliver a program plan for the Queensland Reef Water Quality Program supported by annual investment plans aligned to plan outcomes.	• Annual evaluation report provided on the program
		6.5 Deliver phased investment strategies for Reef Trust addressing critical areas for investment and aligned to plan outcomes.	• Annual evaluation report provided on the program
	Partnerships guide local delivery and implementation of plan outcomes.	6.6 Include local organisations, communities and Traditional Owners in decision-making and priority setting.	• Stakeholders have influenced partnership approaches

Monitoring and evaluating performance supports progress towards targets

Monitoring and evaluation supports adaptive management by assessing progress towards 2025 targets and the effectiveness of interventions.

Table 7. Monitoring progress towards targets

Outcomes	Pathway to outcomes	Actions	Measuring impact
Progress towards plan targets is assessed.	Fit-for-purpose data and information are collected and analysed annually.	7.1 Monitor and model management practice and water quality improvements through the Paddock to Reef program.	• Reef 2050 Water Quality Improvement Plan 2017-2022 Report Card
Effectiveness and efficiency of program and project design is analysed and the lessons are understood.	Program and project effectiveness information is consolidated to guide program and project delivery.	7.2 Assess management of all industries through stewardship and management practice frameworks.	• Regional Reef Report Cards and Reef 2050 Water Quality Improvement Plan 2017-2022 Report Card
		7.3 Assess the water quality and human dimensions outcomes of projects consistently within a program evaluation framework.	• Program evaluation framework
		7.4 Evaluate the effectiveness of governance adaptations and improvements.	• Annual governance benchmarking across Australian Government, Great Barrier Reef Marine Park Authority and Queensland Government • Projects and programs evaluate governance mechanisms
Program and project designs are modified to build on lessons learned from implementation.	Relevant data and information are made available to inform managers and decision-makers.	7.5 Report progress towards targets, objectives and outcomes.	• Reef 2050 Water Quality Improvement Plan 2017-2022 Report Card
		7.6 Communicate regionally relevant information for management decisions and local communities.	• Reef 2050 Water Quality Improvement Plan 2017-2022 Report Card and regional Water Quality Improvement Plans
		7.7 Make data more publicly available.	• RIMREP website operational and used
		7.8 Communicate data and information through a range of visual and creative products.	• RIMREP website, eReefs operational and used

Appendix 1: History of the Reef 2050 Water Quality Improvement Plan 2017-2022

2001 The Great Barrier Reef Ministerial Council accepted a report by the Great Barrier Reef Management Authority on the decline in water quality in the Great Barrier Reef and the importance and urgency in addressing the issue.

2002 An independent panel of experts prepared *A report on the study of land-sourced pollutants and their impacts on water quality in and adjacent to the Great Barrier Reef*.

2002 The Productivity Commission examined and evaluated a number of policy options to address the declining quality of water entering the Reef.

2003 The Reef Water Quality Protection Plan was released for public consultation. Following this consultation, the plan was revised and endorsed by the Great Barrier Reef Ministerial Council.

2005 An audit of the Reef Water Quality Protection Plan was conducted by Howard Partners Pty Ltd and the report formed the basis of *Report to the Prime Minister and the Premier of Queensland—Implementation of the Reef Water Quality Protection Plan Progress to date, challenges and future directions*.

2007 A Reef Water Quality Partnership was established between regional natural resource management organisations and the Australian and Queensland governments to enable coordinated, scientifically robust and collaborative target setting, monitoring and reporting arrangements.

2008 A task force of scientists advised what scientific advances had been made in understanding Reef water quality issues in *Scientific Consensus Statement on water quality in the Great Barrier Reef* and said that current management interventions were not effectively solving the problem.

2008 A Reefocus Summit was held to seek stakeholder views on an updated Reef Water Quality Protection Plan.

2009 The Reef Water Quality Protection Plan 2009 was endorsed by the Australian and Queensland governments.

2010 An audit of the Reef Water Quality Protection Plan was conducted by Lloyd Consulting, which showed that progress on actions was positive.

2011 The first Report Card was released, setting the 2009 baseline against which progress would be measured.

2013 Report Card 2010 was released, showing good progress towards targets.

2013 The Scientific Consensus Statement was updated by leading scientists with the latest information to inform future management.

2013 Release of Report Card 2011, showing continued positive progress towards targets.

2013 The Reef Water Quality Protection Plan 2013 was endorsed by the Australian and Queensland governments.

2014 Release of Report Card 2012 and 2013, showing that positive trends in land management practice change are translating into reductions of key pollutants.

2015 The Reef 2050 Long-Term Sustainability Plan was launched by the Australian and Queensland governments, articulating an overarching framework to protecting the outstanding universal value of the Great Barrier Reef including additional actions on water quality.

2015 Report Card 2014 was launched, showing that landholders are continuing to help protect the Great Barrier Reef by reducing pollutant loads entering the Reef.

2016 The Great Barrier Reef Water Science Taskforce handed down its final report, advising the Queensland Government on how to achieve ambitious water quality targets.

2016 Reef Report Card 2015 was launched with some real positives, but also some areas where we need to focus more effort.

2017 The first time water quality end-of-catchment loads targets are set for the catchments flowing to the Great Barrier Reef.

2017 The Scientific Consensus Statement was updated and expanded to include all land-based sources of water quality impacts to the Reef.

2017 A program logic framework was developed to inform the development of the outcomes focused Reef 2050 Water Quality Improvement Plan 2017-2022.

2017 The draft Reef 2050 Water Quality Improvement Plan 2017-2022 was released for public consultation.

Appendix 2: Regional water quality targets to meet catchment targets by 2025

The catchment (also known as river basin) targets in Appendix 3 have been aggregated to give regional targets for each of the natural resource management regions and the overall targets for the Great Barrier Reef.

The pesticide target remains the same at the catchment, regional and Great Barrier Reef scale: to protect at least 99% of aquatic species at the end of catchments.

Table 8. Regional water quality targets to meet catchment targets by 2025

NRM region	Dissolved inorganic nitrogen		Fine sediment		Particulate nutrients			
					Particulate phosphorus		Particulate nitrogen	
	%	tonnes	%	kilotonnes	%	tonnes	%	tonnes
Cape York	0	0	5	23	5	14	5	48
Wet Tropics	60	1700	25	240	30	360	25	850
Burdekin	60	820	30	890	25	490	25	800
Mackay Whitsunday	70	630	20	130	20	150	20	310
Fitzroy	0	0	25	410	20	430	15	760
Burnett Mary	55	470	20	240	20	210	20	590

Appendix 3: Water quality targets for the Great Barrier Reef catchments by 2025

The end-of-catchment water quality targets are expressed as percentage reductions of anthropogenic loads required by 2025. The corresponding tonnage (or kilotonnes for fine sediment) reduction required to meet the target is also provided. The targets are calculated from the 2013 anthropogenic baseline to reflect previously reported water quality pollutant reductions from 2009 to 2013.

Some catchments with the same percentage target will therefore have different tonnage reductions. Catchments with a zero target have minimal anthropogenic pollutant loads. The aim is to maintain current water quality so that there are no increases in pollutant loads.

The water quality targets are calculated against the Great Barrier Reef Marine Park water quality guidelines which apply uniformly across the Reef. Reporting using percentage means the annual reductions can be tracked over time, even though baselines are updated as knowledge improves.

Targets were not able to be set for all parameters for the Black and Ross rivers as there was insufficient data available to be used in the technical and modelling work. As further data becomes available, these targets can be set in the future.

In parallel to the development of the end of catchment water quality targets, catchment scale management priorities have been identified. The relative spatial priorities for water quality improvement in the Great Barrier Reef catchments are based on the Scientific Consensus Statement assessment of relative risk which assesses the likelihood of ecosystem exposure to anthropogenic pollutants from each river. For example, rivers in the Wet Tropics region influence the area of the Reef where crown-of-thorns starfish impact and therefore are a higher priority for nitrogen reduction.

Note, that this is a result of the biophysical assessment only; results for particulate nutrients have been extrapolated from the fine sediment assessment and are not considered independently. To determine *within* catchment priorities, social and economic factors need to be considered.

Table 9 shows the water quality targets for each catchment with the relative priority for water quality improvement shaded as follows:

	Very high
	High
	Moderate
	Low
	Minimal
	Not assessed

Table 9. End-of-catchment anthropogenic water quality targets for the Great Barrier Reef catchments by 2025 and relative priorities for water quality improvement (t= tonnes; ND= not determined)

NRM region	Catchment/ Basin	Area (ha)	Dissolved inorganic nitrogen target		Fine sediment target		Particulate phosphorus target		Particulate nitrogen target		Pesticide (priority only)
			%	t	%	kilo-t	%	t	%	t	
Cape York	Jacky Jacky Creek	296,330	0	0	0	0	0	0	0	0	
	Olive Pascoe River	417,950	0	0	0	0	0	0	0	0	
	Lockhart River	288,330	0	0	2	1	2	2	2	5	
	Stewart River	274,280	0	0	6	2	6	2	6	7	
	Normanby River	2,439,490	0	0	10	15	10	5	10	15	
	Jeannie River	363,750	0	0	6	2	6	2	6	9	
	Endeavour River	218,240	0	0	10	3	10	3	10	11	
Wet Tropics	Daintree River	210,670	0	0	0	0	0	0	0	0	
	Mossman River	47,240	50	52	0	0	0	0	0	0	
	Barron River	218,880	60	52	0	0	0	0	0	0	
	Mulgrave-Russell River	194,400	70	300	10	16	10	19	10	53	
	Johnstone River	232,390	70	350	40	100	40	250	40	490	
	Tully River	168,350	50	190	20	17	20	23	20	68	
	Murray River	110,840	50	120	20	8	20	11	20	32	
	Herbert River	984,590	70	620	30	99	30	57	30	200	
Burdekin	Black River	105,970	ND	ND	ND	ND	ND	ND	ND	ND	
	Ross River	170,820	60	74	ND	ND	ND	ND	ND	ND	
	Haughton River	405,080	70	640	0	0	0	0	0	0	
	Burdekin River	10,310,940	60	100	30	840	30	440	30	720	
	Don River	373,620	0	0	30	55	30	43	30	75	
Mackay Whitsunday	Proserpine River	249,440	70	110	0	0	0	0	0	0	
	O'Connell River	238,760	70	130	40	96	40	120	40	250	
	Pioneer River	157,360	70	140	20	35	20	23	20	61	
	Plane Creek	253,870	70	260	0	0	0	0	0	0	
Fitzroy	Styx River	301,340	0	0	0	0	0	0	0	0	
	Shoalwater Creek	360,180	0	0	0	0	0	0	0	0	
	Waterpark Creek	183,650	0	0	0	0	0	0	0	0	
	Fitzroy River	14,254,470	0	0	30	390	30	380	30	640	
	Calliope River	224,060	0	0	30	15	30	54	30	107	
	Boyne River	249,630	0	0	40	6	40	5	40	9	
Burnett Mary	Baffle Creek	408,470	50	16	20	11	20	15	20	33	
	Kolan River	290,450	50	34	20	6	20	5	20	14	
	Burnett River	3,319,540	70	150	20	85	20	29	20	68	
	Burrum River	337,170	50	93	20	3	20	3	20	8	
	Mary River	946,580	50	180	20	130	20	160	20	470	

Appendix 4: Implementation schedule

To be developed for final plan.

2017 Scientific Consensus Statement

LAND USE IMPACTS ON GREAT BARRIER REEF WATER QUALITY AND ECOSYSTEM CONDITION

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This document was prepared by a panel of scientists with expertise in Great Barrier Reef water quality. This document does not represent government policy.

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Contents

1. Introduction

The 2017 Scientific Consensus Statement reviews and adds to the scientific knowledge of water quality issues in the Great Barrier Reef from the 2013 statement. It draws heavily on the regional water quality improvement plans and supporting studies, specific research and monitoring results as well as published science to date related to ecological processes operating in the Great Barrier Reef.

This Scientific Consensus Statement applies a risk management framework based on the ISO 31000 (AS/NZS, 2004) shown in Figure 1.

Chapter 1 describes Great Barrier Reef marine and coastal aquatic ecosystem status and condition, identifies the primary drivers, pressures and threats to these systems and the known effects of land-based pollutants based on understanding derived through monitoring and modelling (Schaffelke et al., 2017).

Chapter 2 describes the sources of pollutants, considered as the hazards to Great Barrier Reef ecosystems (Bartley et al., 2017).

Chapter 3 applies the risk assessment components of the framework by evaluating the likelihood, consequences and quantified risk to the Great Barrier Reef coastal aquatic and marine ecosystems, particularly from different nutrient species, suspended sediment (including different size fractions) and pesticides (Waterhouse et al., 2017).

Chapter 4 considers management of the risks (Eberhard et al., 2017).

Chapter 5 presents an overall synthesis and draws on the previous chapters to present a management prioritisation and discussion on management implications of the new knowledge (Waterhouse et al., 2017). It also identifies uncertainties and where there remain differences in the interpretation of the scientific evidence (identified in Chapters 1 to 4).

The scope of the 2017 Scientific Consensus Statement was expanded from 2013 to include additional sections to align with the water quality theme of the Reef 2050 Long-Term Sustainability Plan (Reef 2050 Plan). It covers all land-based pollutant sources including urban diffuse, point source and industrial discharge. The Reef 2050 Plan water quality theme has an additional focus on improving water quality from all sectors including marine-based impacts, such as from dredging, which remain outside the scope of the Reef 2050 Water Quality Improvement Plan 2017-2022 (previously the Reef Water Quality Protection Plan).

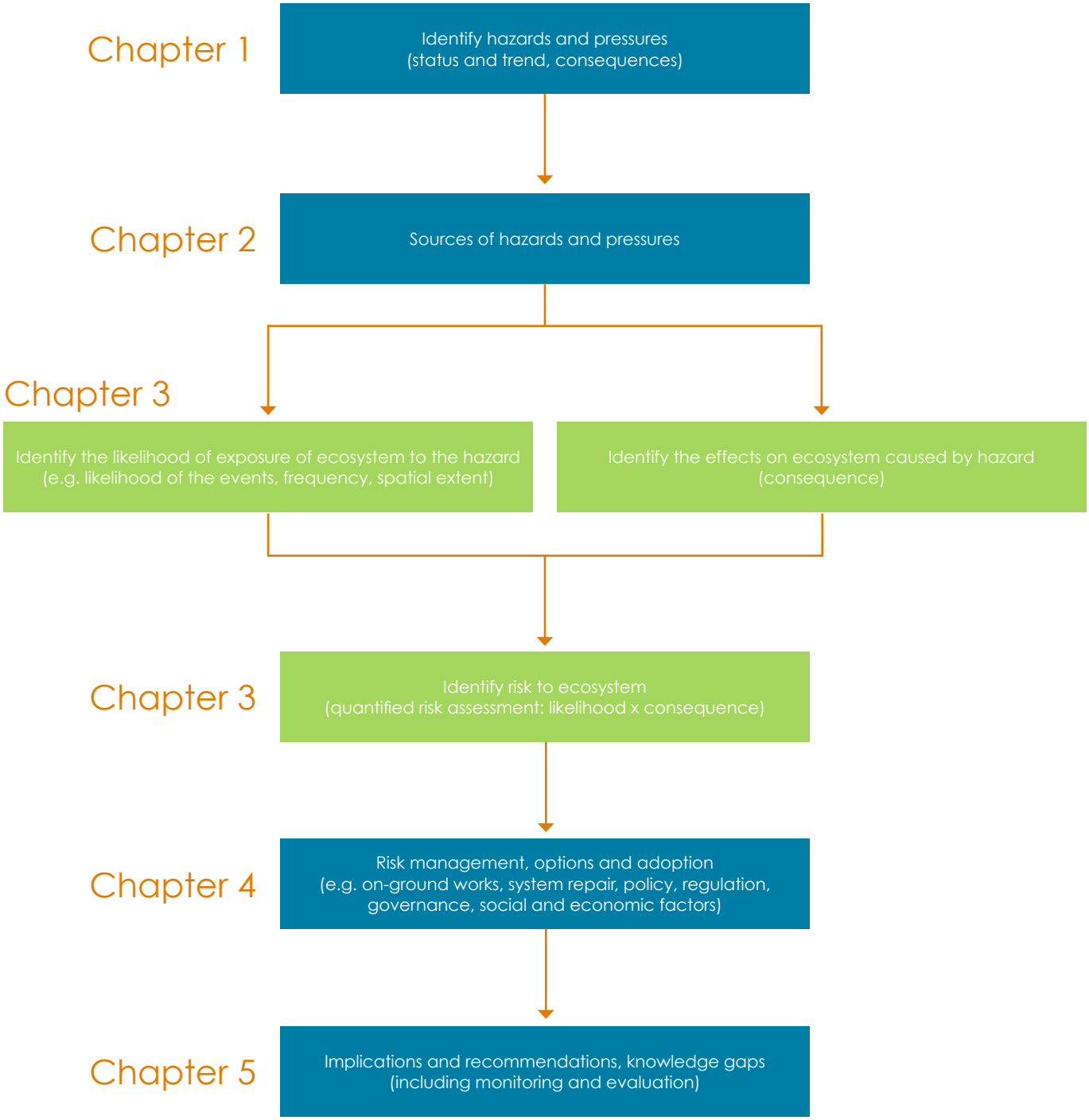
While all land-based pollutant sources have been considered as part of this Scientific Consensus Statement, the emphasis is on the agricultural diffuse sources of pollutants as the dominant contributor of land-based pollutant loads at a regional and Great Barrier Reef-wide scale. Evidence about the effectiveness of water quality management in the Great Barrier Reef reflects the focus on agricultural industries. Chapter 4 highlights there is little direct Great Barrier Reef evidence about the effectiveness of urban water quality management, wetland and treatment systems, and the social, economic and governance literature in this chapter deals almost exclusively with agricultural practice change.

The Reef 2050 Plan also links the ecosystem health theme to the water quality targets under the actions of protecting and restoring, reducing impacts and monitoring and reporting. Accordingly, new sections have been added to the Scientific Consensus Statement to cover coastal aquatic ecosystems in terms of status and water quality impacts, relative risk and management options. For some aspects of these new sections, where there is limited specific knowledge for the Great Barrier Reef, it has been necessary to draw on national and international literature. These aspects are highlighted as knowledge gaps in Chapter 5.

The primary ecosystems considered include coastal wetlands and floodplains, estuaries, marine waters and benthic marine ecosystems with a focus on coral reefs and seagrass. The geographic scope is extended to include reference to the Torres Strait and Hervey Bay. Information is reported at the scale of the six natural resource management regions, 35 main catchments and additional management units in the Burdekin and Fitzroy natural resource management regions (see Figure 2).

The primary source of information in the 2017 Scientific Consensus Statement is published, publicly available information that has undergone a peer review process.

Figure 1: Risk management framework adopted for the 2017 Scientific Consensus Statement showing how each chapter maps into the framework. Derived from AS/NZS (2004).



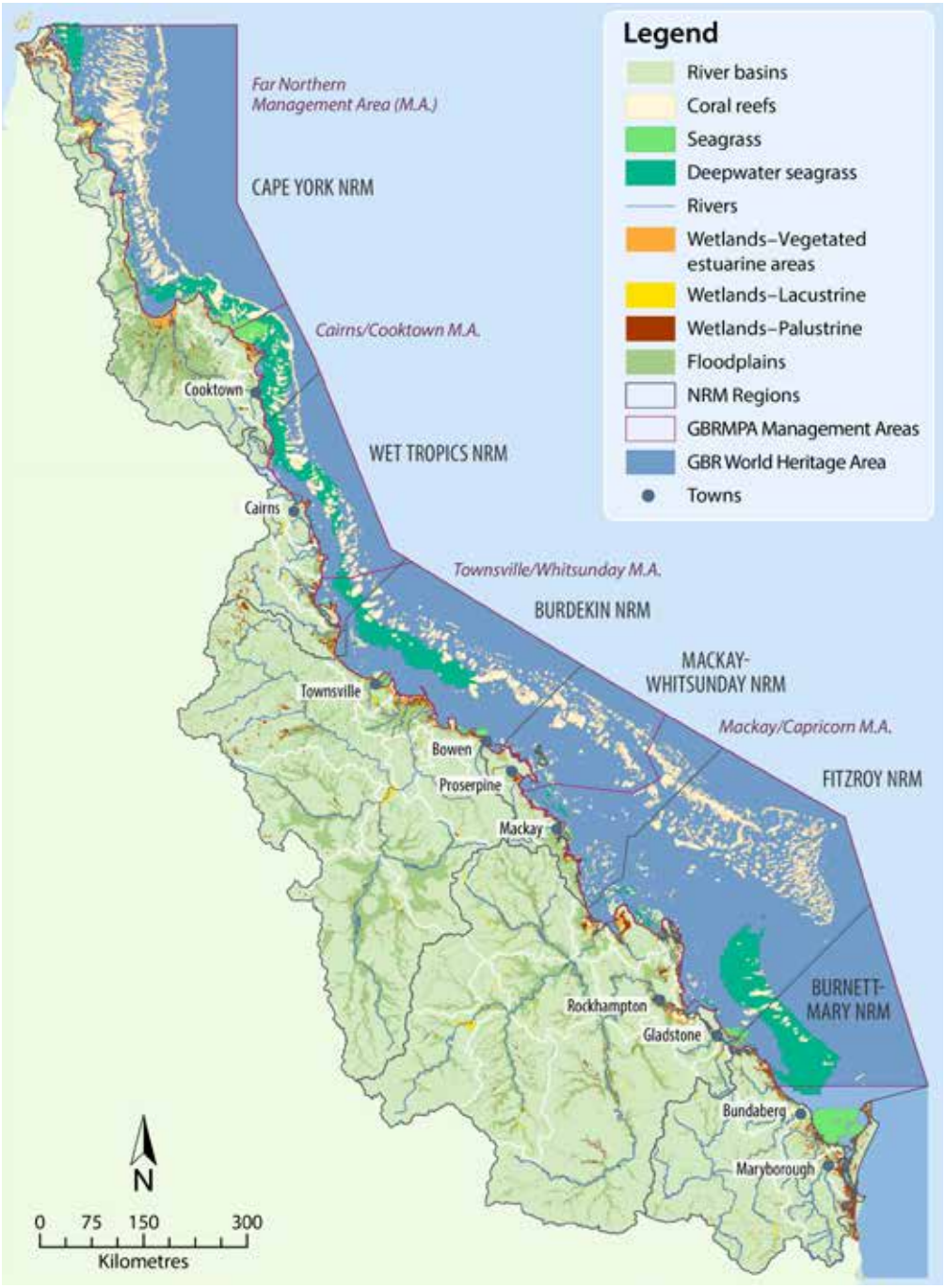
2. Background

The Reef 2050 Water Quality Improvement Plan 2017-2022 is a joint commitment of the Australian and Queensland governments. The plan is a collaborative program of coordinated projects and partnerships designed to improve the quality of water flowing to the Great Barrier Reef. The 2017 Scientific Consensus Statement is a foundational document which provides the scientific understanding underpinning the design and implementation of the Reef 2050 Water Quality Improvement Plan.

The Scientific Consensus Statement has been prepared by a panel of scientists with expertise in Great Barrier Reef water quality science and management. They have reviewed and synthesised the significant advances in scientific knowledge of water quality issues in the Great Barrier Reef from the 2013 Scientific Consensus Statement. The evidence reviewed is summarised in the next section.

In parallel to the update of the Scientific Consensus Statement in 2017, new catchment-based pollutant load reduction targets were developed for the Reef 2050 Water Quality Improvement Plan (Brodie et al., 2017).

Figure 2: Map of the marine natural resource management (NRM) boundaries, coastal aquatic and marine habitats, NRM regions and catchment boundaries included in the 2017 Scientific Consensus Statement. Map prepared by D. Tracey, James Cook University.



3. Scientific Consensus in 2017

This report provides the 2017 Scientific Consensus Statement for the Great Barrier Reef – a review of the *significant advances* in scientific knowledge of water quality issues in the Great Barrier Reef to arrive at a consensus on the current understanding of the system. The consensus statement was produced by a multidisciplinary group of scientists, with oversight from the Reef Independent Science Panel, and supports the development of the Reef 2050 Water Quality Improvement Plan 2017-2022.

The overarching consensus is:

> ***Key Great Barrier Reef ecosystems continue to be in poor condition. This is largely due to the collective impact of land run-off associated with past and ongoing catchment development, coastal development activities, extreme weather events and climate change impacts such as the 2016 and 2017 coral bleaching events.***
>
> ***Current initiatives will not meet the water quality targets. To accelerate the change in on-ground management, improvements to governance, program design, delivery and evaluation systems are urgently needed. This will require greater incorporation of social and economic factors, better targeting and prioritisation, exploration of alternative management options and increased support and resources.***

The evidence base supporting this consensus is provided in a series of four supporting chapters. The main conclusions were:

1. The decline of marine water quality associated with land-based run-off from the adjacent catchments is a major cause of the current poor state of many of the coastal and marine ecosystems of the Great Barrier Reef. Water quality improvement has an important role in ecosystem resilience.
2. The main source of the primary pollutants (nutrients, fine sediments and pesticides) from Great Barrier Reef catchments is diffuse source pollution from agriculture. These pollutants pose a risk to Great Barrier Reef coastal and marine ecosystems.
3. Progress towards the water quality targets has been slow and the present trajectory suggests these targets will not be met.
4. Greater effort to improve water quality is urgently required to progress substantial pollutant reductions using an expanded scope of tailored and innovative solutions. Climate change adaptation and mitigation, cumulative impact assessment for major projects and better policy coordination are also required to protect the Great Barrier Reef.
5. There is an urgent need for greater investment in voluntary practice change programs, the use of regulatory tools and other policy mechanisms to accelerate the adoption of practice change, and robust monitoring and evaluation programs to measure the rate and effectiveness of adoption.
6. Strengthened and more effective coordination of Australian and Queensland government policies and programs, further collaboration with farmers and other stakeholders, and strong evaluation systems are critical to the success of Great Barrier Reef water quality initiatives.
7. Priorities for reducing pollutant loads are now established at a catchment scale, based on the exposure of coastal and marine ecosystems to land-based pollutants, and should be used to guide investment.
8. A greater focus on experimentation, prioritisation and evaluation at different scales, coupled with the use of modelling and other approaches to understand future scenarios, could further improve water quality programs.

4. Independent Science Panel remarks

The Independent Science Panel (the panel) was established in 2009 to provide multidisciplinary scientific advice to the Australian and Queensland governments on the implemention of the Reef Water Quality Protection Plan. In this role, the panel has reviewed the 2013 and 2017 Scientific Consensus Statements.

After reviewing the 2017 Scientific Consensus Statement, the panel agreed:

1. **There has been significant progress since the 2013 Scientific Consensus Statement in understanding sediment, nutrient and pesticide delivery from Great Barrier Reef catchments and their mitigation through improved land management practices.** The new eReefs biogeochemical model tracks sediments and nutrients in the marine environment and connects the impact of these pollutants to water clarity and indicators of ecosystem health. The increased capability of terrestrial and marine models to evaluate processes in the catchments and receiving waters must be supported by additional investment in the in-situ monitoring of coastal water quality. This monitoring will also benefit regional report cards partnerships.
2. **The cumulative effects of multiple pressures substantially reduce the health and resilience of the Great Barrier Reef** including the combined impacts of extreme weather events, climate change and historical developments. In the past four years, a fourth outbreak of crown-of-thorns starfish occurred, originating from reefs impacted by river flows from the Wet Tropics region. In addition, unusually warm sea temperatures in the northern Great Barrier Reef resulted in widespread coral bleaching in 2016 and 2017. However, later low rainfall and run-off has shown the ability of seagrass ecosystems to recover from the acute impacts of run-off. Reducing land-based pollution will improve the resilience of the marine ecosystems to cope with a changing climate.
3. **The robust risk-based approach to land-based pollutants implemented in the 2017 Scientific Consensus Statement represents an improvement** of the risk assessment in the 2013 Scientific Consensus Statement and has allowed high risk pollutants and catchments to be identified. The panel notes that point sources (e.g. urban, industrial and ports) and other pollutants (e.g. marine debris/microplastics, antifouling paint components and personal care products) are included in the 2017 Scientific Consensus Statement, but require more information to understand the level of risk. The panel reaffirms the focus of the Reef Water Quality Protection Plan 2013 and updated plan on diffuse pollution from agricultural sources.
4. **The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program catchment models include more robust estimates of the effectiveness of improved land management practices** as defined by the water quality risk frameworks. The rates of adoption have slowed after a period of early uptake, challenging expectations of meeting the water quality targets entirely from voluntary reforms. In addition to continuous improvement and innovation, the panel believes that transformational change will be required to reach the targets.
5. **Further consideration of economic and social dimensions is needed** in the development and implementation of programs to improve reef water quality.
6. **There is a need for a mechanism of ongoing evaluation of the reef water quality program to inform future program design** because regionally specific feedback on design and delivery can be available before it is published and/or fully evaluated by the consensus process. Future scientific consensus statements could elevate the economic and human dimensions of program design and better communicate the achievement of outcomes for improved reef water quality.
7. **Coordination and collaboration** across all sectors (particularly among levels of government responsible for managing development pressures) is needed **to reduce land-based impacts** on inshore marine water quality. It is clear that the health of the Great Barrier Reef and its catchment ecosystems are linked and need to be improved together. This will require appropriate risk assessments in the planning of all future developments in Great Barrier Reef catchments.
8. **The 2017 Scientific Consensus Statement is currently the best and most authoritative source of information to support evidence-based decisions for better water quality within the Great Barrier Reef World Heritage Area. The panel supports the general findings, conclusions and recommendations of the updated statement.**

5. Summary of evidence to support the 2017 Scientific Consensus Statement

Condition of coastal and marine ecosystems

The decline of marine water quality associated with land-based run-off from the adjacent catchments is a major cause of the current poor state of many of the Great Barrier Reef coastal and marine ecosystems. Additionally, coastal ecosystems have been highly modified and continue to be exposed to a range of pressures from catchment development. The resilience of marine ecosystems was indicated by their ability to at least partially recover from previous losses during periods of low disturbance and reduced catchment pollutant loads. The systems have been severely impacted by a number of recent events—including prolonged periods of extreme sea surface temperatures, tropical cyclones and the progression of the fourth wave of crown-of-thorns starfish population outbreaks. Climate change is predicted to increase the frequency of large-scale bleaching events and the intensity of extreme weather events.

Summary of evidence

- The Great Barrier Reef marine ecosystems and their associated catchments are part of a dynamic, interconnected system. The condition of all parts of the system, including the catchment, is important for the long-term health of the Great Barrier Reef. Each part has its own inherent ecosystem and biodiversity values and provides ecosystem services such as water quality improvement and carbon storage that benefit the receiving marine environment.
- Coastal freshwater wetlands continue to be affected by a range of chronic and acute pressures such as excess nutrient, sediment and pesticide loads; loss of connectivity; changes in hydrology and invasive species.
- Poor marine water quality associated with pollutant run-off from the adjacent catchments, especially during major floods, affects the condition of many of the key marine ecosystems of the Great Barrier Reef.
- Inshore seagrass meadows and coral reefs continue to recover from previous losses due to major run-off events and cyclones, but remain in moderate to poor condition.
- Periods of reduced catchment run-off associated with low rainfall demonstrate the inherent ability of inshore reef communities to recover from acute disturbances. This provides a strong case for reducing the pollutant loads being delivered to the Great Barrier Reef.
- Mid-shelf and outer shelf reefs in the southern half of the Great Barrier Reef have shown the capacity to rapidly recover from previous disturbances; however, a severe mass thermal coral bleaching event in 2016 resulted in significant coral mortality, especially north of Port Douglas.
- Ongoing, warmer-than-average sea temperatures resulted in a further widespread mass coral bleaching event in 2017 which was most intense on reefs between Cairns and Townsville. In addition, a severe Tropical Cyclone Debbie affected reefs in the Mackay Whitsunday region and subsequent flooding also affected the Fitzroy region. Impacts of these events have yet to be quantified.
- Climate change is predicted to increase the intensity of extreme weather events, which are significant in driving impacts to coastal and marine ecosystems.

Recommendations

- **Implement measures to better anticipate and respond to future changes including climate change, coastal urban growth, and agricultural expansion and intensification. This will require: (a) developing a coherent climate adaptation strategy for the Great Barrier Reef catchments; (b) modified water quality planning and delivery approaches; (c) strategies to manage unforeseen impacts of future land use change (e.g. coastal development or land retirement) including offsets or strict conditioning; (d) future scenario modelling; and (e) better standards for cumulative impact assessment including climate scenarios for environmental impact assessment of development proposals in the Great Barrier Reef catchments.**
- Undertake urgent action to maintain and improve the resilience of the coastal and marine ecosystems of the Great Barrier Reef through implementing more intensive management of catchment water quality and other local pressures, active landscape protection and restoration approaches to maintain as many biodiversity and ecosystem functions as possible, and more effective global climate change mitigation measures. A stronger knowledge base about the role of extreme events and a changing climate on end-of-catchment pollutant loads is essential for developing achievable water quality targets.
- Implement a more holistic and coordinated approach to managing wetlands (including rivers) and floodplains and their connections to the Great Barrier Reef by embedding the protection of catchment, estuary and floodplain functions and connectivity in Great Barrier Reef policy. This should also include increased efforts to understand how multiple and cumulative environmental pressures (including water quality) affect recovery processes, to help refine predictions of future condition and resilience of coastal and marine ecosystems.

Risk to coastal and marine ecosystems

The greatest water quality risks to the Great Barrier Reef and coastal ecosystems are from discharges of: (a) nutrients, which are an additional stress factor for many coral species, promote crown-of-thorns starfish population outbreaks with destructive effects on mid-shelf and offshore coral reefs, and promote macroalgal growth; (b) fine sediments, which reduce the light available to seagrass ecosystems and inshore coral reefs; and (c) pesticides, which pose a toxicity risk to freshwater ecosystems and some inshore and coastal habitats.

Summary of evidence

A combination of qualitative and semi-quantitative assessments were used to estimate the relative risk of water quality pollutants to Great Barrier Reef coastal aquatic and marine ecosystem health.

- Increased loads of fine sediments, nutrients (nitrogen and phosphorus) and pesticides were all found to be important at different scales and different locations in the Great Barrier Reef. However, the risks differ between the individual pollutants, source catchments and distance from the coast.
- Exposure to fine sediment is most significant for areas with shallow seagrass and coral reefs on the inner shelf adjacent to basins with high anthropogenic fine sediment loads. The greatest coral reef and seagrass exposure to fine sediment is from the Burdekin, Fitzroy, Mary, Herbert, Johnstone and Burnett catchment areas. The Burdekin and Fitzroy catchments also contribute the greatest fine sediment risk to seagrass ecosystems.
- Exposure to dissolved inorganic nitrogen is most significant for all inner shelf areas and the mid-shelf area between Lizard Island and Townsville adjacent to catchments with high anthropogenic dissolved inorganic nitrogen loads. The relative importance of dissolved inorganic nitrogen to seagrass ecosystems is still uncertain, but it may influence light availability for deep water seagrass in areas deeper than 10 to 15 metres due to increased phytoplankton growth.
- The greatest coral reef and seagrass exposure to dissolved inorganic nitrogen is from the Herbert, Haughton, Johnstone, Mulgrave-Russell, Tully, Plane and Murray catchment areas. The Herbert, Johnstone, Mulgrave-Russell and Tully also contribute the greatest dissolved inorganic nitrogen risk to coral reefs and primary crown-of-thorns starfish outbreaks. Anthropogenic particulate nitrogen is also likely to be of some importance in the same catchment areas, as well as the Fitzroy; however, our knowledge on the bioavailability of particulate nitrogen to the marine ecosystems in relation to that of dissolved inorganic nitrogen is limited.
- Anthropogenic phosphorus loads are considerable from many catchment areas. Knowledge of the relative importance of nitrogen and phosphorus is limited, but nitrogen is considered to be the limiting nutrient and, hence, more important in any form than phosphorus.
- Pesticides pose the greatest risk to ecosystems closest to the source of the pesticides; i.e. freshwater wetlands, rivers and estuaries; followed by coastal ecosystems, seagrass and coral. Catchments within the Mackay Whitsunday region and the Lower Burdekin present a very high to moderate risk to end-of-catchment ecosystems from pesticides, with diuron presenting the highest risk.
- Marine plastic pollution was found to be the highest priority among emerging pollutants. This is particularly an issue in the Cape York region due to exposure to oceanic and local shipping sources. Additionally, chronic contamination of water and sediments with antifouling paints, and exposure to certain personal care products, has been assessed as a risk in regions south of Cape York. All other emerging contaminants were assessed as relatively low risk, with some minor differences between regions.

Recommendation

- Use the Great Barrier Reef catchment-specific pollutant load reduction targets to guide actions to minimise water quality risks to the Great Barrier Reef.

Image: © Tourism and Events Queensland

Sources of land-based pollutants

The main source of excess nutrients, fine sediments and pesticides from Great Barrier Reef catchments is diffuse source pollution from agriculture. Other land uses, including urban areas, contribute relatively small but concentrated pollutant loads, which may be important at local scales.

Summary of evidence

- Water discharged from the catchments into the Great Barrier Reef lagoon continues to be of poor quality in many locations. Knowledge of the major sources and processes contributing to these river pollutant loads has significantly improved due to better modelling and monitoring.
- Sugarcane areas are the largest contributors of dissolved inorganic nitrogen and pesticides, while grazing contributes the largest proportion of sediment and particulate nutrients to the Great Barrier Reef primarily through sub-surface (gully, streambank and rill) erosion. Contributions from other land uses, including urban, are relatively minor in comparison to agriculture but can be important locally.
- At the regional scale, the Wet Tropics, Burdekin and Fitzroy regions contribute most of these river pollutant loads. However, at the catchment scale, areas within the Mackay Whitsunday and Burnett Mary regions are also important contributors, illustrating the value of identifying management priorities at the catchment or finer scale.
- Catchment modelling shows that mean-annual fine sediment, nutrient and pesticide loads delivered to the Great Barrier Reef lagoon have increased substantially since pre-development conditions. They include an: approximate 5.0 fold increase in fine sediment for the entire Great Barrier Reef catchment (range 3.0 to 8.0 fold depending on the region); approximate 2.0 fold increase in dissolved inorganic nitrogen (range 1.2 to 6.0 fold, with the exception of Cape York); approximate 1.5 fold increase in particulate nitrogen (range 1.2 to 2.2 fold) and approximate 2.9 fold increase in particulate phosphorus (range 1.2 to 5.3 fold).
- The mean-annual loads of prevalent pesticides (ametryn, atrazine, diuron, hexazinone, tebuthiuron and simazine) are estimated (modelled) to be around 12,000kg per year across the Great Barrier Reef. The measured pesticide data suggests that most pesticides are found in all regions, even though some are in very small quantities. The catchments that contribute the most pollutants have remained reasonably consistent over the past 10 years.
- Expansion of agriculture in the Great Barrier Reef catchments (e.g. under the Northern Australia Development Plan), major development projects and anticipated growth in coastal populations adjacent to the Great Barrier Reef will increase pollutant loads delivered to the Great Barrier Reef.

Recommendation

- **Continue to prioritise agricultural sources of pollutants in Great Barrier Reef catchment management. Information on the pollutant contributions from non-agricultural sources (e.g. urban, industrial and ports) and other pollutants should be compiled as a priority to support whole-of-catchment management approaches**.

Progress to targets

Progress towards the Reef Water Quality Protection Plan 2013 targets has been slow and the present trajectory will not meet the targets. This puts the Outstanding Universal Value of the Great Barrier Reef under increasing pressure, especially in the context of other pressures such as climate change. Greater effort to improve reef water quality is urgently required to restore and protect the Great Barrier Reef ecosystems.

Summary of evidence

- The Reef Water Quality Protection Plan 2013 included land and catchment management targets to address improved agricultural management practices and the protection of natural wetlands and riparian areas. These targets were based on the conceptual understanding of the link between land condition, management practice standards and water quality outcomes.
- The annual Great Barrier Reef Report Card details progress against the Reef Water Quality Protection Plan targets, with the most recent report card providing 2014-2015 data. Most of the indicators are reported annually, except for the wetland and riparian extent indicators, which are reported every four years (the last report was in 2014).
  - » The overall condition of the inshore marine environment (water quality, seagrass and coral) remains poor, and has not changed greatly since Report Card 2011.
  - » While there has been good progress in adopting improved management practices across the agricultural industries in the Great Barrier Reef catchments, a large proportion (in some cases, up to 77%) of agricultural land is managed using practices which are below best management practice for water quality. This demonstrates the challenges associated with facilitating the adoption of improved (lower water quality risk) land management practices, and highlights the limited progress towards achieving the management practice adoption targets since 2009.
  - » An analysis of the Great Barrier Reef Report Card data indicates the rate of progress towards the targets is slowing and it is unlikely the targets will be met on the current trajectory.
  - » Catchment condition targets are tracking positively, with very good, good and moderate scores for ground cover, wetland loss and riparian extent, respectively.
- The adoption of existing best management practices for agricultural land will not be sufficient to achieve the water quality targets and additional management options need to be urgently trialled and validated in the Great Barrier Reef context and then implemented.

Recommendations

- The recommendations for these findings are combined with those for 'Efforts to improve Great Barrier Reef water quality'. The key message is **that there is a need to urgently implement more targeted and substantial effort to improve water quality in the Great Barrier Reef.**

Image: © Tourism and Events Queensland

Efforts to improve Great Barrier Reef water quality

Current management options to reduce pollutant run-off to the Great Barrier Reef provide a solid foundation for program implementation, but an expanded scope of tailored and innovative solutions is urgently required to progress the substantial pollutant load reductions required to meet the Reef 2050 Water Quality Improvement Plan targets by 2025. There is an urgent need for greater investment in voluntary practice change programs, the use of regulatory tools and other policy mechanisms to accelerate the adoption of practice change, and robust monitoring and evaluation programs to measure the rate and effectiveness of adoption.

Summary of evidence

- There is very high confidence in the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program water quality risk frameworks which are used to assess the effectiveness of agricultural practices for water quality. New research has highlighted the benefits of lower fertiliser (nitrogen) application rates, and site and season-specific fertiliser recommendations, in reducing water quality risk. In grazing, land cover management has been found to be effective at generally reducing erosion. However, gully and streambank erosion remains a major problem and remediation has become a higher priority.
- The adoption of new agricultural practices depends on many factors including individual goals and circumstances, local context, perceived profitability and risk and ease of management. Farmers are diverse, with different goals, motivations and information sources. Conflicting messages about Great Barrier Reef health, blaming farmers and the over-emphasis on science (to the exclusion of local or industry knowledge) have been found to contribute to low acceptance of environmental responsibility.
- Collaborative processes to deliver interventions and improve trust in decisions and data are essential. Local, trusted intermediaries and flexible incentives need to be fostered to improve participation in reef water quality programs.
- Wetland and floodplain protection, management and restoration, as well as engineered treatment systems are required to complement on-farm practices to reduce nutrient, sediment and pesticide run-off.
- Changes in land use to less intensive options (such as from sugarcane to grazing, wetlands or conservation) warrants further consideration to accelerate pollutant load reductions. There is currently limited investigation or evidence of these options in the Great Barrier Reef catchments.
- Additional water quality benefits can be achieved from non-agricultural lands such as urban areas and ports, although our understanding of the effectiveness of different practices for water quality in the Great Barrier Reef is limited.
- Large variations exist in the costs of improving water quality between natural resource management regions, programs and industries. Investments can be better prioritised to improve the efficiency and effectiveness of practice change programs. The costs of meeting the water quality targets has been shown to be very high; much higher than previously thought. As the water quality targets are approached, the costs of additional actions are likely to rise sharply.
- Better prioritisation of investments should take into account the cost-effectiveness of agricultural management options including adoption rates, costs, time lags and climatic influences, as well as risks to the marine environment. The areas where the most cost-effective management options can be achieved are not necessarily the areas that generate the most pollutants.

Recommendations

- **Develop and implement cost-effective techniques to manage gullies and riparian erosion; further develop and implement new approaches to fertiliser management in cropping lands (including the use of enhanced efficiency fertilisers, site-specific fertiliser management, and considering seasonal climate forecasts); and investigate methods to reduce catchment run-off as a result of extreme climatic events.**
- **Introduce tailored practice change programs that target different groups of landholders and involve collaboration with landholders, industry organisations and service providers to design and deliver programs. Include programs that involve knowledge exchange between farmers, scientists and others; address perceptions of risk; provide trusted and diverse advisory services; and deliver adequate financial, cultural and social rewards.**
- **Develop and implement a broader range of management options for pollutant reduction from all land uses considering costs, water quality benefits, other trade-offs and policy instruments. In particular: (a) test and validate the water quality effectiveness of wetland and treatment systems in specific locations to support their broader application; (b) review options for voluntary land use change to less intensive uses which support water quality improvement; and (c) incorporate total water cycle management in expanding urban areas and quantify benefits at local scales. Encourage adoption of proven applications.**
- Undertake a more comprehensive and systematic evaluation of existing and proposed policies and programs to improve their effectiveness in accelerating adoption. Additionally, ensure that an economic assessment of projects, in terms of public costs and private benefits, is undertaken to better judge cost-effectiveness and likely adoption before proceeding.
- Implement regulatory and market mechanisms to favour selection of lower cost projects and faster practice change, supported by voluntary approaches to meet the pollutant reduction targets. A variety of regulatory tools already exist, and others e.g. 'smart regulation' should be considered.

Governance and program delivery arrangements

Great Barrier Reef water quality governance requires a commitment to adaptive, participatory and transdisciplinary approaches, and better use of social, economic and institutional research. There is strong evidence to show where aspects of current water quality management programs can be strengthened. Risks including climate change, major development projects and related policy areas, such as agricultural intensification and coastal development, need to be addressed more directly. Strengthened and more effective coordination of Australian and Queensland government policies and programs, further collaboration with farmers and other stakeholders, and strong evaluation systems are critical to the success of Great Barrier Reef water quality initiatives.

Summary of evidence

- Overall, the governance of the Great Barrier Reef is inherently complex. Coordination between governments and government programs is critical to provide clear policy signals and ensure effective management actions.
- There has been a lack of systematic evaluation of program design and implementation, and limited use of social, economic and institutional research to find and test new solutions and improve program delivery.
- Great Barrier Reef governance requires adaptive, participatory and transdisciplinary approaches:
  - **Adaptive** approaches use modelling and other tools to build system understanding, encourage experimentation and evaluation, and tailor solutions to regional variations. A greater focus on experimentation and evaluation of on-ground works and program delivery would strengthen the adaptive capacity of Great Barrier Reef programs. Current governance arrangements have not effectively supported a culture of innovation for water quality outcomes.
  - **Participatory** approaches can bring more knowledge to the debate about solutions, garner support, coordinate effort and reveal value conflicts. Participation and collaboration are features of Great Barrier Reef policy, planning and implementation. Collaboration between natural resource management organisations and industry peak bodies has facilitated coordinated program delivery. Regional capacity is, however, fragile with changes to natural resource management programs, capacity and funding commitments.
  - **Transdisciplinary** approaches use natural and social sciences and stakeholder knowledge to test and evaluate innovative solutions.
- Climate change, the cumulative impact of major development projects and uncoordinated policies represent critical risks to Great Barrier Reef health.
- Intergovernmental coordination and policy alignment must be improved as they affect all aspects of program design and delivery. Related policy areas, such as agricultural intensification, drought relief and water resource development, and poor alignment with other regional planning and management efforts can have perverse impacts on Great Barrier Reef water quality outcomes.

Recommendations

- **Evaluate the effectiveness, efficiency and outcomes of Great Barrier Reef programs and share learnings at Great Barrier Reef and regional levels to drive improvement in program governance, design, delivery and implementation. Incorporate learnings from social research and international case studies, and commission locally relevant research, to support formal Great Barrier Reef policy review cycles.**
- **Address the significant risks to Great Barrier Reef ecosystems from other policy areas by implementing measures to reduce greenhouse gas emissions, assessing the cumulative impacts of major projects on the Great Barrier Reef, and influencing related policy areas such as agricultural intensification and coastal development that may increase risks to the Great Barrier Reef.**
- Develop stronger alignment between Great Barrier Reef management programs, wetland and floodplain management, and other regional planning and management activities such as land use planning, development assessment and floodplain management.
- Encourage and invest in core natural resource management activities such as local partnerships, planning and community engagement to strengthen the regional, catchment and property-scale delivery network. Longer term funding commitments tied to performance outcomes will provide flexibility to tailor approaches to local contexts.
- Encourage experimentation and innovation by scientists working with local stakeholders to develop, test and evaluate potential new solutions.
- Strengthen intergovernmental coordination to ensure effective management of the Great Barrier Reef. The Reef 2050 Long-Term Sustainability Plan needs greater authority and investment, clearer strategies and better stakeholder engagement.

Catchment-scale management priorities

Several catchments contribute to the highest exposure of coastal or marine ecosystems to pollutants, and are considered a high priority for water quality improvement. These include the Mulgrave-Russell, Johnstone, Tully, Herbert, Haughton, Burdekin, Pioneer, Plane, Fitzroy and Mary catchments. Social and economic information is required to prioritise efforts within catchments.

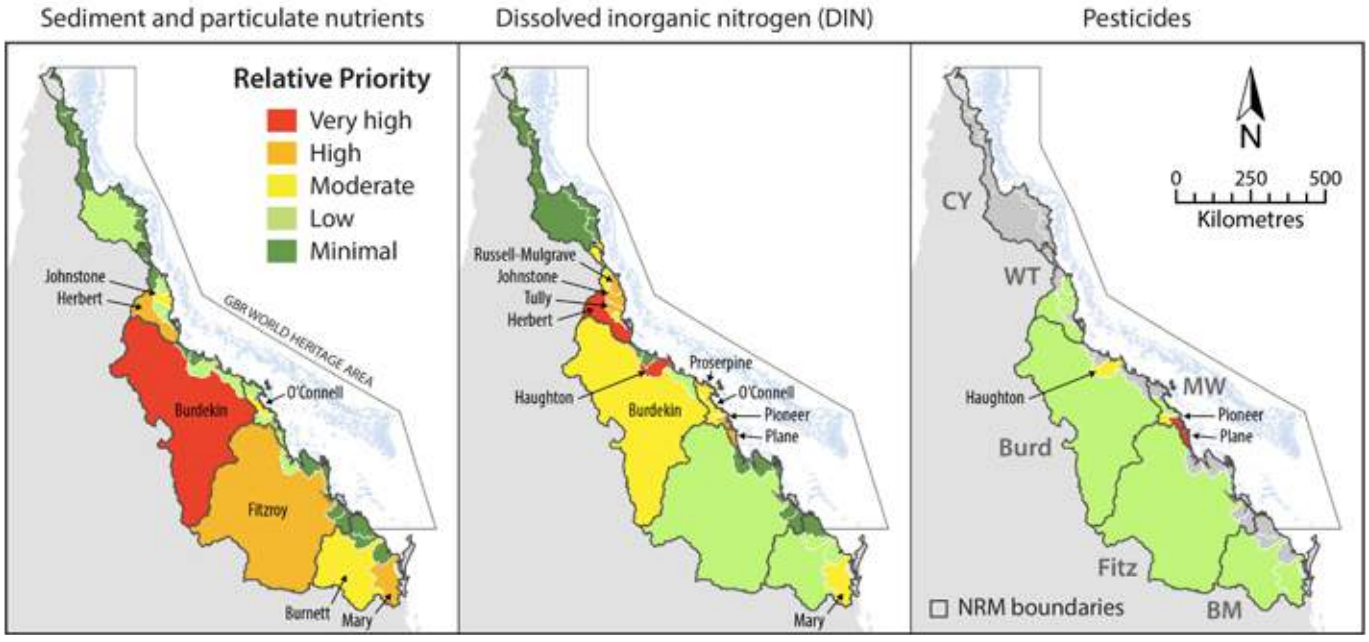
Summary of evidence

- The highest priority areas for reducing fine sediments, dissolved inorganic nitrogen and pesticides loads delivered to the Great Barrier Reef are shown in Figure 3. They are:
  - » Fine sediment and particulate nutrients: Burdekin, Herbert, Fitzroy and Mary catchments.
  - » Dissolved inorganic nitrogen: Herbert, Haughton, Mulgrave-Russell, Johnstone, Tully and Plane catchments.
  - » Pesticides: Plane, Pioneer and Haughton catchments.
- The Cape York catchments could also be a priority for protection and for maintaining current water quality given their relatively low risk contributions and relatively good condition of the adjacent marine ecosystems.
- Comparing the highest priority catchments for pollutant reduction against those with the most cost-effective management options (in $/tonne) shows:
  - » The Mary, Herbert, Fitzroy and Burdekin catchments offer the most cost-effective management for sediment, while actions in the Burdekin, including the Bowen-Broken-Bogie catchment, provide larger scale reductions at higher cost levels.
  - » The results are less clear for dissolved inorganic nitrogen due to limited data availability across the Great Barrier Reef but indications are the Plane, Herbert, Tully and Johnstone catchments are the most cost-effective for reducing dissolved inorganic nitrogen loads through improved sugarcane management.

Recommendations

- **Develop a detailed, comprehensive and costed water quality management plan, drawing on the existing regional water quality improvement plans, to guide strategic investment in priority areas and ensure the water quality targets for the Great Barrier Reef are achieved.**
- **Undertake finer scale spatial prioritisation of management and allocate resource effort across and within the Great Barrier Reef catchments, using (a) biophysical catchment characteristics and the likelihood of exposure of coastal and marine ecosystems to pollutants to identify priority areas at a catchment scale, supported by (b) current practice adoption, and social and economic factors to inform the most cost-effective areas for increased management effort and the choice of policy mechanisms and (c) a range of agricultural management practice, landscape remediation and/or land conversion management scenarios. Incorporate risks to landholders and partners, climate, markets and time lags. Industries such as horticulture and broadacre cropping require further attention as they present an opportunity for cost-effective outcomes in short timeframes.**
- Target funding for improved land management and remediation to the priority catchments identified in the 2017 Scientific Consensus Statement. Areas of lower priority for remediation need to be maintained or improved.

Figure 3: Map illustrating the relative spatial priorities for water quality improvement in the Great Barrier Reef catchments based on the assessment of pollutant exposure and risk to coastal and marine ecosystems. Note this is a result of the biophysical assessment only, and results for particulate nutrients have been extrapolated from the fine sediment assessment and were not considered independently. Social and economic factors should determine priorities within catchments.



Monitoring and modelling

Monitoring and modelling of the Great Barrier Reef ecosystems is a strength of the Reef Water Quality Protection Plan 2013 and its programs, with some spatial limitations. However, there has been limited investment in social and institutional research and monitoring, and a lack of systematic evaluation of delivery processes and governance systems. A greater focus on experimentation, prioritisation and evaluation at different scales, coupled with the use of modelling and other approaches to understand future scenarios, could further improve water quality programs.

Summary of evidence

- The Paddock to Reef Integrating Monitoring, Modelling and Reporting Program (Paddock to Reef program) commenced in 2009 and is the central program for evaluating progress towards the Reef Water Quality Protection Plan management practice, catchment condition and pollutant reduction targets, as well as marine water quality and ecosystem health condition. The scope of the program does not include social (except for management practice adoption reporting), economic or governance indicators. There is also limited marine condition assessment in the northern (Cape York) and southern (Burnett Mary) regions.
- Almost 10 years of data collected under the Paddock to Reef program provides the basis for assessing catchment management effectiveness and catchment and marine water quality and ecosystem condition.
- Regional reporting partnerships have been established involving a broad range of stakeholders. Access to monitoring data outside of the Paddock to Reef program will become more important with the scope of the Reef 2050 Water Quality Improvement Plan 2017-2022 expanded to include non-agricultural land uses.
- The ability to quantitatively attribute changes in catchment activities and end-of-catchment water quality to coastal and marine water quality and ecosystem condition remains limited due to climate variability, sparse monitoring and incomplete operational models. Overall, catchment and marine monitoring and modelling approaches to support evaluation and reporting of the progress towards targets continues to improve. There are still challenges with the lack of data for all indicators in the Cape York and Burnett Mary regions.
- There has been little investment in social, economic and institutional research, or monitoring, evaluation and reporting of indicators related to Great Barrier Reef water quality management, and this constrains the ability to improve the effectiveness of programs.

Recommendations

- Expand the scope of the Paddock to Reef Integrated Monitoring, Modelling and Reporting program to:
  - » Include condition reporting of coastal aquatic ecosystems.
  - » Address the lack of monitoring data, validation of models and the estimation of water quality risks and ecosystem condition in the Cape York and Burnett Mary regions.
  - » Incorporate a formal social and economic monitoring and modelling component.
  - » Address the lack of monitoring data from other pollutants, e.g. marine debris, microplastics, and personal care products.
- Expand and improve public reporting of water quality data from all land uses and whole-of-catchment efforts to support broader community engagement.
- Develop the capacity to model the cumulative impacts of water quality and other pressures (major projects, coastal development) under a range of climate and other scenarios to better inform policy, planning and assessment processes.
- Develop a systematic approach to program evaluations that incorporates social, economic, governance and programmatic dimensions to inform program delivery efforts and support innovation.

6. Knowledge gaps

While a great deal of evidence is available to support the 2017 Scientific Consensus Statement, there are still many important knowledge gaps that need to be addressed to improve our understanding and management of water quality issues in the Great Barrier Reef. Key knowledge gaps and areas for further research are included in each chapter, and highlighted in Chapter 5. These will be incorporated into the updated Reef 2050 Water Quality Research, Development and Innovation Strategy.

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Supporting chapters

Schaffelke, B., Collier, C., Kroon, F., Lough, J., McKenzie, L., Ronan, M., Uthicke, S., Brodie, J., 2017. 2017 Scientific Consensus Statement: A synthesis of the science of land-based water quality impacts on the Great Barrier Reef, Chapter 1: The condition of coastal and marine ecosystems of the Great Barrier Reef and their responses to water quality and disturbances. State of Queensland, 2017.

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Eberhard, R., Thorburn, P., Rolfe, J., Taylor, B., Ronan, M., Weber, T., Flint, N., Kroon, F., Brodie, J., Waterhouse, J., Silburn, M., Bartley, R., Davis, A., Wilkinson, S., Lewis, S., Star, M., Poggio, M., Windle, J., Marshall, N., Hill, R., Maclean, K., Lyons, P., Robinson, C., Adame, F., Selles, A., Griffiths, M., Gunn, J., McCosker, K., 2017. Scientific Consensus Statement: A synthesis of the science of land-based water quality impacts on the Great Barrier Reef, Chapter 4: Management options and their effectiveness. State of Queensland, 2017.

Waterhouse, J., Schaffelke, B., Bartley, R., Eberhard, R., Brodie, J., Star, M., Thorburn, P., Rolfe, J., Ronan, M., Taylor, B., Kroon, F., 2017. 2017 Scientific Consensus Statement: A synthesis of the science of land-based water quality impacts on the Great Barrier Reef, Chapter 5: Overview of key findings, management implications and knowledge gaps. State of Queensland, 2017.

Draft Reef 2050 Water Quality Improvement Plan 2017-2022 consultation survey

The Australian and Queensland governments invite you to have your say on the draft Reef 2050 Water Quality Improvement Plan 2017-2022. This renewed five-year plan details how industry, government and the community will continue to work together to improve the quality of water flowing to the Great Barrier Reef. The draft plan is an update of the Reef Water Protection Plan and supports delivery of the Reef 2050 Long-Term Sustainability Plan.

1. **How well do you think this plan links with the Reef 2050 Long-term Sustainability Plan?**
   a. Not very well
   b. Not well
   c. Neutral
   d. Well
   e. Very well

   Comments:

   Whilst there are clear linkages between both Plans, according to the Australian Academy of Science, the Reef 2050 Long Term Sustainability Plan is inadequate to achieve the goal of restoring or even maintaining the diminished Outstanding Universal Value of the GBR.

2. **The plan represents all industries contributing to run-off from land flowing to the Great Barrier Reef. How adequately do you think this is captured?**
   a. Not very well
   b. Not well
   c. Neutral
   d. Well
   e. Very well

3. **Are any industries missing?**
   a. Yes
   b. No

4. **The framework of the plan identifies the outcomes to be achieved, the land and catchment targets to be reported against and the associated actions contributing to the targets and outcomes. It is designed to provide a clear understanding of how it is all connected. How well has this been articulated in the plan?**
   a. Not very well
   b. Not well
   c. Neutral
   d. Well
   e. Very well

5. **Do you have any suggestions to improve the linkages between actions, outcomes and targets?**
   a. **Yes**
   b. No

   If yes, please outline your suggestions:

   Whilst the plan provides clear linkages between the articulated actions, outcomes and targets it does not present any substantial new funding, legislation or other initiatives which will improve the health of the GBR. This falls short of the additional requirements outlined in the 2017 Scientific Consensus Statement which are required to save the GBR.

6. **The framework identifies activities and investments to accelerate the progress towards the water quality targets and achieve long-term changes to land management practices. Do you have any suggestions about activities/investments that should be included in the plan?**
   a. **Yes**
   b. No

   If yes, please outline your suggestions:

   See Question 9.

7. **The plan includes social, cultural and economic values for the first time. How well do you feel this aspect has been addressed?**
   a. Not very well
   b. Not well
   c. Neutral
   d. **Well**
   e. Very well

8. **The final plan will include an implementation schedule that gives more detail about how the actions will be implemented through programs and investments. What activities is your industry/organisation undertaking that can contribute to the outcomes?**

   It would have been useful to include a preliminary version of the implementation schedule in the current consultation round, as this will form the most important element of the Plan.

   Douglas Shire Council recognises the importance of its role in improving the health of the GBR and will continue to work with the GBRMPA Reef Guardian Council program and the Douglas Local Marine Advisory Committee to share best practice and undertake projects as detailed in its annual Reef Guardian Action Plans. These initiatives relate to: 1. Climate change - e.g. calculating and working to reduce Council's carbon footprint, investing in low energy lighting and utilising gravity fed systems in water processes; 2. Land management - e.g. revegetation programs to stabilise coastal banks and to reduce runoff, and trialling new technology to better control feral pigs; 3. Water management - e.g. expanding current water monitoring in Dickson Inlet and various water saving initiatives; 4. Waste management - e.g. expansion of recyclable materials accepted at Council transfer stations and waste educational campaigns; 5. Community - e.g. continued involvement in the Plastic Free Douglas community group.

9. What additional actions are needed to reflect your industry/organisation's work?

Infrastructure and grant programs should be created and prioritised based on their potential to improve the GBR. This should include additional funding for local governments to implement real measures which will improve the health of the GBR. Programs could include: the sewering of coastal communities located in high water table locations; infrastructure to treat vessel discharges, particularly with regards to nutrient rich sewage effluence in the GBR lagoon, marinas and ports; and the closure of impacting landfills.

10. Please provide any additional comments or suggestions regarding the plan below.

There needs to be a streamlined Federal and State approach if we are to save the GBR. Whilst Douglas Shire Council acknowledges the Plan primarily relates to water quality initiatives, more needs to be done to mitigate climate change. For example, the Federal and State governments continue to support new fossil fuel projects despite the clear climate change implications, e.g. the proposed Carmichael (Adani) coal mine in the Galilee Basin.

11. Are you completing this survey as an individual or as a representative of an organisation?

a. Individual
b. Organisation representative

If completing this survey as an organisation, please specify organisation name:

Douglas Shire Council

12. Would you like your feedback to remain confidential?

a. Yes
b. No

If you answer 'No', your response may be published or quoted in public documents.

13. Contact details (optional)

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14. Please indicate below if you would like to receive:

a. A response to your submission **- Yes**
b. Updates on the plan **- Yes**