



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.

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Foreword

The Great Barrier Reef (the 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 and iconic value as a 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 that the most pervasive and persistent risk to coral reefs worldwide, including the Great Barrier Reef, is climate change. Damage to reefs associated with climate change arises from sea surface temperature increases, ocean acidification, altered weather patterns (such as more intense storms and cyclones) and rising sea levels. 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 affect the health of coral and seagrass habitats, making the Reef less able to withstand or recover from events like the coral bleaching we have witnessed in 2016 and 2017. Equally, the health of the Reef affects the resilience of Reef-dependent and Reef-associated communities.

The Australian and Queensland governments have committed more than \$2 billion over 10 years to protecting the Reef, with an unprecedented level of investment into improving water quality.

This *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, and research and conservation groups. Much has already been achieved by landholders and the community to change and improve their practices to protect the Reef.

We can still do more and a step change is needed. We must accelerate our collective efforts to improve the land use practices of everyone living and working in the catchments adjacent to the Reef through a diversified set of actions. The Reef 2050 Water Quality Improvement Plan now directly aligns with our Reef 2050 Long-Term Sustainability Plan. This includes expanding the scope to address all land-based sources of water pollution, including from agricultural, urban, industrial and public lands. It also recognises the importance of people in creating change and includes our social, cultural and economic values. The Plan sets targets for improving water quality for the 35 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 quality of water flowing into the 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 Leeanne Enoch MP

Minister for Environment and the Great Barrier Reef,
Minister for Science and Minister for the Arts

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





Contents

Foreword	3
Summary	7
Background	8
Scope	11
Outcome, objectives and targets	13
Implementation	21
Reef 2050 WQIP actions and deliverables	26
Glossary	55
Appendix 1: History	59
Appendix 2: Links to further information	60



Summary

The UNESCO World Heritage listed Great Barrier Reef is a place of superlative natural beauty, treasured by its Traditional Owners along with all Australians and the international community. Climate change will likely continue to be the strongest driver of ecological change for the Great Barrier Reef in the future with more intense weather events and cyclones, and increased frequency of coral bleaching events. Improving the quality of the water flowing from the land to the Reef is also critical for the Reef's health and, therefore, its ability to withstand and recover from extreme events.

The five-year Reef 2050 Water Quality Improvement Plan (the Reef 2050 WQIP) now aligns and is nested within the Australian and Queensland governments' Reef 2050 Long-Term Sustainability Plan (Reef 2050 Plan). In particular, the Reef 2050 WQIP seeks to improve the quality of water 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. These include social, cultural, institutional and economic factors: from the aspirations and capacities of landholders, industries and communities, to their stewardship practices, and, broader governance of the reef.
- setting separate targets for reducing water pollution from each catchment, to enable better prioritisation of actions.

The Reef 2050 WQIP is based on the best available independent scientific advice, as provided by the 2017 *Scientific Consensus Statement* – Land use impacts on Great Barrier Reef water quality and ecosystem condition (Scientific Consensus Statement). 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."*

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."

Partnerships across all sectors at all levels continue to be the key to making progress towards the water quality targets. This includes governments working together and with agriculture, industry, urban development and construction, conservation, community and natural resource management stakeholders.

The Plan recognises that governments and stakeholders have made significant achievements in improving the quality of water reaching the Reef. 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 and sustain the adoption of best management practices. The Plan also recognises that agricultural industries are not the only source of poor water quality but, collectively, agriculture dominates land use in the catchment and is, therefore, the major focus.

The desired outcome of the Reef 2050 WQIP is to ensure that **'Good water quality sustains the Outstanding Universal Value of the Great Barrier Reef, builds resilience, improves ecosystem health and benefits communities.'**

Water quality targets define the required reductions in sediment and nutrient loads by 2025 for the catchments discharging to the Reef. The pesticide target ensures aquatic ecosystems are protected. Water quality modelling and other scientific information has been used to develop targets to improve the health and resilience of the Reef, at a scale that is more relevant to catchment management than in previous plans.

Progress towards these targets will be delivered 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 streambanks, gullies, riparian vegetation and wetlands.

The Reef 2050 WQIP will be implemented using an adaptive management approach, informed by best science, where actions are regularly monitored to see how well they are working. In this way, actions can be continuously adapted and improved.



Background

The enhanced management of water quality flowing to the Great Barrier Reef commenced with the release of the *Reef Water Quality Protection Plan* in 2003. This followed an independent *Report on the Study of Land-Sourced Pollutants and their Impacts on Water Quality in and adjacent to the Great Barrier Reef*. Subsequent iterations of the *Reef Water Quality Protection Plan* were released in 2009 and 2013 (see Appendix 1 for a history timeline).

Since the first *Reef Water Quality Protection Plan* was released, both the ecological status of the Reef and the effectiveness of water quality management have received extensive scrutiny. This includes three Scientific Consensus Statements on water quality in the Great Barrier Reef (released in 2008, 2013 and 2017) which have drawn on the latest science to establish with more certainty the risks that water pollutants pose to coastal and marine ecosystems of the Reef.

Progress to date – building on past achievements

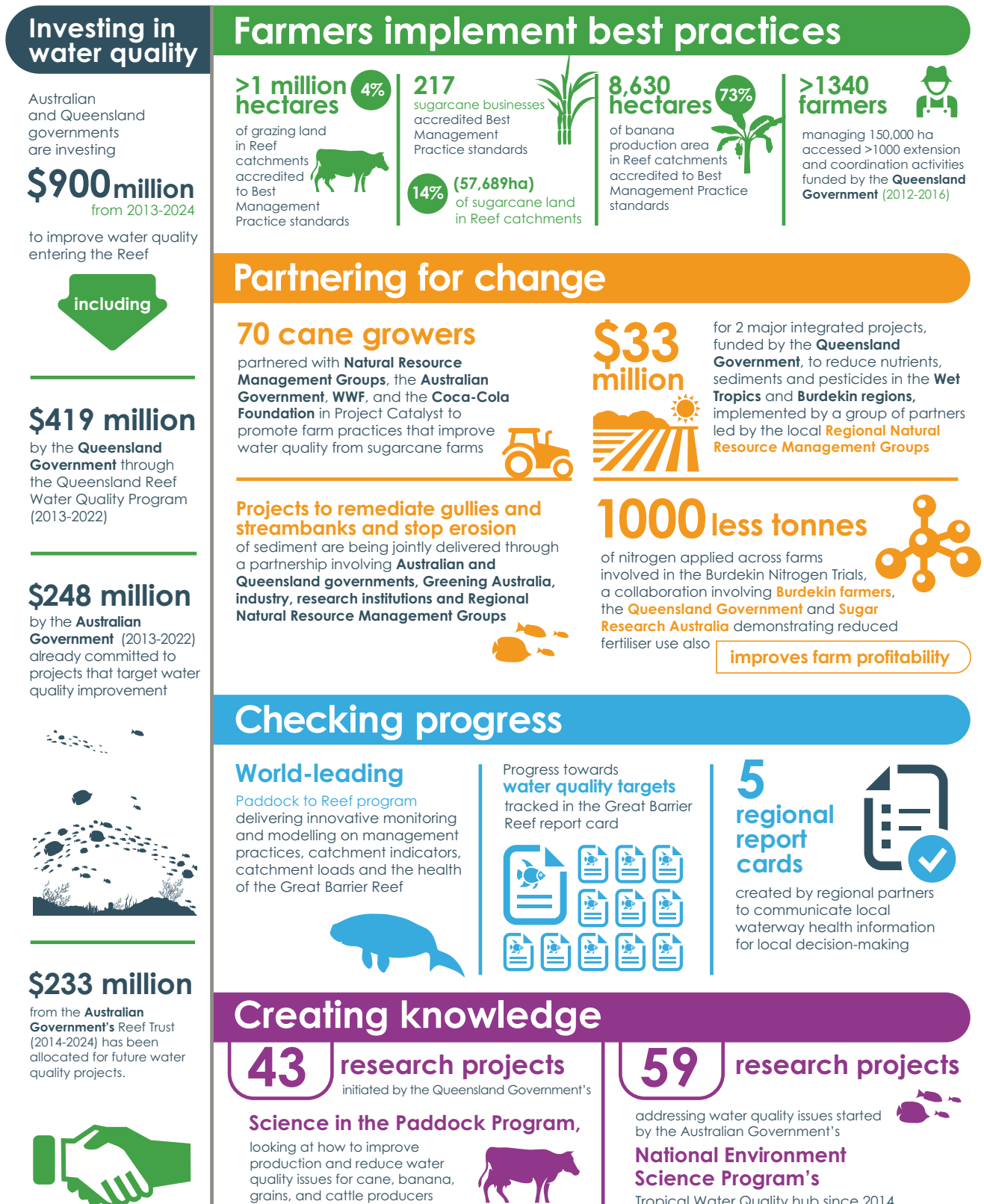
The joint efforts of government, industry, land managers and communities since 2003 have helped to deliver land management and water quality improvement. Figure 1 provides a visual summary of recent and current programs to manage water pollution from reef catchments and their achievements.

Industry leads with best management practices

The agricultural sector is taking positive steps to support progress towards the targets. For instance, the Smartcane Best Management Practice (BMP), Grazing BMP and Banana BMP programs for farm management are examples of strong partnerships involving the agricultural industry, natural resource management bodies, land managers and governments to improve productivity, profitability and sustainability of farm enterprises.

This Plan builds on our achievements to date, while recognising the need to accelerate adoption of improved land and catchment management.

Figure 1. The Plan builds on current programs and collective achievements in improving water quality



Plan builds on findings from past evaluation

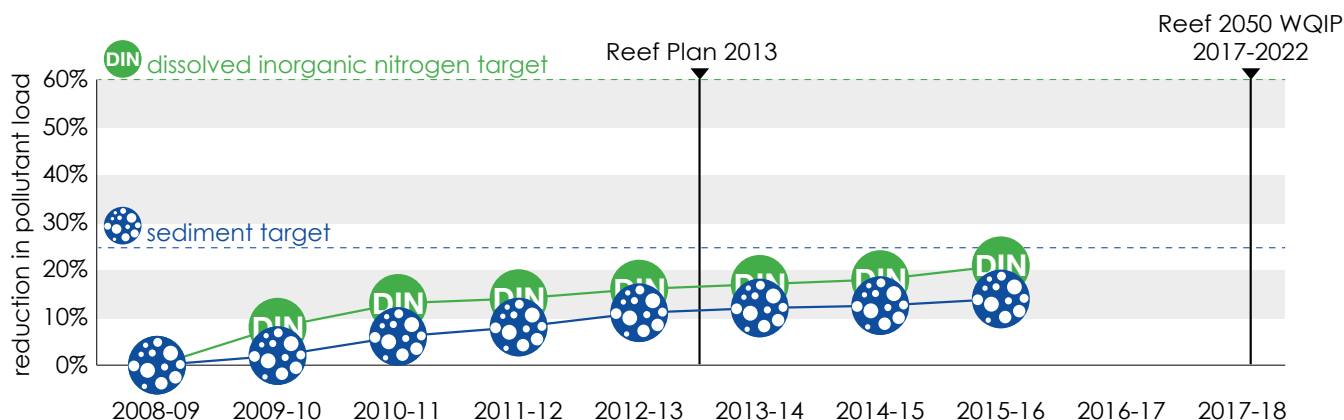
The Reef 2050 WQIP responds to the Australian and Queensland governments' ongoing commitment to adaptively manage water quality initiatives in response to evaluation findings.

Australian and Queensland government investment in Reef water quality initiatives has been subject to a range of evaluation activities in recent years. For example, in 2015, the Queensland Audit Office found that funding for improving Great Barrier Reef water quality was fragmented and there needed to be more accountability for Queensland Government expenditure. In response, the Office of the Great Barrier Reef was established to coordinate the Queensland Government's Reef water quality management initiatives.

The Queensland Government then convened the Great Barrier Reef Water Science Taskforce (the Taskforce) to provide advice on the best approach to achieve the water quality targets. The Taskforce evaluated current water quality efforts and noted that existing initiatives were not bringing about rapid or widespread changes to water quality. Figure 2 shows the progress to date as tracked through the Great Barrier Reef Report Cards.

Figure 2. Progress from Reef Report Cards to 2016

Long-term progress towards 2025 water quality targets



The Taskforce report of 2016 recommended a mix of policy, regulation and investment to accelerate progress towards the targets. The Taskforce's recommendations were accepted in-principle by the Queensland Government and are incorporated into the actions in this Plan.

In 2016, the Australian Government's Reef Trust program was audited to assess the effectiveness of program design and implementation. The audit found the Reef Trust was largely effective and had incorporated the lessons learned from previous Reef programs. The program has also recently undergone a mid-term review of its outcomes and targets. Recommendations will be incorporated into the remaining investment phases of the program.

The Reef 2050 WQIP responds to findings from these evaluations by incorporating actions to improve governance, alignment and coordination of investment in Reef water quality. It also includes a mix of regulatory and voluntary actions that align with recommendations from the Taskforce and 2017 *Scientific Consensus Statement* about what is needed to accelerate progress towards the targets.

Scope

Context

In 2015, the Australian and Queensland governments released the *Reef 2050 Long-Term Sustainability Plan* (Reef 2050 Plan). The Reef 2050 Plan identifies 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 WQIP is included as an action within the water quality theme of the Reef 2050 Plan. Its specific purpose is to identify management and monitoring requirements for all land-based pollution to improve the quality of water flowing from catchments adjacent to the Reef. The name of the plan has changed from the *Reef Water Quality Protection Plan* to the *Reef 2050 Water Quality Improvement Plan 2017-2022* to better demonstrate its alignment with the Reef 2050 Plan.

The Reef 2050 WQIP provides an overarching framework to deliver strategic priorities across Reef catchments. Regional Water Quality Improvement Plans guide the implementation of projects within regions and specific catchments. The regional plans support the Reef 2050 WQIP by providing locally relevant information and guiding local priority actions within catchments.

Implementation of the Reef 2050 WQIP will require a strong partnership approach. It will need collaboration and commitment from government, industry and the broader community, including Natural Resource Management (NRM) bodies. Reef-dependent and Reef-associated communities will contribute in various ways.

Science advice on key pollutants

The *2017 Scientific Consensus Statement* supports the continued need to focus efforts on reducing water pollution to improve the resilience of coastal and marine ecosystems of the Reef.

The *2017 Scientific Consensus Statement* concludes that the greatest water quality risks to the Reef are from:

- nutrients, which are an additional stress factor for many coastal coral species, promote crown-of-thorns starfish population outbreaks with destructive effects on mid-shelf and off-shore coral reefs, and promote macroalgal growth
- fine sediments, which reduce the available light to seagrass ecosystems and inshore coral reefs
- pesticides, which pose a toxicity risk to freshwater ecosystems and some inshore and coastal habitats.

In addition to these risks, the increased presence of waste plastics, including micro-plastics, is an emerging pollution threat to the Reef. Plastics directly harm iconic species like dugongs, turtles and seabirds and can contribute to disease outbreaks in corals.

The impacts of all these pollutants on the coastal and marine ecosystems of the Reef is complex. What is certain is they have been found to be important at different scales and locations across the Reef. Risks differ depending on the individual pollutant, its source and how far the Reef is from the coast.

Figure 3 provides a visual summary of the linkages between activities in the catchment and impacts on coastal and marine ecosystems of the Reef. It also shows how activities in the catchments can deliver a net impact on the environment, and highlights the intrinsic social and economic values of the Reef.

Land uses in scope

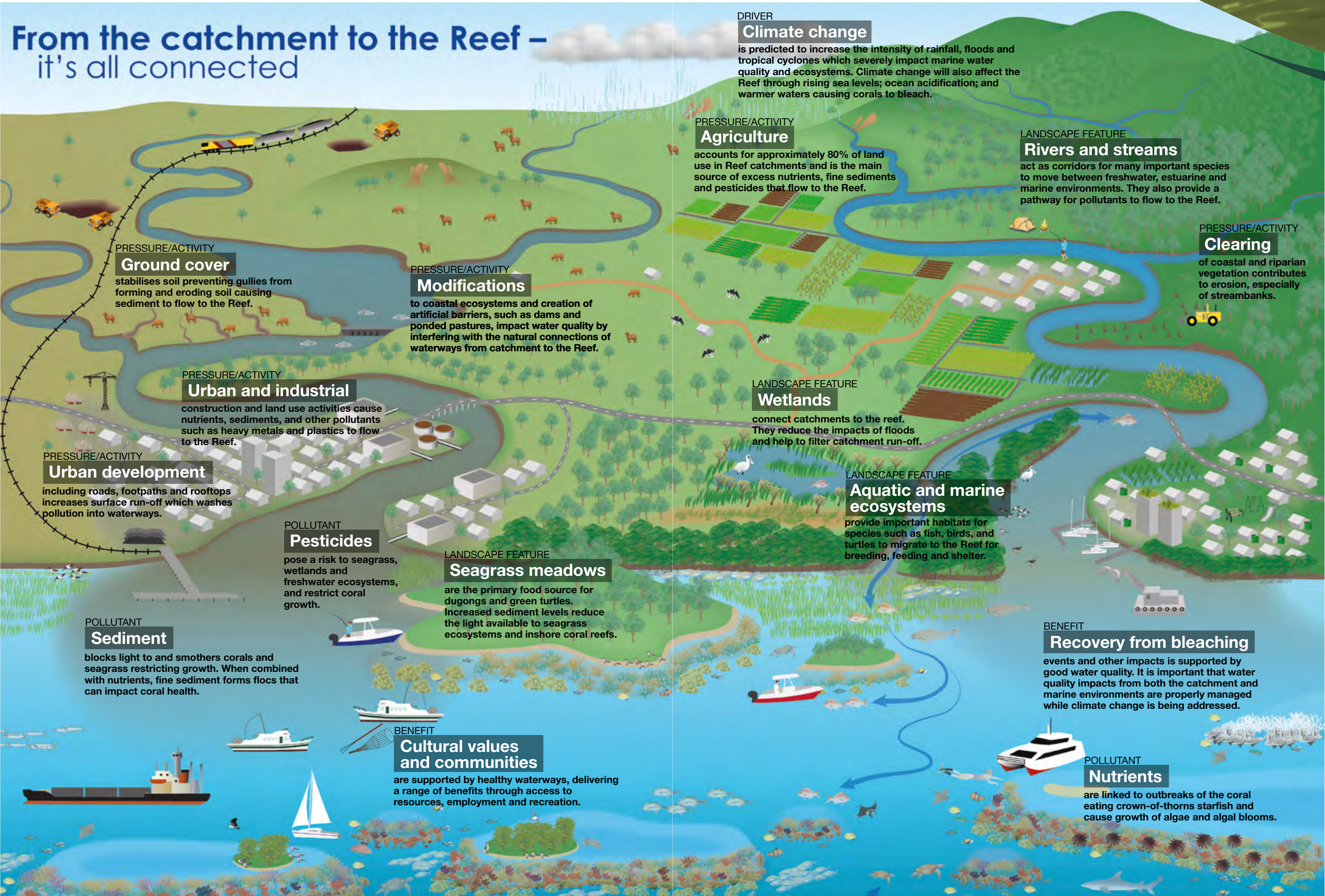
The focus of this Plan has expanded to address all agricultural activities and other land-based pollutant sources including urban-diffuse, point source and industrial discharge. Some examples of land-based activities that are now within the scope of the plan include intensive animal production, manufacturing and industrial activities, mining, rural and urban residential, transport and communication corridors, and waste treatment and disposal. The main sources of water pollution from Reef catchments continue to be from agriculture. However, the Reef 2050 WQIP recognises that while urban and industrial land uses provide a relatively small contribution to water pollution overall, they can create concentrated pollution that has important local impacts. Including these activities within scope is part of an integrated approach to catchment management.

Activities to improve water quality at the end-of-catchment also deliver benefits for wetlands within the catchment by protecting their multiple values and the role they play in the ecosystem health of the Great Barrier Reef.

Recognising the importance of communities, industries and land managers in influencing water quality outcomes, the Reef 2050 WQIP includes specific consideration of the human dimensions of achieving water quality improvements. These include social, cultural, institutional and economic factors: from the aspirations and capacities of landholders, industries and communities, to their stewardship practices, and broader governance of the Reef.

Finally, targets for reducing water pollution have been set at the catchment, regional and whole-of-Reef scale, which means actions and effort can be focussed on the highest risk catchments.

Figure 3. The connections between the catchments and the Reef



Building the Reef's resilience to climate change with improved water quality

The Reef is under increasing pressure from the cumulative effects of climate change, land-based run-off, increasing coastal development and direct uses such as tourism, fishing and shipping. Climate change is identified as the biggest threat to the Reef in the *Great Barrier Reef Outlook Report 2014*. It affects weather patterns (increasing the intensity of cyclones and storms), increases sea temperatures resulting in coral bleaching, and causes ocean acidification and rising sea levels. There is sound evidence that good water quality increases the resilience of the Reef to pressures from climate change and reduces the Reef's recovery time following catastrophic events.

The Reef 2050 WQIP includes land-based risks that need to be considered and managed in the context of climate change. Climate change makes the task of improving water quality in our rivers, streams, wetlands and estuaries even more challenging. Consequences of greenhouse gas emissions in the years and decades to come are likely to include increases in the intensity of extreme weather events including cyclones. Rainfall events and associated flooding are likely to become more intense as global warming continues. There will be a tendency for more large-scale flood events to contribute significant volumes of freshwater to the marine environment, bringing additional sediment, nutrients and pesticides to the Reef. In addition, scientific evidence shows that increasing sea temperatures can make the effect of water quality pollutants more toxic. These inputs increase the stresses on coastal and marine ecosystems.

Outcome, objectives and targets

Outcome

The Reef 2050 WQIP outcome links the Reef 2050 Plan water quality and community benefits themes, recognising that one cannot be achieved without the other. The 2050 outcome is:

Good water quality sustains the Outstanding Universal Value of the Great Barrier Reef, builds resilience, improves ecosystem health and benefits communities.

Objectives

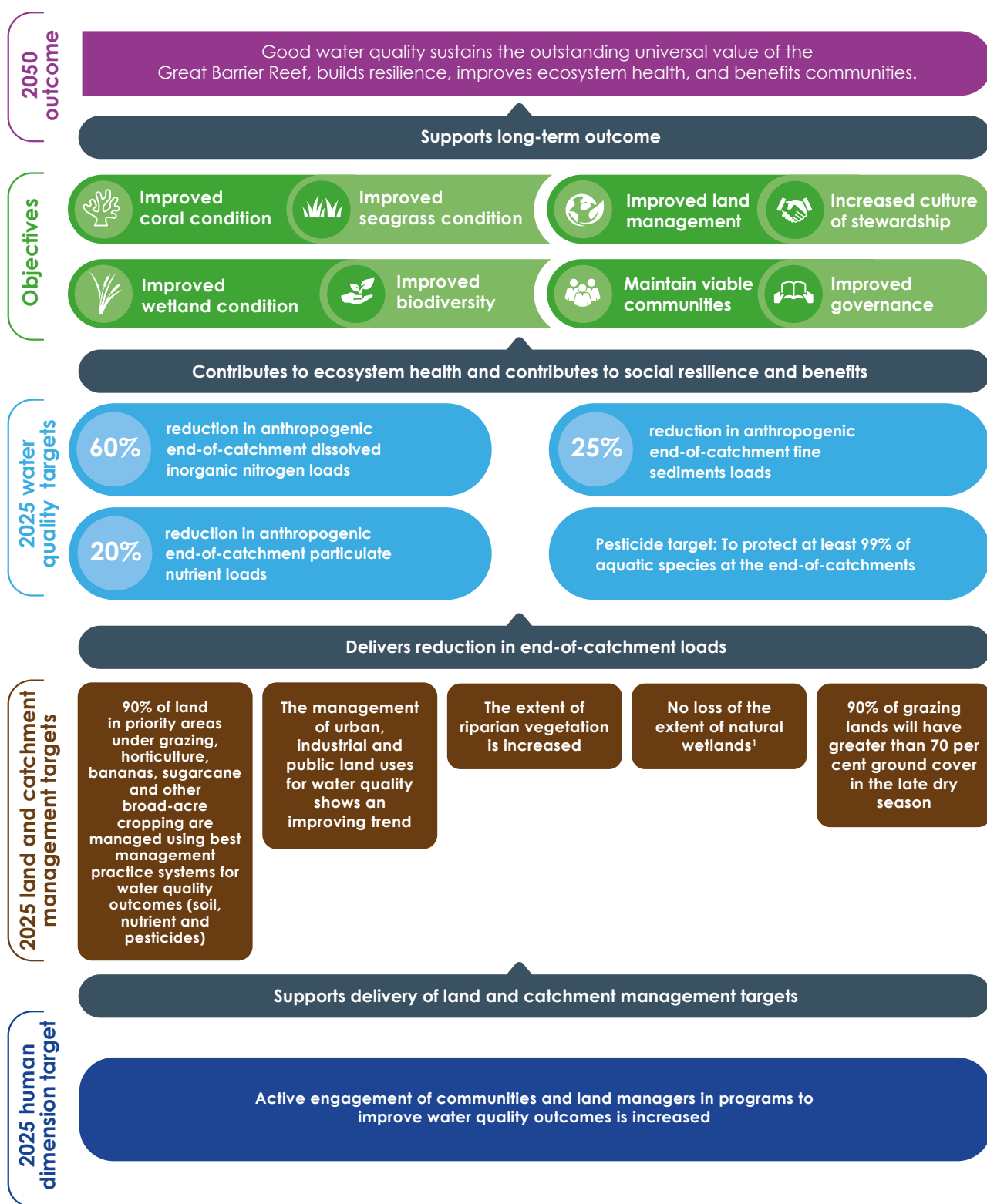
The objectives of this Plan demonstrate the link between broader Reef health and improving water quality, and the human factors that are key in influencing Reef health. These objectives demonstrate the nesting of the Reef 2050 WQIP within the broader Reef 2050 Plan.

Targets

This Plan includes a hierarchy of targets. The human dimensions target focuses on the social, cultural, institutional and economic factors that underpin water quality improvements. Land and catchment management targets are set at the whole-of-Reef scale for tracking and reporting changes that lead to water quality improvement. Targets are set for reducing sediment and nutrient pollution loads and ensuring aquatic ecosystems are protected from pesticides at the end of the catchment. The sediment and nutrient catchment targets have been aggregated to provide indicative targets at the whole-of-Reef and regional scale.

Figure 4 shows the link between the outcome, objectives and targets of the Reef 2050 WQIP.

Figure 4. Summary of Reef 2050 WQIP outcome, 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.

Water quality targets

The water quality targets for dissolved inorganic nitrogen, fine sediment (which is measured as total suspended solids), particulate phosphorus and particulate nitrogen provide an unprecedented level of scientific understanding into what is required from the catchments to support Reef health. The targets are shown for the catchment, region and whole-of-Reef scales.

There is insufficient science to set quantitative water quality targets for other pollutants, including plastics. As the science is refined, quantitative measures can be developed for other pollutants.

Whole-of-Reef targets

The whole-of-Reef targets for nutrients and sediments (as shown in Figure 4) have been developed by aggregating the catchment targets. These indicative targets will help with tracking and communicating overall progress of the Plan.

Regional water quality targets

Catchment targets for nutrients and sediment have been aggregated to give indicative targets for each of the regions (see Table 1). The Cape York and Fitzroy region targets for dissolved inorganic nitrogen are to maintain the current load (MCL).

Table 1. Regional water quality targets

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

Catchment water quality targets

The catchment (also known as river basin) water quality targets for nutrients and sediments are based on the Great Barrier Reef Marine Park Authority's *Water Quality Guidelines for the Great Barrier Reef Marine Park*. They are expressed as end-of-catchment load reductions (Table 2). The catchment water quality 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.

Catchment water quality targets are based on the need to improve the health and resilience of the Reef. Targets were set by using a combination of catchment modelling (to estimate reductions needed from improved land management practices) and eReefs marine water modelling (to calculate how pollutants impact the Reef). Expert scientific advice and technical knowledge complemented the outputs of the modelling. These targets provide an unprecedented level of scientific understanding. They are consistent with the framework of targets identified in previous plans but are now drawn from a scientific understanding of the specific water quality needs for each river catchment, based on the parts of the Reef each river affects.

The target for pesticides is set at the end of the catchment and is the same for all catchments and regions. It has been changed to a concentration based target rather than a loads based target. This aligns directly with the outcome of the Reef 2050 WQIP, to have greater ecological relevance for protecting aquatic ecosystems of the Reef from pesticide impacts, and is compatible with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. The target is based on the concentrations required to protect at least 99% of aquatic species at the river mouth.

The 2025 end-of-catchment water quality targets are expressed as percentage reductions of anthropogenic loads and the required reduction is also shown in tonnes (or kilotonnes for fine sediment). The targets are calculated from the 2013 anthropogenic baseline to reflect previously reported water quality pollutant reductions from 2009 to 2013. Reporting percentages means annual reductions can be tracked over time, even though baselines are updated as knowledge improves. Tonnage reductions are most relevant when comparing the effort required between catchments as some catchments with the same percentage target will have different tonnage reductions reflecting the different scale of the challenge.

Catchments with an MCL (Maintain Current Load) target have minimal anthropogenic pollutant loads. The aim for this category of catchments is to maintain current water quality so that there are no increases in pollutant loads.

Targets could not 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.

Table 2. End-of-catchment anthropogenic water quality targets for the Reef catchments by 2025 and relative priorities for water quality improvement (t = tonnes, MCL = maintain current load, ND = not determined)

Management priority					
	Very high		Moderate		Minimal
	High		Low		Not assessed

Region	Catchment/ Basin	Area (ha)	Targets								Pesticide target to protect min 99% of aquatic species at end-of-catchment
			Dissolved inorganic nitrogen		Fine sediment		Particulate phosphorus		Particulate nitrogen		
			tonnes	% reduction	kilo-tonnes	% reduction	tonnes	% reduction	tonnes	% reduction	
Cape York	Jacky Jacky Creek	296,330	MCL	MCL	MCL	MCL	MCL	MCL	MCL	MCL	
	Olive Pascoe River	417,950	MCL	MCL	MCL	MCL	MCL	MCL	MCL	MCL	
	Lockhart River	288,330	MCL	MCL	1	2	2	2	5	2	
	Stewart River	274,280	MCL	MCL	2	6	2	6	7	6	
	Normanby River	2,439,490	MCL	MCL	15	10	5	10	15	10	
	Jeannie River	363,750	MCL	MCL	2	6	2	6	9	6	
	Endeavour River	218,240	MCL	MCL	3	10	3	10	11	10	
Wet Tropics	Daintree River	210,670	MCL	MCL	MCL	MCL	MCL	MCL	MCL	MCL	
	Mossman River	47,240	52	50	MCL	MCL	MCL	MCL	MCL	MCL	
	Barron River	218,880	52	60	MCL	MCL	MCL	MCL	MCL	MCL	
	Mulgrave-Russell River	194,400	300	70	16	10	19	10	53	10	
	Johnstone River	232,390	350	70	100	40	250	40	490	40	
	Tully River	168,350	190	50	17	20	23	20	68	20	
	Murray River	110,840	120	50	8	20	11	20	32	20	
	Herbert River	984,590	620	70	99	30	57	30	200	30	
Burdekin	Black River	105,970	ND	ND	ND	ND	ND	ND	ND	ND	
	Ross River	170,820	74	60	ND	ND	ND	ND	ND	ND	
	Haughton River	405,080	640	70	MCL	MCL	MCL	MCL	MCL	MCL	
	Burdekin River	10,310,940	100	60	840	30	440	30	720	30	
	Don River	373,620	MCL	MCL	55	30	43	30	75	30	
Mackay/ Whitsunday	Proserpine River	249,440	110	70	MCL	MCL	MCL	MCL	MCL	MCL	
	O'Connell River	238,760	130	70	96	40	120	40	250	40	
	Pioneer River	157,360	140	70	35	20	23	20	61	20	
	Plane Creek	253,870	260	70	MCL	MCL	MCL	MCL	MCL	MCL	

Region	Catchment/ Basin	Area (ha)	Targets								Pesticide target to protect min 99% of aquatic species at end-of-catchment
			Dissolved inorganic nitrogen		Fine sediment		Particulate phosphorus		Particulate nitrogen		
			tonnes	% reduction	kilo-tonnes	% reduction	tonnes	% reduction	tonnes	% reduction	
Fitzroy	Styx River	301,340	MCL	MCL	MCL	MCL	MCL	MCL	MCL	MCL	
	Shoalwater Creek	360,180	MCL	MCL	MCL	MCL	MCL	MCL	MCL	MCL	
	Waterpark Creek	183,650	MCL	MCL	MCL	MCL	MCL	MCL	MCL	MCL	
	Fitzroy River	14,254,470	MCL	MCL	390	30	380	30	640	30	
	Calliope River	224,060	MCL	MCL	15	30	54	30	107	30	
	Boyne River	249,630	MCL	MCL	6	40	5	40	9	40	
Burnett Mary	Baffle Creek	408,470	16	50	11	20	15	20	33	20	
	Kolan River	290,450	34	50	6	20	5	20	14	20	
	Burnett River	3,319,540	150	70	85	20	29	20	68	20	
	Burrum River	337,170	93	50	3	20	3	20	8	20	
	Mary River	946,580	180	50	130	20	160	20	470	20	

Relative spatial management priorities

The relative spatial priorities for water quality improvement in the Reef catchments are based on the 2017 *Scientific Consensus Statement* assessment of relative risk, which assesses the likelihood of ecosystem exposure to anthropogenic pollutants from each river. This means that catchments with similar targets may have different relative priorities. For example, rivers in the Wet Tropics region flow into the crown-of-thorns starfish initiation zone and, therefore, nitrogen loads are a greater risk in this region. The Mary River flows into important seagrass habitats in Hervey Bay and, therefore, is a higher priority for sediment reduction than other rivers with similar targets.

Catchment management priorities have been identified as a result of biophysical assessment only. To determine priorities within catchments, human dimensions factors need to be considered.

Table 2 shows water quality targets for each catchment with the relative spatial management priority for water quality improvement.

Land management targets

Land management targets are based on increasing the area of land managed using best management practices for water quality outcomes. Work will continue to develop quantitative targets for other land uses such as for urban areas.

Catchment management targets

Threats to the Reef are numerous and can be located some distance from the Reef itself. The catchment management targets in this Plan address some key indicators that can be tracked with current monitoring programs to ensure progress is being made. As such, an integrated approach is required which considers multiple threats, values and benefits for the whole catchment.

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

The ground cover target focusses on late dry season ground cover levels across grazing lands, recognising that water quality risk is generally highest at the onset of the wet season. The target incorporates an area-based component (i.e. 90% of grazing lands will have achieved the ground cover target), while providing for natural variability in ground cover levels. Research supports a ground cover target of 70% to minimise erosion.

The wetlands target focusses on 'no loss' of natural wetlands. The condition of Reef wetlands is captured as an objective of improved water quality and is included under the ecosystem health theme in the Reef 2050 Plan.

The riparian vegetation target focuses on extent.

Human dimensions target

Human dimensions are defined as the human factors that exist at all social scales and play a role in shaping social, economic, cultural and environmental outcomes associated with the Reef. The focus on human dimensions recognises that the Reef needs to be considered as a socio-ecological system.

In the context of water quality, human dimensions include social, cultural, institutional and economic factors: from the aspirations and capacities of landholders, industries and communities, to their stewardship practices, and broader governance of the Reef.

The human dimensions target recognises that actively engaging the communities and land managers who influence water quality is critical to support progress towards land and catchment management outcomes. The human dimensions target will be further refined as the human dimensions indicators relevant to Reef water quality are identified and a baseline is developed.

Investing in outcomes for the Reef

The ongoing investment required to achieve the water quality improvement targets will need to continue to be supported by strong collaborative arrangements. Across governments, industry and the community, the Reef 2050 Plan Investment Framework identified more than \$1.28 billion has been committed to Reef actions over a five-year period, of which more than \$573 million is dedicated to improving the quality of water flowing to the Reef.

Investment will be sourced from the Australian Government's Reef Trust program, National Landcare Program and National Environmental Science Program's Tropical Water Quality Hub. The Queensland Government's major investment program is the Queensland Reef Water Quality Program with other actions delivered through broader government policy work and programs such as the Queensland Indigenous Land and Sea Ranger Program.

Australian Government

Reef Trust

More than \$700 million (2014-2015 to 2023-2024) has been allocated to the Reef Trust for cost effective, strategic, targeted investment for on-ground actions to improve water quality, improve the health and resilience of coastal habitats, and improve and protect marine biodiversity. Guided by the best available science and building on previous investments, the Reef Trust will continue to be delivered in phases in collaboration with the Queensland Government and the Great Barrier Reef Marine Park Authority, natural resource management organisations, non-government organisations and industry.

The Reef Trust—Great Barrier Reef Foundation Partnership has been established to implement key actions and outcomes of the Reef 2050 Plan. The Partnership specifically allocates \$201 million to address water quality by further improving farming practices, reducing fertiliser use and increasing the uptake of new technology and land management practices.

National Landcare Program

The National Landcare Program continues to be a source of funding for actions to improve water quality entering the Reef. In addition, outcomes and impacts from activities funded through the National Landcare Program can contribute to water quality improvements. Key components of the program include Reef 2050 funding and Regional Land Partnerships programs relevant to Reef catchments.

National Environmental Science Program

The National Environmental Science Program's Tropical Water Quality Hub's research commits nearly \$32 million (2014-2015 to 2020-2021) for innovative research into practical solutions to maintain and improve tropical water quality from catchment to coast.

Queensland Government

Queensland Reef Water Quality Program

The Queensland Reef Water Quality Program (QRWQP) was established by the Queensland Government to coordinate annual funding of \$35 million for implementing foundational water quality programs and \$90 million over five-years to implement the Great Barrier

Reef Water Science Taskforce's recommendations. In 2018 an additional \$13.8 million was committed to support the transition of graziers, and cane and banana growers to improved practices bringing the program total over \$261 million. The program is implemented jointly by the Queensland Department of Environment and Science, Department of Agriculture and Fisheries, and Department of Natural Resources, Mines and Energy in partnership with stakeholders.

The objective of the QRWQP is to progress the water quality targets under the Reef 2050 WQIP by enabling landholders to improve their management practices and the quality of water entering the Reef catchments. Associated outcomes contribute to farm enterprise productivity, profitability and sustainability addressing the community benefits identified in this Plan. The program also supports key research including field trials, and ongoing monitoring and evaluation.

Local government

Each year, Reef catchment councils invest more than \$100 million in day-to-day activities specifically to improve water quality and ecosystem health. Queensland's local governments have multiple roles in improving water quality in the Reef lagoon. Councils connect with their communities every day—from running awareness campaigns in local schools, libraries and environmental education centres, to creating erosion and sediment control demonstration sites and training courses for the construction industry.

They provide grants and in-kind support to community groups working to restore degraded creeks and waterways, and working with landholders to manage waterweeds and pests like feral pigs. In addition to fostering stewardship and increased capacity within the community and industry, local governments are responsible for enforcing state regulations relating to construction industry sediment and erosion control and stormwater improvements. As major land managers, they comply with many regulations that directly apply to their daily activities, from monitoring wastewater outflows and meeting license conditions, to installing fish passages as a part of bridge upgrades.

Reef catchment councils work together to improve practices and support each other's programs through the Reef Guardian Councils partnership with the Great Barrier Reef Marine Park Authority and the Reef Urban Stormwater Management Group.

Implementation

Implementation principles

The implementation activities in this Plan are designed to align with the following decision-making principles that underpin the Reef 2050 Plan:

Maintaining and enhancing Outstanding Universal Value in every action

- Protecting the Outstanding Universal Value of the World Heritage Area is the prime consideration when planning, development and management decisions are made.
- Values and ecological processes in poor condition are restored and values and ecological processes in good condition are maintained.
- Economic growth is sustainable and consistent with protecting Outstanding Universal Value.

Basing decisions on the best available science

- Decisions are based on the full range of knowledge, including scientific understanding, Traditional Owner and community knowledge.
- Decisions take into consideration information on the current and emerging risks associated with climate change.
- Management is adaptive and continually improving, informed by the outcomes of monitoring programs.

Delivering a net benefit to the ecosystem

- Decisions are underpinned by the principles of ecologically sustainable development, including the precautionary principle.
- Impacts are avoided and residual impacts mitigated.
- Offsets are considered only where impacts cannot be avoided or mitigated.
- Actions that restore ecosystem health and resilience — delivering an overall improvement in the Reef's condition—are fostered.

Adopting a partnership approach to management

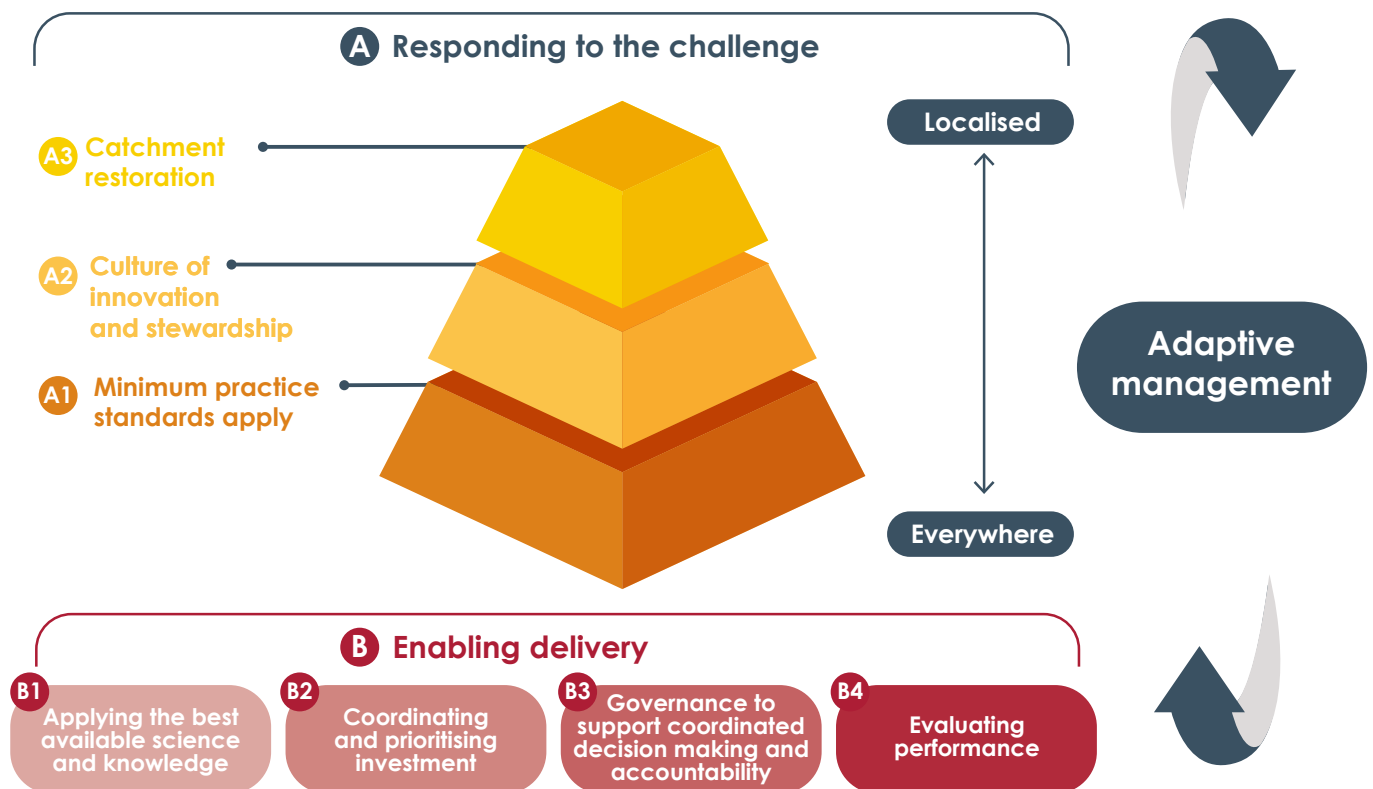
- Governance arrangements are transparent and accountable.
- Decisions continue to support a wide range of opportunities for sustainable economic, social and cultural activities, including traditional use.
- Management is cooperative; empowering partners, fostering stewardship and building community support.
- Delivery of local and regional actions is informed by engagement with Traditional Owners, industry, regional bodies, local governments and the community.
- Innovation in management is fostered.

Implementation of the Reef 2050 WQIP is structured around two bodies of work: (A) Responding to the challenge and (B) Enabling delivery (see Figure 5). The pathway to achieving the targets and associated intermediate outcomes and actions is captured in Figure 6.

The bodies of work are further divided into seven work areas that correspond directly to the recommendations of the *2017 Scientific Consensus Statement*.

This approach to implementation aligns actions with intermediate outcomes identifying *how* and *why* a desired change is expected to occur within each work area. Achieving the intermediate outcomes will support progress towards the Reef 2050 WQIP targets.

Figure 5. Implementing Reef 2050 WQIP



How we will progress towards the targets

This Plan recognises the need to urgently increase efforts to improve the quality of water flowing to the Reef. It meets this challenge by using an expanded scope of tailored solutions, outlined under the work areas below.

A. Responding to the challenge includes on-ground delivery actions to implement the changes required to support progress towards the targets. This is divided into three concurrently implemented work areas:

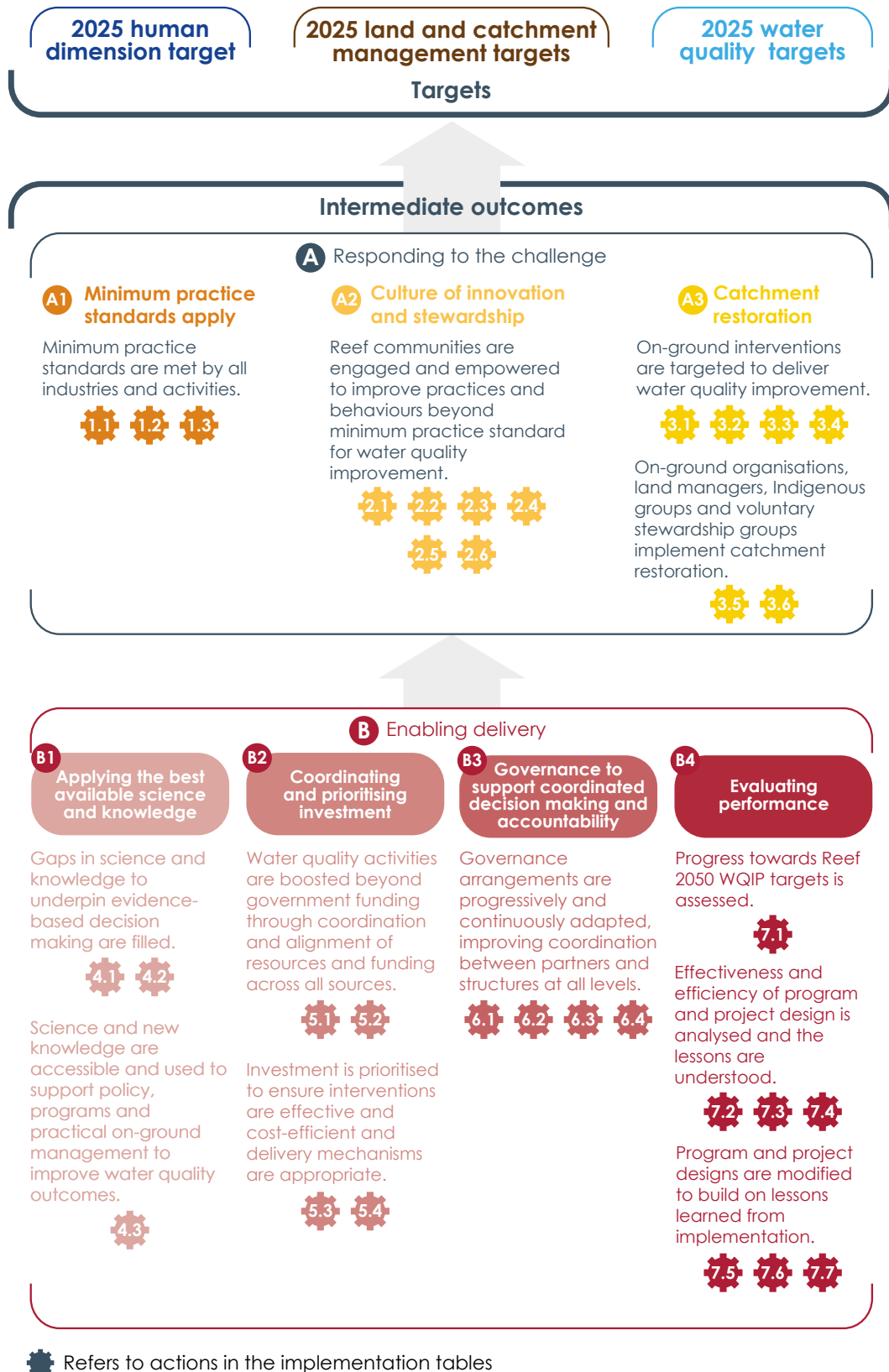
- A1. *Minimum practice standards* will be applied across all industries and land uses. Achieving this will eliminate the highest risk practices to deliver a step-change in progress towards the water quality targets across all catchments.
- A2. Industries and communities will be supported to build a *culture of innovation and stewardship*. This will deliver further improvements to water quality by building capacity of land managers to exceed minimum practice standards and trial innovations through a range of approaches that maintain viable communities and support lasting change.
- A3. *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 to the Reef, and improve biodiversity and the natural environment for all to enjoy.

B. Enabling delivery includes actions that support on-ground delivery through Responding to the Challenge, divided into four work areas:

- B1. *Best available science and knowledge* provides a foundation for improved on-ground responses.
- B2. *Investment* is coordinated, prioritised based on risk to the Reef and supported by local decision-making.
- B3. *Governance* supports coordinated decision-making and accountability of investments to the actions and outcomes of this Plan.
- B4. *Evaluating performance* tracks progress towards the targets and evaluates the effectiveness of activities to feed into the adaptive management of responding to the challenge.

Implementation tables outline the intermediate outcomes of each work area which link to the targets as shown in figure 6. The implementation tables also identify the pathways and actions to achieve the intermediate outcomes and the deliverables that will contribute to actions, with the lead parties and contributors. Tables A1 to A3 also identify the land and catchment management targets each work area contributes to and indicative measures for tracking progress. Descriptions following each table provide an overview of the rationale supporting the inclusion of various activities in each work area.

Figure 6. Pathway to Reef water quality improvement targets



Reef 2050 WQIP actions and deliverables

A: Responding to the challenge

The aim of this body of work is on-ground action across the range of land uses in Reef catchments to accelerate progress towards the targets. Existing information and tools will be used to prioritise efforts across catchments and land uses, acknowledging that agriculture is the predominant land use and, therefore, contributes the majority of land-based pollutants to the Reef.

Implementation table A1: Minimum practice standards apply everywhere

Contributes to achieving land and catchment targets:

- 90% of agricultural land in priority areas 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
 - improved management of urban, industrial and public land uses.

The following measures will help to track the impact of this work area:

- rate of compliance against minimum standards and legislative requirements
 - participation in best management practice programs
- effectiveness of minimum standards and legislative requirements to reduce water quality risk.

Intermediate outcomes	Pathway to intermediate outcomes	Actions	Delivery	Lead	Partners
Minimum practice standards are met by all industries and activities.	Minimum practice standards are set based on reducing risk to water quality and maintaining business profitability.	1.1 Implement minimum practice standards for agricultural industries, which can be met either voluntarily, e.g. through industry-led best management practice (BMP) programs, or as a result of regulation.	Mandate minimum practice standards for water quality in the <i>Environmental Protection Act 1994</i> for agricultural industries.	Queensland Government	
			Implement a targeted compliance program for Reef regulations to ensure minimum practice standards are met.	Queensland Government	
			Expand availability of BMP programs for all agricultural industries in all catchments.	Queensland Government	Industry, Natural Resource Management bodies
			Enforce <i>Vegetation Management Act 1999</i> , <i>Land Act 1994</i> , and <i>Water Act 2000</i> for water quality outcomes.	Queensland Government	
		1.2 Ensure that urban, industrial and mining activities comply with requirements under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> , <i>Planning Act 2016</i> , <i>Environmental Protection Act 1994</i> , and <i>Waste Reduction and Recycling Act 2011</i> .	Ensure any conditions for activities that are referred and assessed under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> as having a significant impact on a matter of National Environmental Significance, are complied with, reported annually and enforced under the Compliance and Enforcement Policy.	Australian Government	
			Implement water quality requirements under the State Planning Policy 2017 and update in local government planning schemes.	Queensland Government, local government	
			Build compliance capacity for erosion and sediment control during urban, industrial and infrastructure construction and maintenance.	Local government, Queensland Government	Industry
			Develop an accreditation process for organisations that deliver erosion and sediment control and urban stormwater management to provide an alternative mechanism for meeting regulatory requirements.	Queensland Government, local government	Industry
			Run community awareness campaigns to support reporting of illegal activities.	Local government, Queensland Government	
			Implement the Queensland Urban Stormwater Strategy.	Local government, Queensland Government	Industry, Natural Resource Management bodies
			Review and update water quality objectives and water quality guidelines at regionally relevant scales under the Environmental Protection Policy (Water) 2009.	Queensland Government	Local government
			Enforce requirements relating to water quality for industrial discharges by environmentally relevant activities under the <i>Environmental Protection Act 1994</i> .	Queensland Government	
			Use the Water Tracking and Electronic Reporting System to capture point source release monitoring and tracking data to inform environmental regulation.	Queensland Government	
			Implement plastic bag ban, container refund scheme and the plastic pollution reduction plan to reduce sources of waterway debris in Reef catchments.	Queensland Government, local government	
			Support councils in reducing litter and illegal dumping and enforcing compliance, e.g. through delivery of training, development of toolkits and community of practice guidelines.	Queensland Government	Local government
		1.3 Refine existing standards, regulations and planning frameworks as new information improves knowledge for all industries.	Ensure continuous improvement of Best Management Practice module content and standards, and accreditation and data reporting systems.	Agricultural industry, Queensland Government	
			Review regulations for agricultural environmentally relevant activities under the <i>Chemical Usage (Agricultural and Veterinary) Control Act 1988</i> to ensure currency with modern chemical standards and product references	Queensland Government	
			Update the Voluntary Market Based Nutrient Management and Point-source Water Quality Offsets Policies in line with new science and practice standards.	Queensland Government, local government	
			Review water quality standards for industrial development as part of the remake of the Environmental Protection Regulation 1998 and Environmental Protection (Water) Policy.	Queensland Government	
			Update the Queensland Public Lands Strategy in line with new science, policy, risks and management principles.	Queensland Government	

Minimum practice standards apply everywhere

The purpose of this intermediate outcome is to make a significant contribution to water quality through ensuring minimum practice standards are applied across all sectors and all land-based pollutant sources. It recognises the *2017 Scientific Consensus Statement* emphasising “agricultural diffuse sources of pollutants as the dominant contributor of land-based pollutant loads at a regional and Great Barrier Reef-wide scale”.

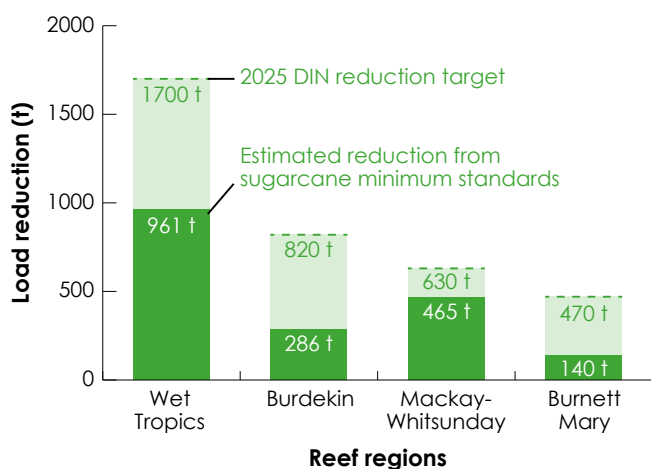
This work area will leverage existing regulation for urban and industrial land uses and expand regulation, as required, for all agricultural land uses. This responds to the Taskforce recommendation that regulation will be needed to achieve compliance by agricultural land managers operating below minimum acceptable standards, eliminate the highest risk practices and deliver significant progress towards the water quality targets across all catchments.

Agriculture

Adoption of minimum standards of agricultural practice will be achieved by a combination of voluntary, industry-led Best Management Practice (BMP) programs and regulation.

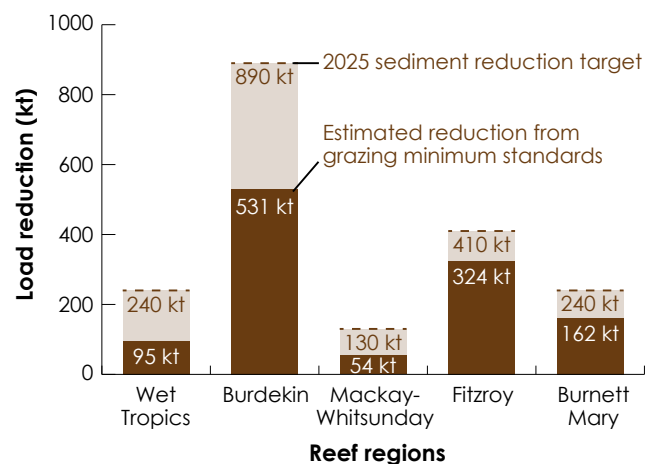
The modelling scenarios from the *Costs of achieving the water quality targets in the Great Barrier Reef* (Alluvium Consulting) estimate that achieving minimum standards (moderate to low risk) everywhere for sugarcane will deliver the following load reductions (in tonnes) and progress towards the 2025 regional targets for dissolved inorganic nitrogen (DIN).

Progress to dissolved inorganic nitrogen targets



Similarly, the modelling scenarios from the report estimate that achieving minimum standards (low risk) everywhere for grazing will deliver the following load reductions (in kilotonnes) and progress towards the 2025 regional targets for sediment.

Progress to sediment targets



The modelling scenarios are indicative estimates only and will be updated with newer information and improved modelling by 2020.

Urban and industrial lands

Urban development and industrial activities are already regulated. Water quality requirements (minimum standards) for urban land uses are set through the *Planning Act 2016* and the *State Planning Policy 2017*. The majority of compliance and development assessment for urban development is the responsibility of local governments. The Queensland Government invests in capacity building for local government and industry to implement effective compliance and development assessment programs.

Industrial land uses (environmentally relevant activities) are regulated under the *Environmental Protection Act 1994*. Examples of environmentally relevant activities include sewage treatment plants, aquaculture and some extractive and petroleum activities.

Work has begun to improve the Queensland Government Water Tracking and Electronic Reporting System (WaTERS) to capture and make available, point source release monitoring and tracking data and information.

Public lands

Improved management of public lands is important for decreasing diffuse source water pollution and fostering a sense of collaborative effort. In particular, unsealed roads and road construction activities can be a major source of sediment for some catchments. The Reef Water Quality Protection Plan Public Lands Strategy 2009 will be updated to review and improve management of public lands.

Vegetation management

The 2015-2016 State-wide Landcover and Trees Study report identifies that woody vegetation clearing rates in Reef catchments have increased substantially since 2012. This increase in woody vegetation clearing may have negative impacts in terms of sediment run-off to the Reef. Chapter two of the 2017 Scientific Consensus Statement identifies that: *"Clearing of forest can result in a doubling of run-off. In general, if tree clearing and any associated land use change expose and/or disturb the soil surface, then water and sediment loss are likely to increase. Additionally, there is an enormous amount of literature demonstrating that vegetation in riparian zones has positive benefits in terms of reduced channel erosion"*.

The Queensland Government is committed to strengthening and enforcing vegetation clearing laws under the Vegetation Management Act 1999.

Plastic pollution

The increased presence of waste plastics, including micro-plastics, is an emerging pollution threat to the Reef. Chapter one of the 2017 Scientific Consensus Statement states that: *"Marine debris has been detected along the coastlines and in coastal and marine waters of the Reef. Fragmentation of marine plastics will ultimately contribute to micro plastics contamination, which has recently been documented in Great Barrier Reef waters. Studies identified that micro plastic fragments are most likely derived from single-use disposable packaging and fishing equipment"*.

The Queensland Government is taking steps to address this emerging threat by banning the supply of single-use plastic shopping bags and introducing a beverage container refund scheme. The plastic bag ban will commence on 1 July 2018, while the beverage container refund scheme will commence on 1 November 2018. Queensland is also developing a plastic pollution reduction plan that will consider other sources of plastic pollution. Local governments enforce littering laws and ensure the implementation of water sensitive urban design and litter racks to capture solid waste.



Implementation table A2: Culture of innovation and stewardship

Contributes to achieving land and catchment targets:

- 90% of agricultural land in priority areas 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
 - improved management of urban, industrial and public land uses
 - increase in active engagement of communities and land managers in programs to improve water quality.

The following measures will help to track the impact of this work area:

- changes in uptake or participation by land managers across projects and initiatives
 - changes in knowledge, attitudes, skills and aspirations of land managers and communities
- changes in management practice made by land managers.

Intermediate outcomes	Pathway to intermediate outcomes	Actions	Delivery	Lead	Partners
Reef communities are engaged and empowered to improve practices and behaviours beyond minimum practice standard for water quality improvement.	Build capacity and capability of land managers, industries and local governments to improve practices.	2.1 Support land managers, industries and local governments to adopt improved management practices, e.g. through coordinated extension, education and awareness programs.	Implement the recommendations from the Practice Change, Education and Extension in Reef Catchments review report to enhance extension delivery, coordination and capacity.	Queensland Government	
			Deliver extension and education targeted at adoption of improved practices (including protection of wetlands) through the Reef Water Quality Program and Reef Trust projects, e.g. BMP extension and education, Project Pioneer –Innovation in Grazing Management, and Reef Alliance – Growing a Great Barrier Reef.	Queensland Government, Australian Government	Industry, Natural Resource Management bodies
			Promote and increase use of decision support tools and databases in on-ground management, e.g. VegMachine, Forage and WetlandInfo.	Queensland Government	Local government, Industry, Natural Resource Management bodies
			Deliver projects focused on behaviour change that minimise negative impacts of water quality from agricultural areas, such as Cane Changer, Science in the Paddock, Major Integrated Projects and Reef Trust (e.g. Project Pioneer).	Queensland Government, Australian Government, local government	Industry, Natural Resource Management bodies
			Deliver communication and education activities to foster behaviour within communities and industries that minimise negative impacts on water quality from urban areas, e.g. Urban Stormwater Capacity Building project, Burdekin Shire Council Schools Littering and Recycling education program and Cairns Regional Council's Nature-based Learning Grant.	Local government	Great Barrier Reef Marine Park Authority, Natural Resource Management bodies, Healthy Land and Water
			Build capacity of local governments and industry to design, deliver and maintain: <ul style="list-style-type: none">• total water cycle management, e.g. through continuing to support the Reef Urban Stormwater Improvement Management Group.• water sensitive urban design into new and existing urban and industrial development.	Queensland Government, local government	Industry, Natural Resource Management bodies
			Facilitate erosion and sediment control training for local governments and industry to reduce pollutants from urban areas.	Queensland Government, local government	
		2.2 Empower stewardship leaders to influence peers and the broader community to adopt improved practices.	Facilitate peer to peer learning, mentoring and influencing opportunities, e.g. through the Reef Water Quality Education and Extension Program, Major Integrated Projects, Science in the Paddock Program, Urban Stormwater Capacity Building Project and Reef Trust's Project Uplift.	Queensland Government, Australian Government, local government	Industry, Natural Resource Management bodies
			Ensure Reef Guardians and other stewardship leaders have knowledge and skills to enhance their capacity to influence stewardship of the Reef.	Great Barrier Reef Marine Park Authority	Queensland Government, Australian Government, local government, Natural Resource Management bodies
			Continue to participate in the Reef Guardian Councils program, and encourage and incentivise Reef Catchment Councils to join the program.	Local government	
	Build motivation, capacity and capability of extension and education providers.	2.3 Support extension and education providers to deliver effective extension and education programs that reach a broad audience of land managers.	Expand capacity and skills of extension officers, e.g. through piloting an agriculture capacity building program to employ and train graduate officers; and considering continuation of this pilot.	Queensland Government	Industry, Natural Resource Management bodies
			Increase student motivation to complete agriculture science qualifications.	Queensland Government, agriculture industry	
	Barriers to participation and change are reduced or removed.	2.4 Identify and address barriers to change and practice improvement uptake through programs and policy.	Undertake targeted research about barriers and motivators as part of existing projects and programs, e.g. the Cane Changer Project, Major Integrated Projects, Reef Water Quality Extension and Education, and Science in the Paddock programs.	Queensland Government	
			Conduct economic evaluations to validate the economics of management practices that improve water quality and provide information to landholders as part of the extension program.	Queensland Government	
			Support the sugarcane industry to overcome barriers to adopting more efficient farming systems through the Reef Trust Project Uplift Farming Systems Initiative.	Australian Government	
		2.5 Provide incentives to support land managers, including Traditional Owners, with practice change.	Investigate, develop and implement market-based incentive options to support adoption of practices, e.g. trial Reef Credits under the Major Integrated Projects and continue reverse tenders under the Reef Trust.	Australian Government, Queensland Government	
			Deliver grants and incentives to support adoption of improved practices through Reef Trust projects.	Australian Government	Natural Resource Management bodies, industry, local government
		2.6 Trial and implement innovative monitoring, land management and treatment system solutions that aim to deliver water quality benefits.	Deliver the Great Barrier Reef Innovation Fund to trial innovative water quality monitoring, agricultural management practices, and water treatment systems and identify new 'best practices'.	Queensland Government	
			Implement Reef Trust projects to trial targeted approaches to water quality improvement, e.g. cane farmer trials of enhanced efficiency fertiliser in the Great Barrier Reef Catchments project.	Australian Government	
			Foster innovation and continuous improvement in the management and release of point-source discharges and industrial land run-off. Develop leading practice standards based on successful trials to encourage broader adoption of improved management.	Local government, industry	Queensland Government
			Deliver on-ground projects to implement agricultural management and treatment systems that successfully deliver water quality benefits, e.g. through the Science in the Paddock and Reef Trust programs.	Australian Government, Queensland Government	

Culture of innovation and stewardship

The 2017 Scientific Consensus Statement recommends that “greater incorporation of social and economic factors” and “exploration of alternative management options and increased support and resources” are needed to achieve improvements toward the water quality targets. The Statement also confirms “there is an urgent need for greater investment in voluntary practice change programs”.

The Statement recommends that governments and partners “introduce tailored practice change programs that target different groups of landholders, industry organisations and service providers to design and deliver programs” and “develop and implement a broader range of management options for pollutant reduction from all land uses”.

Industries and communities will be supported to build a culture of innovation and stewardship. Implementation table A2 outlines intermediate outcomes and actions to engage land managers to go beyond minimum standard and build on improvements to water quality. Extension and education programs will be expanded and enhanced to reach more farmers and complemented by other practice change programs such as Cane Changer. These programs facilitate local leadership and connections to get communities working together for positive change that leads to water quality improvements.

Programs to develop and trial innovative and new solutions for implementation on farm respond to the recommendations in the 2017 Scientific Consensus Statement to “test and validate the water quality effectiveness of wetland and treatment systems in specific locations to support broader application”. Such innovations have the potential to deliver solutions that may be more cost-effective or enable more rapid improvements.

The Queensland Government is actively encouraging a culture of innovation and stewardship to improve water quality in urban environments. It is doing this through investing in science, technology and capacity building to develop new best practice guidelines for urban stormwater management, and erosion and sediment control. This will assist urban-based industries and local governments to deliver water quality improvements.

Urban communities also need to be knowledgeable about the water cycle and how day-to-day activities and decisions affect local waterways. The 2017 Scientific Consensus Statement recommends incorporating “total water cycle management in expanding urban areas”. Local government and many Natural Resource Management bodies play an important role in building awareness and local community knowledge of water issues in Reef catchments. Local information sharing workshops (facilitating an erosion and sediment control ‘Community of Practice’) can also serve as a vehicle for developing regional or local campaigns to increase local community “water literacy” about the importance of good urban stormwater management and erosion and sediment control on urban construction sites. A water literate community is more likely to drive voluntary compliance with adopting industry best practice guidelines under legislative requirements.

The Great Barrier Reef Marine Park Authority's Reef Guardian program recognises examples of good environmental stewardship within Reef catchment communities and industries and empowers those involved to influence others. Many other programs and investments in Reef protection promote voluntary practice change and influence Reef stewardship. Collaboration and adding value to such investments are guiding operational principles for the Reef Guardian program. Program activities aim to build a network of informed, connected and empowered environmental stewards influencing community stewardship of the Reef.



Implementation table A3: Catchment restoration

Contributes to achieving land and catchment targets:

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

The following measures will help to track the impact of this work area:

- the cost of, and benefits generated by, interventions as part of project and program monitoring
 - changes in engagement by stakeholders through projects and initiatives
- outcomes achieved through partnerships, including new partnerships.

Intermediate outcomes	Pathway to intermediate outcomes	Actions	Delivery	Lead	Partners
On-ground interventions are targeted to deliver water quality improvement.	Information supports the design of interventions, including locations and methods.	3.1 Use whole-of-system catchment management, planning and information to support prioritisation.	Use modelling, gully, ground cover, riparian extent, wetland and Walking the Landscape mapping to identify sites for on-ground intervention that maximise water quality benefits and consider co-benefits.	Queensland Government, Australian Government	
		3.2 Use guidelines, Traditional knowledge and decision support tools to design and inform interventions.	Implement the Queensland Wetlands Program to deliver wetlands tools and WetlandInfo to support on-ground management of wetlands. Use the Gully and Stream Bank Toolbox and lessons from relevant monitoring and research projects to inform design and selection of site remediation actions.	Queensland Government Program delivery agents	
	Innovative approaches are used to continuously improve methodologies for catchment repair for water quality improvement.	3.3 Trial and implement innovation in catchment repair projects to reduce sediment and nutrient delivery to the Reef.	Trial innovative approaches to catchment repair, e.g. through Major Integrated Projects, Innovative Gully remediation projects and Creek to Coral projects.	Queensland Government, Australian Government, Greening Australia	Local government, Natural Resource Management bodies, industry
			Deliver targeted catchment repair projects including riparian revegetation, gully repair, streambank stabilisation and coastal wetlands rehabilitation through the Major Integrated Projects, Land Restoration Fund and Reef Trust (e.g. the Gully Erosion Control projects and the Reef Trust/Greening Australia partnership).	Queensland Government, Australian Government, local government	Natural Resource Management bodies, industry
		3.4 Modify existing urban area stormwater management and rehabilitate urban waterways.	Identify and prioritise strategic opportunities for pollution reduction in urban waterways.	Local government	
On-ground organisations, land managers, Traditional Owner groups and voluntary stewardship groups implement catchment restoration.	Strong and collaborative partnerships are developed to deliver on-ground catchment repair interventions.	3.5 Partner with voluntary stewardship groups, Traditional Owner groups, Indigenous Land and Sea Rangers and other organisations to deliver catchment repair projects.	Expand the Queensland Indigenous Land and Sea Ranger program in Reef catchments. Align the work of Indigenous Land and Sea Ranger teams to deliver catchment repair interventions that address water quality.	Queensland Government	
		3.6 Support the development of ground up, multi-stakeholder programs for the delivery of catchment repair projects.	Strengthen regional partnerships (such as Reef Alliance, regional waterway health and water quality reporting partnerships) to support water quality improvement initiatives aimed at on-ground actions, monitoring and reporting.	Queensland Government, Australian Government, local government	Industry, Natural Resource Management bodies

Catchment restoration

The Taskforce identified the need to include catchment restoration to meet the water quality targets: *"Achieving ecosystem restoration and repair is considered particularly important, recognising that best management practice alone will not meet the water quality targets and that restoration in strategic locations is expected to contribute to better outcomes for water quality and overall Reef health"*.

The 2017 Scientific Consensus Statement emphasises that *"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"*. The Statement notes *"Sediment source tracing in several catchments has identified that approximately 90% of fine sediment delivered to the Great Barrier Reef is from sub-surface erosion (which could be derived from gully, bank, scald or deep rill erosion)"*. The drivers for high anthropogenic sediment loads include poor land cover and surface condition that leads to high runoff and erosion, particularly in the case of gully erosion. Although local factors such as soil type are also important. Many catchment management issues are a legacy of past land management practices and government policies designed to promote the expansion of agriculture in Queensland. This led to extensive land clearing and management decisions that were later identified to be causing water quality issues for the Reef. Addressing these legacy issues goes beyond current management practice.

Implementation table A3 outlines a range of activities focussing on riparian vegetation, streambanks, gullies, waterways and wetlands, building on work previously undertaken. To deliver optimum outcomes, a culture of ownership, innovation and stewardship across a broad range of stakeholders will be required.

This work will also help to address legacy issues from past development and land use change, slow the movement of water to the Reef, and help to stop erosion occurring. Catchment restoration will also improve biodiversity and ecosystems, helping to reduce carbon emissions through carbon sequestration. A range of catchment restoration activities is underway across Reef catchments, which includes trialling new and innovative approaches and delivering tried and tested catchment repair solutions. Trialling innovations in gully repair is expected to identify more cost-effective methods of remediation.

This Plan continues the principle of prioritising investment at targeted sites by applying appropriate catchment restoration actions to maximise water quality benefits and deliver co-benefits, e.g. for biodiversity, ecosystem health and carbon emissions. A range of information sources and tools is available to support the prioritisation of these activities including regional Water Quality Improvement Plans.

The catchment projects outlined in implementation table A3 promote the ongoing partnership approach in progressing water quality improvement involving all levels of government, regional Natural Resource Management bodies, industry peak bodies, communities, land managers and Traditional Owners.

Great Barrier Reef Gully and Streambank Joint Program

The Australian and Queensland governments' Great Barrier Reef Gully and Streambank Joint Program brings together government, corporate and philanthropic funding to deliver a cohesive joint program of erosion management and sediment reduction. This program has committed approximately \$46 million over six years, establishing the foundation for greater collaborative efforts into the future.

B: Enabling delivery

To accelerate progress towards meeting the Reef 2050 WQIP targets, on-ground management programs and activities need to be supported by robust science, coordinated investment efforts, and effective governance and evaluation arrangements. The Taskforce final report concluded that governance and investment in water quality programs and research needs to be better coordinated, targeted, and aligned across governments in order to improve the delivery of water quality outcomes.

The Australian, Queensland and local governments will continue to work together with partners to ensure that Reef water quality investment is coordinated and aligned, research is targeted and informs investment priorities, investment is boosted beyond government funding, and appropriate governance structures are in place to support on-ground management.



Implementation table B1: Applying the best available science and knowledge

Underpins evidence-based decision-making and informs on-ground actions to meet water quality improvement outcomes.

The following measures will help to track the impact of this work area:

- extent to which priority research gaps are being addressed
- extent to which new knowledge is communicated to a broad range of users.
- extent to which knowledge generated through synthesis workshops informs projects and programs

Intermediate outcomes	Pathway to intermediate outcomes	Actions	Delivery	Lead	Partners
Gaps in science and knowledge to underpin evidence-based decision making are filled.	Research and knowledge generation are collaborative and targeted at addressing on-ground delivery knowledge gaps.	4.1 Identify, prioritise and fill knowledge gaps through the Reef 2050 WQIP Research, Development and Innovation (RD&I) Strategy.	Update the Reef 2050 WQIP RD&I Strategy utilising the 2017 Scientific Consensus Statement.	Queensland Government, Australian Government, research institutes	
			Address priority gaps in the Reef 2050 WQIP RD&I Strategy through Reef water quality research and development programs, e.g. the NESP Tropical Water Quality Hub.	Queensland Government, Australian Government (including Great Barrier Reef Marine Park Authority and National Environmental Science Program), research institutes	
		4.2 Integrate forms of knowledge including science, policy, management, Traditional Owner and community through regular synthesis workshops and theme-specific working groups to support consistent communication messages and guidance for managers.	Hold regular science – policy – management synthesis workshops.	Queensland Government, Australian Government	
			Capture on-ground management knowledge and expertise to provide guidance for program designers and managers.	Queensland Government, Australian Government	
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.	4.3 Deliver decision support tools, communication and education products tailored to specific audiences.	Implement the Great Barrier Reef Science Communication Implementation Plan and continue to coordinate water quality communication activities through the Reef 2050 Communication Network.	Queensland Government, Australian Government including Great Barrier Reef Marine Park Authority	
			Develop new tools and technologies to support land managers and program managers, e.g. develop a Land Condition Assessment Tool and an online tool to calculate expected water quality impacts of farm management changes.	Queensland Government	Natural Resource Management bodies, science and research institutions

Applying the best available science and knowledge

The Taskforce advised that improved alignment of research and innovation would enhance the ability to deliver substantial water quality improvements. The intermediate actions and outcomes in implementation table B1 are designed to apply the science to the areas of highest priority.

The Queensland and Australian governments will work with research institutes and other partners to identify research needs in relation to Reef water quality in a joint Reef 2050 WQIP Research, Development and Innovation Strategy (RD&I Strategy). This RD&I Strategy will build on the identified research gaps in the *2017 Scientific Consensus Statement*.

The key programs that contribute to Reef water quality research under the RD&I Strategy include the National Environmental Science Program's Tropical Water Quality Hub and the Queensland Government Science in the Paddock Program. The Tropical Water Quality Hub funds innovative research for practical solutions to maintain and improve water quality from catchment to coast. The Science in the Paddock Program funds on-ground research to support agricultural land managers to trial and implement improved practices for water quality outcomes. Other programs that conduct research focused on broader goals (e.g. industry productivity) may also help to fill research gaps relevant to Reef water quality.

To support the ongoing integration of research, policy making and management practice, a regular synthesis workshop will be held to bring together scientists, policy makers, program managers, land managers and Traditional Owners.

Enhanced science communication tools are being developed to ensure new knowledge relevant to Reef water quality is communicated in a coordinated way through a range of platforms. The Reef 2050 Communication Network will continue to meet on an ongoing basis to support consistent communication messages and coordination of activities across governments and partners.



Implementation table B2. Coordinating and prioritising investment

All investment streams are prioritised, aligned and coordinated to deliver water quality improvements.

Intermediate outcomes	Pathway to intermediate outcomes	Actions	Delivery	Lead	Partners
Water quality activities are boosted beyond government funding through coordination and alignment of resources and funding across all sources.	Investment sources are expanded and diversified.	5.1 Identify opportunities for innovative financing mechanisms to amplify funding for water quality outcomes.	Use market-based instruments, e.g. Reef credits and green bonds Land Restoration Fund, Clean Energy Finance Corporation, to expand investment sources.	Queensland Government, Australian Government	
		5.2 Identify opportunities for co-investment or alignment of funds and resources with industry, research organisations, philanthropists, Natural Resource Management bodies, community and corporate organisations to achieve water quality objectives.	Expand successful co-investment partnerships with organisations such as Greening Australia, MSF Sugar and Great Barrier Reef Foundation and create new partnerships. For example, Reef Trust will continue to explore opportunities for co-investment and collaboration.	Australian Government, Queensland Government	Natural Resource Management bodies, industry
			Use Reef Trust to consolidate funding from offsets and apply in a strategic manner for the most effective outcomes.	Australian Government	
			Expand on cross-government co-investment opportunities.	Australian Government, Queensland Government, local government	
Investment is prioritised to ensure interventions are effective and cost-efficient and delivery mechanisms are appropriate.	Decision support tools are used to prioritise investment locations, timeframes and interventions.	5.3 Prioritise investment across Reef catchments according to catchment priorities and targets.	Use decision support tools, Walking the Landscape workshops, regionally developed plans and modelling scenarios, e.g. eReefs and Source Catchments, to determine program priorities.	Australian Government, Queensland Government, local government	
			Operationalise the Reef Water Quality Costing Tool developed by Alluvium Consulting to inform the most cost-effective mix of interventions to improve water quality across Reef catchments.	Queensland Government	
	A mix of investment mechanisms is used to achieve cost efficiencies.	5.4 Identify the benefits and appropriate applications of different investment mechanisms.	Apply the lessons from the various funding and investment projects, such as Major Integrated Projects, reverse tenders and green bonds, to future delivery of Reef 2050 WQIP outcomes.	Australian Government, Queensland Government	

Coordinating and prioritising investment

The principles of strategic, cost-effective investment to address priority actions to improve water quality will continue to underpin government investment into Reef water quality improvement. Options to expand the pool of funding will also continue to be investigated and implemented including:

- **Leveraging** funding through co-investment partnership arrangements, such as existing partnerships with Greening Australia through the Queensland Government Innovation Fund and Reef Trust.
- **Innovative financing mechanisms** to boost funding beyond government sources. The Taskforce Report recognised that market-based approaches such as water quality credit trading offered a potential mechanism for facilitating future economic expansion within end-of-catchment nutrient and sediment load targets.
- A **'Reef Credits' scheme** under the Major Integrated Projects, which will create a market where landholders can create and sell Reef Credits to buyers including government, industry and not-for-profit organisations. The National Environmental Science Program is also exploring trading in water quality credits.
- **Other funding instruments** such as Clean Energy Finance Corporation loan facilities.
- **Financial offsets** derived from projects that impact on Great Barrier Reef Marine Park and World Heritage Area Matters of National Environmental Significance. These funds can be paid into the Reef Trust and, subsequently, used to invest in a number of offsetting actions including improving water quality.

Governments will use the Reef 2050 WQIP catchment management priorities and targets to direct regional investment. Modelling scenarios and local and regionally developed plans, in particular the regional Water Quality Improvement Plans and other decision support tools, will also assist with prioritising investment at a finer scale. This will build on the *2017 Scientific Consensus Statement* and the *Great Barrier Reef Outlook Report*.

In 2016, the *Costs of achieving the water quality targets for the Great Barrier Reef* (Alluvium Consulting) report combined water quality modelling scenarios with economic modelling to estimate the costs of undertaking a number of management actions to achieve the Reef 2050 Plan water quality targets. This work provided a significant step toward understanding the total investment requirements and will be built upon in developing a Reef Water Quality Costings tool. This will involve updating the modelling scenarios and estimated costs of activities based on the latest science and knowledge and rerunning the analysis against the end-of-catchment targets in this Plan. This work will be completed in time to inform the update of the Reef 2050 Investment Framework following the full review of the Reef 2050 Plan in 2020.



Implementation table B3. Governance to support coordinated decision-making and accountability

Ensures decision-making at appropriate levels and accountability of investments with Reef 2050 WQIP outcomes.

Intermediate outcomes	Pathway to intermediate outcomes	Actions	Delivery	Lead	Partners
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, in line with the Reef 2050 Plan governance structures.	Hold regular Executive Steering Committee meetings in accordance with agreed Terms of Reference.	Australian Government including Great Barrier Reef Marine Park Authority, Queensland Government	
			Hold regular Independent Expert Panel and Independent Science Panel meetings.	Australian Government, Queensland Government	
	Policy, regulatory mechanisms, on-ground delivery and funding strategies are aligned.	6.2 Ensure program design aligns with water quality priorities.	Deliver the Queensland Reef Water Quality Program Plan to show how investment aligns with Reef 2050 WQIP work areas and priorities.	Queensland Government	
			Deliver phased investment strategies for Reef Trust addressing critical areas for investment and aligned to Reef 2050 WQIP targets.	Australian Government	
		6.3 Ensure accountability of investment to outcomes in the Reef 2050 WQIP.	Review Reef Trust governance arrangements, as required, and in response to the Reef Trust mid-term evaluation.	Australian Government	
			Deliver Queensland Reef Water Quality Program annual investment plans outlining how funds will be expended, aligned to Reef 2050 WQIP work areas and priorities.	Queensland Government	
	Coordinated partnerships ensure effective delivery and implementation of Plan outcomes.	6.4 Include all stakeholders including local organisations, communities and Traditional Owners in decision-making and priority setting.	Provide annual investment reports for the Queensland Reef Water Quality Program and Reef Trust outlining how funds have been expended.	Queensland Government, Australian Government	
			Representation and engagement on partnerships and committees.	All regional partners	
			Establish mechanisms to ensure decision-making across all levels of government is coordinated and delivers water quality improvement outcomes.	Local Government Association of Queensland, Queensland Government, Australian Government including Great Barrier Reef Marine Park Authority, local government	

Governance to support coordinated decision-making and accountability

The 2017 Scientific Consensus Statement identifies that: *"The governance of the Great Barrier Reef represents a 'wicked' problem that is resistant to solution because of its inherent complexity. Coordination between governments and government programs is critical to provide clear policy signals and effective action in agricultural land use and management"*. This evidence highlights that Great Barrier Reef governance requires adaptive, participatory and transdisciplinary approaches.

The Statement recommends several governance reforms to:

- *"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"*
- *"encourage experimentation and innovation by scientists working with local stakeholders to develop, test and evaluate potential new solutions"*.

These approaches will be crucial given the expanded scope of the Reef 2050 WQIP to include all land-based pollutant sources including urban diffuse, point source and industrial discharge.

The activities outlined in implementation table B3, address the governance recommendations from the Statement. They support decision-making at appropriate levels and ensure on-ground programs, research, investment and communication are coordinated and contribute to Reef 2050 WQIP targets. All work is underpinned by administrative arrangements that ensure funds are acquitted and managed appropriately.

Key governance arrangements include the Great Barrier Reef Ministerial Forum that oversees Reef decision-making, and the Australian and Queensland government Executive Steering Committee which collaborates, jointly manages work programs and aligns policy, regulatory mechanisms, on-ground delivery and funding strategies.

Reef Trust governance and administrative arrangements sit alongside arrangements for the Reef 2050 WQIP. They ensure all Reef Trust funds are effectively managed and directed towards priority on-ground actions.

The Reef 2050 Independent Expert Panel provides advice on Reef Trust funding priorities. The Reef Independent Science Panel provides scientific expertise to guide reporting, monitoring and evaluation on water quality programs.

Partnerships with local organisations, Natural Resource Management bodies, industries, community groups and Traditional Owners will guide local delivery and implementation of the Plan. They will inform decision-making and priority setting through regional partnerships and representation on the Reef 2050 Advisory Committee.



Implementation table B4. Evaluating performance

Ensures progress towards the targets is tracked and activities are evaluated to feed into adaptive management of programs.

Intermediate outcomes	Pathway to outcomes	Actions	Delivery	Lead	Partners
Progress towards Reef 2050 WQIP targets is assessed.	Fit-for-purpose data and information are collected and analysed regularly.	7.1 Monitor and model management practice and water quality improvements through the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef).	Deliver the Paddock to Reef program.	Queensland Government, Australian Government, including Great Barrier Reef Marine Park Authority	
			Incorporate water quality risk management practice frameworks for urban and industrial land uses into the Paddock to Reef program.	Queensland Government	
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.	Develop and apply management practice frameworks for urban, industrial land uses.	Queensland Government, regional partnerships, local government, industry	
		7.3 Assess the water quality and human dimensions outcomes of projects within a consistent evaluation framework.	Develop a baseline for a variety of practice, behavioural and attitudinal drivers that influence Reef water quality. The baseline will be consistent with related Reef 2050 Plan targets.	Queensland Government	
			Develop and implement a water quality focused human dimensions monitoring and reporting program to inform the Reef 2050 Integrated Monitoring, Modelling and Reporting Program.	Queensland Government	Great Barrier Reef Marine Park Authority
		7.4 Evaluate the effectiveness of programs, governance mechanisms and adaptations.	Develop an evaluation framework for programs to inform investment and the mix of mechanisms used to achieve water quality actions and targets.	Queensland Government	
			Evaluate effectiveness of the Queensland Reef Water Quality Program and provide guidance for adaptive management.	Queensland Government	
			Monitor, evaluate and report on the performance of Australian Government projects that contribute to Reef 2050 WQIP.	Australian Government	
			Evaluate effectiveness of joint governance arrangements and committees.	Queensland Government, Australian Government, including Great Barrier Reef Marine Park Authority	
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.	Regularly release a Great Barrier Reef Water Quality Report Card.	Queensland Government, Australian Government, Great Barrier Reef Marine Park Authority	
			Report on implementation of Reef 2050 WQIP actions through Reef 2050 Plan implementation reporting.	Queensland Government, Australian Government	
		7.6 Communicate regionally relevant information for management decisions and local communities.	Provide support for Regional Report Card Partnerships to produce regional report cards.	Queensland Government, Australian Government	
			Continue to build cultural reporting capacity in regional report cards (including ranger programs).	Regional partnerships	
		7.7 Make data and information publicly available through a range of communication products.	Evolve reporting platforms to improve public availability and visualisation of data and information, e.g. disseminate progress of Reef 2050 WQIP implementation through the Monitoring, evaluation, reporting and improvement tool (MERIT) database.	Queensland Government, Australian Government, including Great Barrier Reef Marine Park Authority	
			Use the eReefs platform to show what is happening on the Reef and provide scenarios to guide prioritisation, risk assessment, target setting and assess water quality condition.	Commonwealth Scientific and Industrial Research Organisation, Bureau of Meteorology, Australian Institute of Marine Science, Great Barrier Reef Foundation, Queensland Government	

Evaluating performance

Adaptive management is fundamental to ensure continuous improvement of Reef water quality programs and initiatives. The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program) will continue to provide the principal framework for evaluating progress towards Reef 2050 WQIP targets, reported regularly through the Great Barrier Reef Report Card.

The program collects and integrates data and information on agricultural management practices, catchment indicators, catchment loads and the health of the Reef. It monitors and models the impact management practice change is having on water quality improvement at a number of scales: catchment, paddock scale and marine. The data is analysed to determine the progress towards the targets.

The Paddock to Reef program will undergo a five year review and be expanded to include urban, industrial (including mining), and public land uses by developing management practice frameworks to assess water quality management on these land uses.

The Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) is the overarching reporting program for the Reef 2050 Plan. The Paddock to Reef program will continue to be the reporting program for catchment water quality and will feed information into the broader RIMReP.

The Paddock to Reef program provides quantitative measures of the impact of water quality improvement activities. In addition, the effectiveness and efficiency of water quality programs, project design and governance, will be analysed to determine their successes and failures. This data will be consolidated in order to guide program and project decision making and delivery. An evaluation framework is being developed for the Queensland Reef Water Quality program to inform the mix of mechanisms used to increase progress towards the water quality targets. This framework will underpin annual program evaluations and enable adaptive management.

A range of factors influence an individual's willingness and capacity to make practice improvements to achieve water quality outcomes – the 'human dimensions'. The importance of understanding these factors and designing programs and interventions accordingly has been given priority in this Plan. A baseline for a variety of practice, behavioural and attitudinal drivers and barriers that influence reef water quality will be developed to deliver an understanding of the current situation. A water quality focused human dimensions monitoring and reporting program will be developed and implemented, linking with the broader human dimension monitoring within the RIMReP.

The joint governance arrangements and various Reef committees are evaluated through regular reviews and self-evaluations. In addition, funding has been allocated to evaluate different governance mechanisms for enhanced program delivery.



Communication of information and data

Clear and transparent communication regarding the health of the Reef and the effectiveness of management initiatives is vital for decision-makers, the community and stakeholders.

The results from the Paddock to Reef program are reported in the Great Barrier Reef Report Card. The report card tracks the progress toward the Reef 2050 WQIP targets and reports on the condition of the marine environment. It is the prime mechanism for evaluating the success of the combined Australian and Queensland government programs. The Report Card ensures that progress data and information are available to inform stakeholders and decision-makers.

Program reporting platforms are reviewed regularly to improve the availability and visualisation of data. For example, Paddock to Reef's catchment monitoring program is trialling an innovative application interface to view Reef water quality monitoring data in real time. This approach could be extended to provide public access. Work is underway to develop visualisation products for Reef catchment modelling and a geospatial database for agricultural management practice data.

The Great Barrier Reef Report Card is complemented by regional waterway health report cards that provide information relevant to local communities and decision-makers on the health of their waterways. The report cards are produced by the regional waterway health partnerships. The partnerships will continue to evolve their report cards to ensure they meet the needs of the local community. For example, some partnerships will work with Indigenous ranger programs to build cultural monitoring and reporting capacity. There is a focus on building linkages between the report card outcomes and management responses. An urban management practice adoption framework is being developed which incorporates stewardship and an urban waste component. The Mackay Whitsunday and Wet Tropics partnerships report on marine debris and are looking to develop indicators that help define the local problem, identify sources of litter and pathways for debris reduction.

The Australian and Queensland governments continue to improve methods for delivering information to a diverse set of stakeholders to support program and project designs, and revised governance and delivery structures. The eReefs platform will continue to play an important role in communicating what is happening on the Reef and will be used to forecast the impact of catchment run-off on the Reef.



Glossary

Adaptive management	a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs.
Anthropogenic	caused or influenced by humans.
Best management practices	defined in Reef 2050 Water Quality Improvement Plan - Water Quality Risk Frameworks for each major agricultural industry. These frameworks identify the management practices with greatest potential influence on off-farm water quality, and articulate a reasonable best practice level which can be expected to result in a moderate-low water quality risk.
Biodiversity	the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. (Convention on Biodiversity— Article 2. Use of terms)
Catchment	the natural drainage area upstream of a point that is generally on the coast. It generally refers to the 'hydrological' boundary and is the term used when referring to modelling in this document. There may be multiple catchments in a basin.
Catchment loads	estimated average annual loads of key pollutants (nutrients and sediments) for the catchments that drain into the Great Barrier Reef.
Coastal ecosystems	inshore, coastal and adjacent catchment ecosystems that connect the land and sea and have the potential to influence the health and resilience of the Great Barrier Reef.
Community benefits	cultural, social and economic benefits such as employment, income, understanding, appreciation, enjoyment, personal connection, health and access to Reef resources. (Great Barrier Reef Outlook Report 2014)
Condition	the 'health' of a species or ecosystem which includes factors such as the level of disturbance from a natural state, population size, genetic diversity, and interaction with invasive species and diseases. (State of the Environment Reporting, Department of the Environment)
Connectivity	the extent to which a species or population can move among landscape elements in a mosaic of habitat types.
Ecosystem	a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. (Biodiversity Convention)
Great Barrier Reef (the Reef)	in this Plan the Great Barrier Reef or the Reef, is taken to mean the Great Barrier Reef World Heritage Area.
Human dimensions	in the sense that human behaviour will impact on water quality outcomes, these include social, cultural, institutional and economic factors: from the aspirations and capacities of landholders, industries and communities, to their stewardship practices and broader governance of the Reef.
Indicators	physical, chemical, biological or socio-economic measures that best represent the key elements of a complex ecosystem or an environmental issue.

Industry	agricultural industries and other industries regulated under Queensland's Environmental Protection Act 1994.
Intermediate outcomes	statements of the desired outcomes that will be delivered in each of the work areas of this Plan. Intermediate outcomes in Responding to the Challenge will lead to progress in achieving the 2025 land and catchment management targets.
Marine ecosystems	include salt marshes, intertidal zones, estuaries, lagoons, mangroves, coral reefs, the deep sea and the sea floor.
Minimum practice standards	in the context of this Plan, refer to minimum management practices or processes that are known to reduce nutrient and sediment losses from land-based activities.
Natural resource management (NRM)	the protection and improvement of environmental assets such as soils, water, vegetation and biodiversity.
Natural Resource Management group (NRM group)	an independent not-for-profit organisation that works within a region to support and promote environmental protection and sustainable agricultural practices. These deliver nationally important outcomes that assist Australia to meet its national and international obligations by building local community and industry engagement, skills and capacity in natural resource management and sustainable agriculture, and support Indigenous participation in delivering NRM outcomes
Nutrients	nutrients are the natural chemical elements and compounds that plants and animals need to grow. Carbon, hydrogen and oxygen are abundant nutrients in nature, but nitrogen and phosphorus are not always so freely available. They promote plant growth, making increased levels (e.g. from excess fertilisers) an issue for the Great Barrier Reef.
Objective	within the context of this Plan, these are goals that will contribute to achieving the Reef 2050 Water Quality Improvement Plan outcome.
Outcome	in the context of this Plan, an overall statement of what is expected to be achieved for water quality, which will contribute to achieving the Reef 2050 Plan vision.
Outstanding Universal Value	cultural and/or natural significance that is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity.
Pathway to outcomes	statements that link the actions to the intermediate outcomes, helping to explain the logic of how the actions will deliver outcomes.
Pesticides	collectively refers to herbicides, insecticides and fungicides.
Plastics	products, wholly or substantially composed of plastic, which can be present in land-sourced water run-off and present an unacceptable risk of polluting Reef ecosystems.
Priority areas	this refers to the relative priorities identified in the 2017 Scientific Consensus Statement (Very high, High, Moderate, Low, Minimal or Not assessed) for water quality improvement for each pollutant by catchment indicated in table 2.
Reef	see Great Barrier Reef.

reef	(lower case) refers to reefs in general, a broad or all-purpose term.
Region	natural resource management regions covering the Great Barrier Reef catchments. The regions are Cape York, Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary.
Resilience	refers to the capacity of a system to resist and recover from disturbances and undergo change while still retaining essentially the same function, structure and integrity. It is not about a single state, but the capacity of an ever-changing, dynamic system to return to a healthy state after disturbance or impact.
Riparian	relating to, or situated on, the bed and banks of a river or watercourse.
Sediment	one of the parameters for which there are Reef water quality targets. The sediment target is for total suspended solids (TSS) in water run-off from land-based sources.
Target	within the context of the Plan, targets are short-term goals that will contribute to achieving the objectives for each theme.
Total suspended solids	sediments can be derived from both natural and modified landscapes through erosion and can be present in various forms in water. Total suspended solids is an indicator of particulate matter in water.
Trend	a general direction in which something is developing or changing.
UNESCO World Heritage	The United Nations Educational, Scientific and Cultural Organization (UNESCO) identifies world heritage sites as those of Outstanding Universal Value which meet certain selection criteria.
Values	in the context of the Plan, these are aspects of the Reef's ecosystem from which communities derive a benefit or play a role in maintaining.
Water quality	refers to the chemical, physical, biological and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose.
Regional water quality improvement plans	designed to identify the main issues that impact aquatic ecosystems from land-based activities and prioritise management actions to reduce the discharge of pollutants within a natural resource management region. Water quality improvement plans are non-legislative regional planning instruments.
World Heritage Area	Great Barrier Reef World Heritage Area.



Appendix 1: History

2001 The Great Barrier Reef Ministerial Council accepted a report by the Great Barrier Reef Marine Park 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 were 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 were 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 how to achieve its ambitious water quality targets.

2016 Reef Report Card 2015 was launched outlining progress and areas where more focus was required.

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

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 prepared 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.

2018 The Reef 2050 Water Quality Improvement Plan 2017-2022 was endorsed by the Australian and Queensland governments.

Appendix 2: Links to further information

Document/Site	Document/ site purpose	Link
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	The Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as matters of national environmental significance.	http://www.environment.gov.au/epbc
<i>Environmental Protection Act 1994 (EP Act).</i>	The Environmental Protection Act 1994 is a key element of Queensland's environmental legal system. Its objective is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes (ecologically sustainable development).	https://www.ehp.qld.gov.au/management/env-policy-legislation/
Great Barrier Reef Outlook Report	The report is required under the Great Barrier Reef Marine Park Act 1975 (section 54) and aims to provide a regular and reliable means of assessing Reef health and management in an accountable and transparent way.	http://www.gbrmpa.gov.au/managing-the-reef/great-barrier-reef-outlook-report
Reef Trust Monitoring and Reporting Plan	In line with the Australian National Audit Office recommendations, this monitoring and reporting plan identifies processes for monitoring and evaluating the Reef Trust through: <ul style="list-style-type: none"> • identified actions, outputs and outcomes • evaluating achievements and impacts • adaptively managing investment to address the health and resilience of the Reef. 	http://www.environment.gov.au/marine/gbr/publications/reef-trust-monitoring-reporting
Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) Strategy	When completed, this will integrate all the monitoring and reporting within the Great Barrier Reef World Heritage Area and adjacent catchments relevant to the delivery of the Reef 2050 Long-Term Sustainability Plan.	http://www.gbrmpa.gov.au/managing-the-reef/reef-integrated-monitoring-and-reporting-program/ecosystem-health
Paddock to Reef Monitoring, Modelling and Reporting Program	This program models data received on 10 inter-related components from actions related to improving water quality entering the Reef. Modelled responses to reductions in nutrients, sediment and pesticides are used to develop the Great Barrier Reef Report card.	https://www.reefplan.qld.gov.au/measuring-success/paddock-to-reef/
Great Barrier Reef Report Card	Report cards measure progress towards the Reef water quality targets. The information in these reports determines the success of actions and identifies whether further measures need to be taken to address water quality in the Great Barrier Reef.	https://www.reefplan.qld.gov.au/measuring-success/report-cards/

Document/Site	Document/ site purpose	Link
Regional report cards	Regional report cards detail regional progress towards the water quality improvement targets. Four Report Cards have been developed.	<p>Mackay-Whitsunday Healthy Rivers to Reef Partnership: http://healthyriverstoreef.org.au/report-card-results/</p> <p>Fitzroy Partnership for River Health: https://riverhealth.org.au/report-card/ehi/</p> <p>Gladstone Healthy Harbour Partnership: http://rc.ghhp.org.au/report-cards</p> <p>Wet Tropics Healthy Waterways Partnership: http://wettropicswaterways.org.au/report-card/</p>
eReefs	Using the latest technologies to collate data, and new and integrated modelling, eReefs provides visualisation, communication and reporting tools. It provides Reef information akin to that provided by the Bureau of Meteorology for weather.	http://ereefs.org.au/ereefs/about
Australian and New Zealand guidelines for fresh and marine water quality	The Water Quality Guidelines have been prepared as part of the National Water Quality Management Strategy. They provide government and the general community (particularly catchment/water managers, regulators, industry, consultants and community groups) with a sound set of tools for assessing and managing ambient water quality in natural and semi-natural water resources.	http://www.agriculture.gov.au/water/quality/nwqms/nwqms-introduction-australian-nz-guidelines-fresh-marine-water-quality
Great Barrier Reef Marine Park Authority's water quality guidelines for the Great Barrier Reef marine park	These guidelines focus on levels of sediments, nutrients and pesticides — the main catchment run-off pollutants that affect water quality on the Great Barrier Reef. Regional catchment-level objectives are being implemented under Queensland's Environmental Protection (Water) Policy 2009 for the Reef catchment.	http://www.gbrmpa.gov.au/managing-the-reef/how-the-reefs-managed/water-quality-in-the-great-barrier-reef/water-quality-guidelines-for-the-great-barrier-reef

Document/Site	Document/ site purpose	Link
Regional Water Quality Improvement Plans	<p>These plans were developed using Reef Program to guide regional and Australian Government investment prioritisation.</p> <p>These have guided delivery partner investment prioritisation planning in Reef Trust Phase II, III and IV.</p>	<p>Eastern Cape York Water Quality Improvement Plan: http://waterquality.capeyorknrm.com.au/water-quality/eastern-cape</p> <p>Wet Tropics Water Quality Improvement Plan 2015-2020: https://terrain.org.au/Projects/Water-Quality-Improvement-Plan/</p> <p>Burdekin Water Quality Improvement Plan 2016: http://www.nqdrytropics.com.au/wqip2016/</p> <p>Mackay Whitsunday Water Quality Improvement Plan 2014-2021: http://reefcatchments.com.au/water/wqip/</p> <p>Fitzroy Water Quality Improvement Plan 2015: https://riverhealth.org.au/projects/fba-wqip/</p> <p>Water Quality Improvement Plan for the Burnett Mary Region, 2015: http://www.bmrg.org.au/resources/publications/water-quality-improvement-plans/</p>
Reef Trust governance processes and principles	Details of Reef Trust governance and administration arrangements including supporting science and evidence base and advisory bodies.	http://www.environment.gov.au/marine/gbr/reef-trust
Australian National Audit Office review of the design and implementation of the Reef Trust	Review which found that the Department of the Environment and Energy has been largely effective in designing and implementing the Reef Trust but is yet to report on program-level achievements.	https://www.anao.gov.au/work/performance-audit/reef-trust-design-and-implementation
Reef 2050 Long-Term Sustainability Plan	The Plan sets clear actions, targets, objectives and outcomes to drive and guide the short, medium and long-term management of the Reef. This addresses the cumulative impacts on the Reef to increase its resilience to longer-term threats such as climate change.	http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan
Reef Trust Investment Strategies – Phase I, II, III, IV and V	Identifies the priority investments to be supported through each phase.	http://www.environment.gov.au/marine/gbr/reef-trust/investments/approach
Marine Monitoring Program	Funded through the Australian Government Reef Program, it is a component of the Paddock to Reef Monitoring, Modelling and Reporting Program.	http://www.gbrmpa.gov.au/managing-the-reef/how-the-reefs-managed/reef-2050-marine-monitoring-program

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2017 Scientific Consensus Statement	This report is based on a review of the significant advances in scientific knowledge of water quality issues in the Great Barrier Reef. Produced by a multidisciplinary group of scientists, with oversight from the Reef Independent Science Panel, this plan supports the development of the Reef 2050 Water Quality Improvement Plan 2017–2022 and underpins water quality investment decisions.	https://www.reefplan.qld.gov.au/about/reef-science/scientific-consensus-statement/
Great Barrier Reef Intergovernmental Agreement	Establishes the framework for the Australian and Queensland governments to work together to protect the Great Barrier Reef.	https://www.environment.gov.au/marine/gbr/protecting-the-reef/intergovernmental-agreement
National Environmental Science Program Tropical Water Quality Hub	Invests in research to address water quality issues.	http://nesptropical.edu.au/
Australia's Native Vegetation Framework	Guides native vegetation management across the Australian landscape. The framework recognises that native vegetation is crucial for the health of Australia's environment, that it supports the economy and productivity as well as biodiversity and that it is embedded within Australia's cultural identity.	http://www.environment.gov.au/land/publications/australias-native-vegetation-framework
Australia's Biodiversity Conservation Strategy 2010–2030	Provides a guiding framework for conserving Australia's biodiversity over the coming decades.	http://www.environment.gov.au/biodiversity/publications/australias-biodiversity-conservation-strategy
Strategy for Australia's National Reserve System 2009–2030	Guides the work on the National Reserve System, the most secure way of protecting native habitat.	http://www.environment.gov.au/land/nrs/publications/strategy-national-reserve-system
Species Profile and Threats Database	Provides conservation advice by natural resource management region including a protected matters search tool, regional natural resource management plans, issues for the region and contact information.	http://www.environment.gov.au/cgi-bin/sprat/public/conservationadvice.pl
Directory of Important Wetland in Australia	The Directory identifies nationally important wetlands and contains information about their social and cultural values and some of the ecosystem services and benefits they provide.	https://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands
Great Barrier Reef Marine Park Authority	Includes information on managing and visiting the Great Barrier Reef.	http://www.gbrmpa.gov.au/
Clean Energy Finance Corporation	There is significant opportunity for agribusinesses to transform their businesses by maximising energy efficiency and installing renewable energy. The uptake and implementation of these technologies can reduce on-farm energy costs, and in some cases, lead to increased yields.	https://www.cefc.com.au/where-we-invest/agribusiness.aspx

