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MACKAY WHITSUNDAY

Regional Water Quality Strategy

2025 - 2035

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Part A: Purpose and Context of the Mackay Whitsunday Regional Water Quality Strategy

1 Introduction

1.1 Background and purpose

The Mackay Whitsunday Natural Resource Management (NRM) region (the 'Region') is located in the central coast of Queensland and is adjacent to the Great Barrier Reef (GBR) and spans approximately 9,029 km². The Region contains outstanding natural assets, including parts of the GBR World Heritage Area, with vast tracts of coral reef and seagrass meadows, as well as diverse wetland ecosystems, and nationally recognised areas such as the Goorganga Plain wetlands complex. These areas support critical ecosystem services and are valued for commercial and recreational fisheries, tourism, and cultural purposes by Traditional Owners. The Region supports diverse economic activities, including Australia's largest sugarcane production area (accounting for approximately one-third of the nation's sugar output), beef cattle grazing, horticulture, commercial fishing, mining services, and high-quality nature-based tourism. The Region generates over \$22 billion in value annually for Queensland and the broader Australian economy.

The **Mackay Whitsunday Regional Water Quality Strategy 2025 to 2035** (the Strategy) is a key component of the Australian Government funded Mackay Whitsunday Region Landscape Repair Program. The Landscape Repair Program is a major initiative focusing on reducing fine sediment export to help improve the quality of water flowing from the basins in the Region to the GBR, while also delivering multiple additional benefits for the local environment and local communities. Whilst funded as part of this program, the Strategy is not limited to addressing sediment and also extends beyond a focus on just priority pollutants in the Region to address regional priorities for water quality management and improvement.

The Strategy is a 10-year roadmap to guide and support Reef Catchments, regional stakeholders, delivery partners, local communities, Traditional Owner groups and potential investors in prioritising resources and investment into activities that reduce the risk of land-based pollutants delivered to the GBR. It identifies outcomes, objectives, management strategies and actions and where appropriate, priorities for water quality improvement in each of the four major drainage basins within the Region, relevant to the current understanding of local water quality impacts, drivers and management options. It also identifies capacity and capability requirements for delivery and implementation of the regional water quality priorities, including recommended approaches for community, stakeholder and Traditional Owner engagement, processes to review and evaluate the effectiveness of the Strategy, potential risks and constraints to implementation, and strategic opportunities to collaborate and align with related initiatives.

The Strategy is a dynamic resource that will be updated at least twice (mid-point and endpoint reviews) to 2035 to contextualise and inform the development of more specific water quality projects and programs in the Region. Program-specific implementation and action plans will be developed in alignment with the regional priorities when funding is made available, according to investors' objectives and priorities. It is linked to the objectives of the Reef 2050 Catchment Water

Quality Strategy¹ (Reef 2050 CWQS) and the intent is that potential investors, including but not limited to the Australian and Queensland governments, will be able to align programs and projects with the priorities identified within the Strategy.

1.2 Scope

The geographic scope of the Strategy encompasses the four major drainage basins of the Mackay Whitsunday Region – Proserpine, O'Connell, Pioneer and Plane, and the adjacent marine areas of the GBR World Heritage Area. The ecosystems being considered include freshwater wetlands (with a focus on floodplain wetlands), coastal and marine ecosystems including coral reefs and seagrass. There is insufficient data to inform the assessment of Region-wide ecosystem condition and pollutant exposure to other marine ecosystems and species such as mangroves, soft bottom communities, most plankton communities and fish. The main land uses being considered in the Strategy are grazing, sugarcane, horticulture, dryland cropping, and urban. While other land uses including forestry and conservation areas may be important in some locations, there is typically limited opportunity for pollutant load reductions in these areas.

The pollutants of primary concern in the Mackay Whitsunday Region are dissolved and particulate nutrients (nitrogen and phosphorus), fine sediment and pesticides. Other pollutants such as trace metals may be relevant at local scales. The nutrient and sediment targets defined in the Reef 2050 CWQS are basin- specific loads-based targets, and the pesticide target for all basins is based on the concentrations required to protect 99% of aquatic species at the river mouth.

The development of regionally specific targets is also outside of the scope of the Strategy. The Reef 2050 WQIP defined targets for a range of indicators related to end of catchment loads, catchment condition and human dimensions. The Reef 2050 CWQS has revised this approach slightly, focusing targets on water quality improvement measures (i.e. loads of sediment and nutrients and risk of pesticides), with catchment and marine condition measures presented as indicators – e.g. ‘No loss of the extent of natural wetlands (lakes, swamps and estuarine wetlands)’, ‘Improved wetland condition’, ‘Improved coral condition’, ‘Improved seagrass condition’. The previous riparian vegetation target is now expressed as an indicator ‘Loss of woody vegetation in riparian areas is decreased’, and a new groundcover indicator is recommended - ‘Adequate ground cover (≥70%) in the late dry season’. Determination of adequate cover varies across the GBR catchments and definition of these levels is outside of scope of the Strategy. The Reef 2050 CWQS also addresses urban land use management through an indicator – ‘Increased reduction of pollutants from urban water management’.

The previous Human dimensions and Management Practice Adoption targets are now also expressed as indicators, with changes to the wording of those as well – ‘Increase in capability, opportunity, and motivation for stewardship to achieve water quality outcomes among agricultural landholders and Reef communities’ and ‘Increase in agricultural land management practice change’ (respectively). The decision to move away from a Management Practice Adoption target was informed by a recent review of these targets (DPI, 2025), conducted with input from industry, NRM, and conservation stakeholders, which emphasised the complexity of setting realistic and relevant adoption targets across diverse regions. It recommended discontinuing the GBR-wide voluntary land management targets in favour of more context-specific approaches, including consideration of local environmental and social factors. Rather, the review identifies and outlines *Potential Adoption* opportunity for specific priority management practices that may accelerate progress toward water quality targets in

¹ https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0031/427837/reef-2050-catchment-water-quality-strategy.pdf

priority catchments. This is highlighted for incorporation into future agricultural program design and delivery which is beyond the scope of this Strategy.

Other areas out of scope of the Strategy include analysis of the costs of implementing the strategies and actions, which will be addressed through respective funding bids and programs, and regional priorities that are not directly related to water quality benefits for the Region. These priorities are addressed through other regional planning processes, such as the Mackay Whitsunday Isaac NRM Plan.

1.3 Policy and program alignment

The Strategy sits within a much larger framework of policies and programs for water quality improvement in the GBR, and potential additional benefits, including the GBR-wide (and overarching) Reef 2050 Long Term Sustainability Plan, Reef 2050 CWQS, Reef 2050 Wetlands Strategy and Reef 2050 Indigenous Implementation Plan (see Figure 1). The six Regional Water Quality Strategies are nested under the Reef 2050 CWQS, the Vision of which is: *'A healthy catchment for a healthy Reef and healthy people'*. At the Regional level, the Strategy will also need to link and align with plans and initiatives where water quality is one of several themes or program areas within a broader scope, such as the Mackay Whitsunday Isaac NRM Plan and Traditional Owner Strategic Plans. Similarly, integration with Catchment Action Plans already in development will be essential (e.g. the Proserpine Catchment Action Plan), following the principles of the Whole-of-System Values Based Framework (see Section 1.4) and encompassing a wider range of ecosystem services.

The high-level priorities set out in this Strategy then feed into the more detailed levels of planning and implementation, including those specific to programs such as the Reef Trust Landscape Repair Program, Reefwise Farming and the Proserpine Integrated Project.

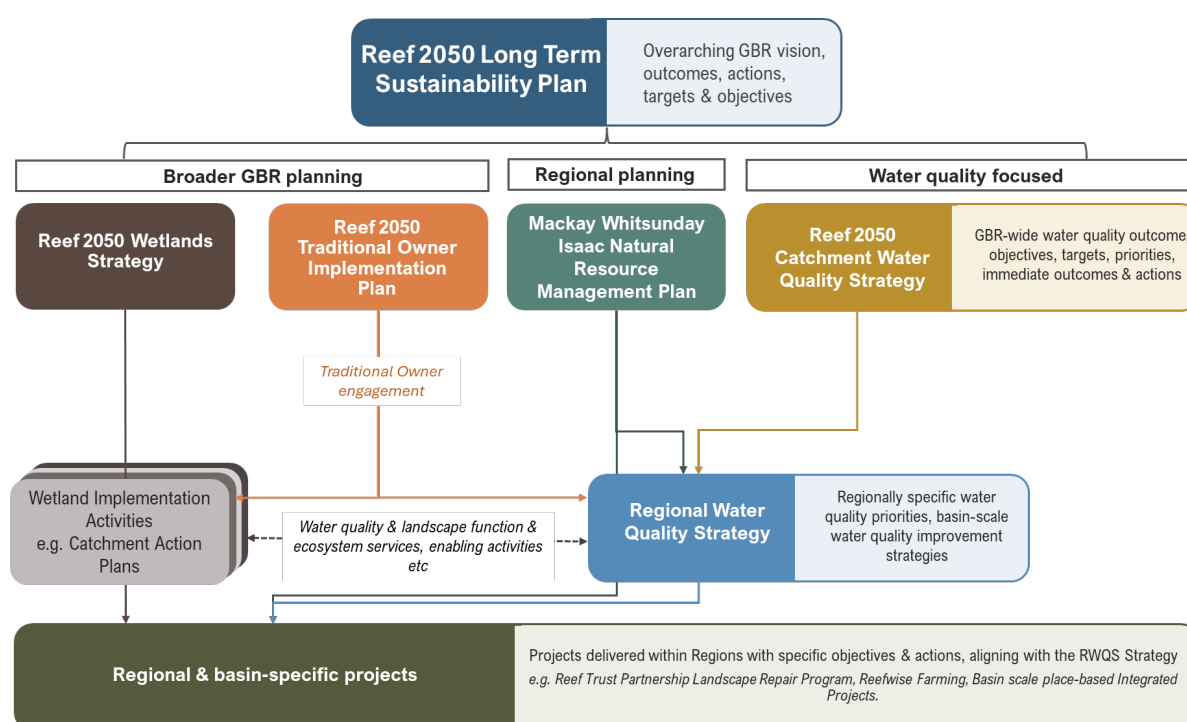


Figure 1. Example of how the Mackay Whitsunday Regional Water Quality Strategy sits in the GBR planning and policy frameworks.

1.4 Guiding principles

The Strategy seeks to support a holistic approach to water quality improvement in the Region, recognising the complex interactions between biophysical, social and economic drivers, and the opportunities for potential co-benefits. The Whole-of-System Values Based Framework (WoSVBF), developed by the Queensland government as part of the Queensland Wetlands Program (DESI, 2022), aims to guide such holistic approaches for catchment management. However, adopting a full whole-of-system approach is beyond the scope of the Strategy, as it would require considering the full suite of direct and indirect drivers and pressures influencing catchment systems – including elements not directly related to water quality. Instead, the Strategy draws on key WoSVBF principles to guide the strategic development of water quality focused management options. These include:

- Consider system connections when developing and implementing management interventions, including connections between the biophysical environment, the beneficiaries of the services provided by that ecosystem and their values.
- Use a values-based, holistic management approach to achieve outcomes that consider the biophysical environment alongside social, economic and cultural outcomes.
- Engagement - involve all relevant groups (including Traditional Owners) of the system to ensure their needs and values have been considered and incorporated into the design of management interventions, including knowledge sharing.
- Foster integration - break down silos between groups, stakeholders, and sectors to foster collaboration and coordinated action.
- Make decisions based on the best available knowledge at several scales; that is, at the site, catchment, and system-scales (e.g. how can the knowledge about the broader system be used to inform site-specific management interventions?).
- Select management interventions for the appropriate spatial and temporal scales.
- Incorporate adaptive management by embracing flexibility and continuous learning, allowing strategies to evolve based on new information and changing conditions.

The Strategy guides regional water quality management for 10 years, through to 2035. The importance of long-term funding has been reinforced in multiple evaluations of previous GBR water quality investment programs. Documented benefits of long-term planning and associated investments include positive and ongoing stakeholder engagement, greater consistency and integration among program elements and improved implementation through continuous learning and adaptation of program design. Limitations or challenges associated with short-term planning are particularly evident in maintaining capacity and a skilled workforce, landholder engagement and delivering strategic outcomes.

While the Strategy guides regional investment priorities for water quality improvement, the delivery of these priorities is not necessarily resourced. In addition, there is no central coordinating body to ensure that there is cooperation between relevant programs or investments. Therefore, actions that foster collaboration between delivery partners and support maintenance of stakeholder networks are a key component and an underpinning principle of the Strategy.

1.5 Approach to developing the Strategy

The Strategy has been developed with a strong underpinning of scientific evidence, management experience and consultation with stakeholders and technical experts. The major steps involved are illustrated in Figure 2 and include:

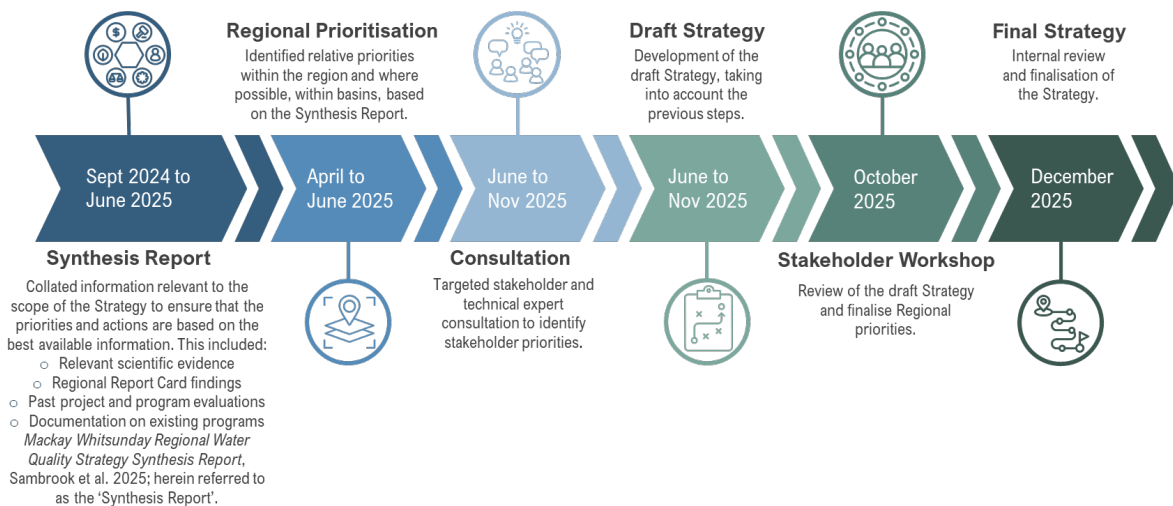


Figure 2. Major steps in the development of the Strategy.

1.6 Document structure and navigation

This document is structured into three Parts to help readers navigate the Strategy and its development that spans across multiple scales (regional, basin and sub-catchment) and management dimensions (Figure 3). The structure maps out the *Why*, *What* and *How* of the Strategy:

Part A – Purpose and Context of the Mackay Whitsunday Regional Water Quality Strategy

Part A (Sections 1 and 2) explains why the Regional Water Quality Strategy is needed. It outlines the purpose, scope, guiding principles, and policy alignment, and provides the regional context, including a summary of the evidence that has informed the Strategy development.

Part B – Regional Strategic Framework and Basin Application

Part B (Sections 3 and 4) forms the core of the Regional Water Quality Strategy and Basin Water Quality Improvement Strategies. It introduces the Regional Water Quality Strategy Framework in Section 3 and explains how the framework was used to guide the integration of regional- and basin-level assessments and supporting evidence to develop a portfolio of prioritised and targeted Action and Delivery Strategies for each basin to collectively contribute to the achievement of the Mackay Whitsundays' Regional Objectives and Outcome.

The Basin Water Quality Improvement Strategies in Section 4 are designed specifically for each of the four Mackay Whitsundays' basins and identify what actions are required, where they should be applied, and the scale and intensity of management needed across three Strategic Action Areas:

- I. Sustainable land use and management
- II. Natural Systems Repair
- III. Actions to support scaled delivery

Part C – Regional Implementation

Part C (Section 5) focuses on how the Strategy will be delivered and sustained over time at a regional scale. It sets out the enabling conditions required to support basin-level delivery, including investment priorities, governance and coordination, Traditional Owner engagement, regional capacity, knowledge sharing, science and innovation, and monitoring, evaluation and adaptive management.

Together, these three Parts provide a clear line of sight from regional objectives, through basin-scale strategic action, to coordinated regional implementation, ensuring that basin-level efforts collectively contribute to achieving the Mackay Whitsundays' Regional Water Quality Outcomes.

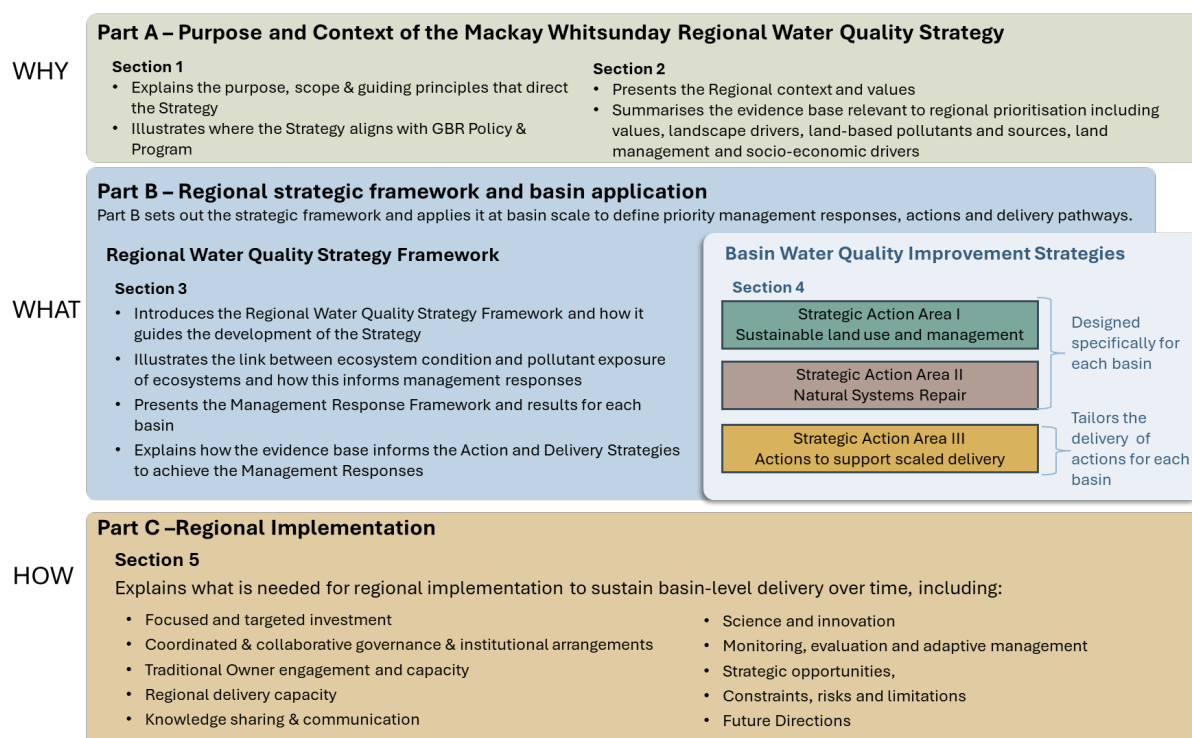


Figure 3. Overview of the document structure showing how Parts A, B and C align across regional and basin scales.

2 The Mackay Whitsunday Region

A comprehensive understanding of the environmental, social, and economic drivers of water quality and the condition of ecosystems in the Mackay Whitsunday Region is essential to underpin the Strategy. The Synthesis Report provides the detailed evidence base, drawing on a comprehensive review of scientific research, assessments of past initiatives and documentation of current programs. The below summary provides contextual insights; the full Synthesis Report should be consulted for detailed information (including referenced materials).

2.1 Geographic scope and characteristics

The Mackay Whitsunday Region is the smallest of the six GBR NRM regions, covering 9,029 km² or 2% of the GBR catchment area. It extends from just south of Bowen in the north, to Clairview Creek in the south. Bordered by the Connors-Clarke ranges to the west and the Coral Sea to the east, the Region encompasses the renowned GBR World Heritage Area including the tourism hotspot of the Whitsunday Islands. Despite its small size, the Mackay Whitsunday coastline (including the Whitsunday Islands) accounts for approximately 20% of the GBR's total coastline.

The Region's climate represents a transitional zone between the wet and dry tropics, with high rainfall and productive, mineral-rich soils. Catchments in the Region receive high to very high rainfall,

predominantly in the summer months (December to April). The area experiences occasional cyclones, including Severe Tropical Cyclone Debbie in March 2017.

The Mackay Whitsunday Region has a population of approximately 175,700, mainly living in urban centres along the coastal zone. The Region supports a range of industries including tourism, mining, ports, fisheries and agriculture. The agricultural sector plays a significant role in the regional economy. The Region is the largest sugarcane-producing area in Australia (covering 17% of the Region), accounting for approximately one-third of the nation's sugar output. Complementing this are large areas for grazing (43% of the Region) and smaller areas of horticulture and cropping (0.2%).

2.2 Values at risk

The Mackay Whitsunday Region is a high value area in terms of its terrestrial, freshwater, coastal and marine assets. It encompasses 3,212 km² of coral reefs and 502 km² of seagrass meadows, and as at 2021, around 445 km² of intertidal wetlands including salt flats, saltmarshes and mangroves, and 326 km² of freshwater wetlands including natural and slightly modified riverine, palustrine and lacustrine wetlands. The Region is home to several wetlands of national importance including Broad Sound, Edgumbe Bay, Sandringham Bay and Sarina Inlet, three Dugong Protection Areas— Edgumbe Bay, Repulse Bay-Newry Island-Ball Bay and Ince Bay-Llewellyn Bay-Clairview, and eight Fish Habitat Areas—Bassett Basin, Broad Sound, Cape Palmerston – Rocky Dam, Edgumbe Bay, Midge, Repulse, Sand Bay and West Hill. Approximately 19% of the Region is in conservation areas, including Eungella National Park, Whitsunday Islands National Park, Cape Palmerston National Park, and the Goorganga Plains (Reef Catchments 2014). These high value areas also support many species, some of which are listed as threatened or vulnerable under either the Australian *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and/or Queensland *Nature Conservation Act 1992*, and have significant cultural values. The Region's ecosystems support a substantial tourism industry, predominantly catering to domestic visitors, making the Mackay Whitsunday Region the second-largest tourism area in the GBR region.

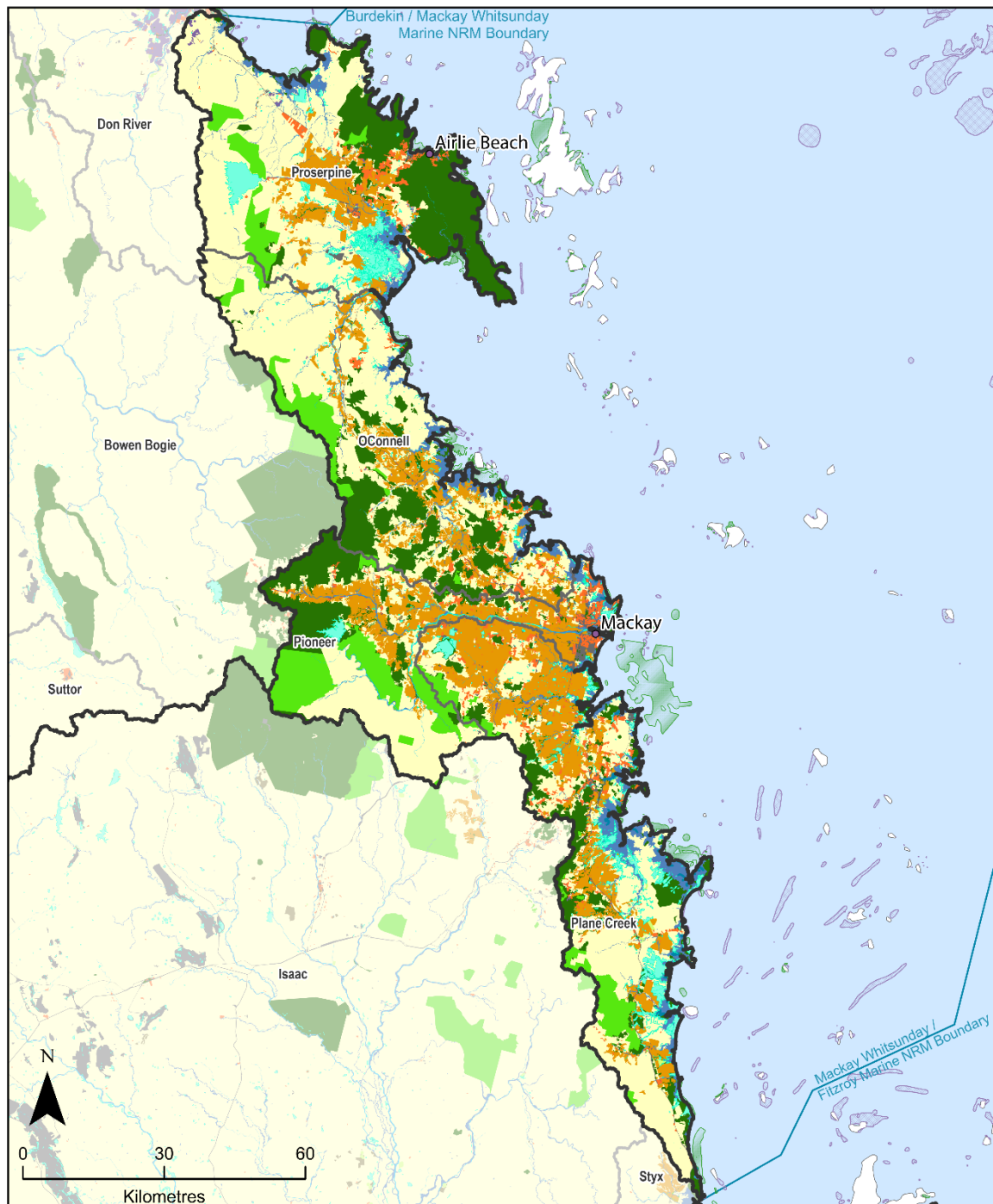


Figure 4. Land use and aquatic ecosystems in the Mackay Whitsunday NRM region. (Note: Wetlands data based on 2019 extent data from WetlandInfo version 6 (Queensland Government, 2022); land use data (Queensland Government 2021). Marine habitats sourced from the Great Barrier Reef Marine Park Authority.

2.3 Traditional Owners and Custodianship

The Mackay Whitsunday Region is home to seven distinct Traditional Owner groups, Yuwibara, Juru, Gia, Ngaro, Koinjmal, Barada, and Widi, each with cultural responsibilities for lands and waters within the Region (MWI TORG, 2017). These groups maintain deep connections to Country, which include significant sites, cultural practices, and responsibilities that have been passed down through generations. Historically, areas within the Region served as important meeting places, with shared cultural sites such as fish traps, burial grounds, and artefact locations that remain vital for maintaining connections to land and water (DESI 2020).

Traditional Owners of the Mackay Whitsunday Region have articulated a comprehensive vision for their future role in managing and protecting Country. Their primary aspiration is to develop an active role in managing, maintaining, and protecting their lands and sea within the Region, working together with mutual respect and understanding to make the Region a leader in proactive cultural heritage and environmental management (MWI TORG, 2017).

Traditional Owner groups are leading the design, development, and implementation of their individual Healthy Country Plans (HCP), reflecting their vision for self-determination and long-term self-management of Country. A key aspiration is achieving economic independence, enabling groups to move beyond advisory roles into active management and decision-making. This includes building capacity to attract investment, secure funding, and undertake contracts, tenders, and fee-for-service activities. By leveraging Federal, State, and Local Government funding as a foundation, these groups can catalyse further investment to support the implementation of their HCPs and achieve sustainable independence.

2.4 Landscape drivers

The landscapes of the Mackay Whitsunday Region have undergone considerable transitions due to changing land uses, intensive development, and modification. These alterations have had significant impacts on water quality, demonstrated by the higher pollutant loads entering the GBR since European settlement. Several landscape drivers can influence the quantity and type of pollutants entering waterways. These include vegetation clearing particularly from riparian zones, the loss and/or modification of floodplain wetlands, the condition of groundcover, and the presence and extent of gully networks. Each of these drivers can influence the generation, mobilisation, and transport of pollutants through various pathways into waterways. When combined with climatic factors, such as intense rainfall events following periods of drought, these factors can lead to pulse events where pollutants are rapidly mobilised and transported downstream. Understanding the distribution, extent and impact of these drivers is essential for effective water quality management, allowing for targeted interventions that address the root causes of degraded water quality. Table 1 presents the most recent data available for these landscape drivers for each of the four Mackay Whitsunday basins. The implications of their current status are discussed in more depth in the Basin Water Quality Improvement Strategies in Section 4 of the Strategy. For more information on the methods used to examine the landscape drivers, refer to Waterhouse et al. (2025).

Table 1. Landscape drivers that can influence water quality in the Mackay Whitsunday Region. For more information on methods and data sources, refer to Waterhouse et al. (2025).

Basin	Annual average rainfall (mm)	Mean late dry season groundcover (%) [1987–2022]	Historical and recent native vegetation clearing				Freshwater floodplain wetland modification and/or loss by 2017 as a percentage of historical extent	Gullies	
			Vegetation type	Remnant vegetation in 2018 (ha)	Cleared by 2018 (%)	Recent native vegetation clearing (ha) [2019–2022]		Average Annual Sediment Supply (AASS): Total eroded soil mass – both fine and coarse sediment; Gully length: Extent of gully network	
Proserpine	1,474	87%	All woody vegetation	157,133	36%	1,219	35%	AASS (tonnes per year)	38,848
			Floodplain vegetation	20,148	72%	307		Gully length (km)	381
			Stream & river riparian areas	28,619	32%	176		Erosion rate (tonnes per km per year)	102
			Freshwater floodplain wetland riparian areas	3,881	58%	3			
O'Connell	1,705	89%	All woody vegetation	120,765	47%	1,540	82%	AASS (tonnes per year)	15,841
			Floodplain vegetation	10,221	84%	483		Gully length (km)	161
			Stream & river riparian areas	27,552	44%	263		Erosion rate (tonnes per km per year)	98
			Freshwater floodplain wetland riparian areas	652	43%	3			
Pioneer	1,578	89%	All woody vegetation	105,805	36%	253	92%	AASS (tonnes per year)	6,615
			Floodplain vegetation	12,981	77%	77		Gully length (km)	67
			Stream & river riparian areas	25,850	27%	53		Erosion rate (tonnes per km per year)	99
			Freshwater floodplain wetland riparian areas	659	49%	1			
Plane	1,526	87%	All woody vegetation	119,759	52%	1,030	78%	AASS (tonnes per year)	7,689
			Floodplain vegetation	15,151	86%	339		Gully length (km)	75
			Stream & river riparian areas	22,573	55%	188		Erosion rate (tonnes per km per year)	103
			Freshwater floodplain wetland riparian areas	3,154	41%	3			

2.5 Primary pollutants and sources

The key pollutants influencing water quality in the Mackay Whitsunday Region are dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP), fine sediments, particulate nutrients (particulate nitrogen and phosphorus), and pesticides. The Mackay Whitsunday Region faces the most significant pesticide pollution challenge of any GBR region, maintaining the highest pesticide risk condition rating across all regions, with basin-level results consistently ranging between 'Poor' and 'Very Poor' since 2016. End-of-catchment monitoring shows sustained very high pesticide risk, with some catchments recording a wet season daily average pesticide risk of 33.4% to 42.3% of species affected.

It is acknowledged that while nutrients, sediments and pesticides are well documented and routinely monitored in the GBR, many other pollutants can enter waterways and potentially affect a range of ecosystems (Chariton & Hejl, 2024). These include metals, persistent organic pollutants, PFAS, plastics, pharmaceuticals, veterinary chemicals, personal care products and sunscreens. Evidence for these pollutants in the GBR is far more limited (Chariton & Hejl, 2024), and they are therefore outside the scope of this Strategy.

Despite occupying only 2% of the GBR catchment area, the Region accounts for 8.4% of the GBR's annual dissolved inorganic nitrogen (DIN) loads (777 tonnes). DIN loads have increased by 0.8 to 3.5 times compared to pre-development rates across the basins, with anthropogenic sources accounting for 53–78% of current loads depending on the basin.

The Region contributes 5.6% of total fine sediment loads to the GBR (429 kilotonnes annually). Current fine sediment exports are estimated to be between 2.3 and 4.8 times pre-development rates across the Region's basins.

Dissolved Nutrients

- Sugarcane is the dominant source of DIN, contributing 51% of regional exports from 17% of the land area, demonstrating the intensity of nutrient export from this land use.
- The Plane Basin shows the highest modelled annual average DIN loads (230 tonnes per year) with the largest sugarcane area (~65,000 hectares). It is also the largest contributor to DIP loads (135 tonnes per year), considerably higher than other basins in the Mackay Whitsunday Region.
- Urban areas and sewage treatment plants contribute meaningful proportions of DIN loads ranging between 8.6 and 14% depending on the basin.

Sediment and particulate nutrients

- Grazing and streambank erosion collectively account for the majority of fine sediment loads across basins, with streambank erosion (77%) the dominant transport pathway.
- The O'Connell Basin contributes 50% of the regional sediment load despite covering only 26% of the area, showing the highest anthropogenic influence (4.8 times increase from pre-development).
- Gully erosion contributes less than 1% of regional fine sediment loads, the lowest proportion among GBR regions.

Note that these patterns are similar for particulate nutrients.

Pesticides

- All four basins show high-very high pesticide risk, with the Proserpine and Plane basins scoring 'very poor' for seven and nine consecutive years (2015–2024) respectively.
- Diuron and imidacloprid are the main contributors (> 50%) to total pesticide risk across catchments, with imazapic, atrazine, metolachlor, hexazinone, MCPA and metsulfuron-methyl also being key contributors.
- Sugarcane, horticulture, dryland & irrigated cropping are considered to have a higher potential risk of pesticide runoff to receiving waterways compared to other land uses such as grazing and urban. Of those higher risk land uses, sugarcane has the largest spatial area in the Mackay Whitsunday Region.
- Marine modelling shows pesticide exposure extends into inshore marine environments, affecting important seagrass habitats, coral reefs, and Dugong Protection Areas, particularly.

These pollutants can have significant impacts on receiving environments, affecting freshwater, estuarine, and marine ecosystems. Fine sediments reduce light availability for seagrass and corals, while excess nutrients can lead to algal blooms and reduce coral health. The highest risk pesticides detected are primarily herbicides, including photosystem II herbicides like diuron that can directly impact photosynthetic organisms, and insecticides like imidacloprid that can directly impact aquatic insects and crustaceans. The combined effects of these pollutants are exacerbated by climate change pressures, reducing ecosystem resilience and recovery capacity.

2.6 Land management and socio-economic drivers

Landholder adoption of improved land management practices is influenced by factors operating across multiple scales - from broader systemic forces through to individual decision-making.

External Factors

At the macro level, governance systems, policy and legislation, economic conditions, and cultural norms all shape the enabling environment for practice change. At the meso level, industry bodies, R&D agencies, and community networks also play important roles. These broader forces direct and constrain what occurs at the individual level, ultimately affecting the efficiency and effectiveness of adoption efforts.

For the sugarcane industry, mill operations and supply chain arrangements can influence grower decisions. Unplanned mill downtimes, late-season harvest timing, cane supply arrangements and scheduling constraints can disrupt optimal planting and fertiliser application timing. In this way, mill performance acts as a systemic external driver that can constrain regional water quality improvement efforts.

In addition to established agricultural land uses, the Region is experiencing peri-urban expansion and shifts in grazing systems, including the growth of nutrient-intensive beef finishing enterprises. These transitions can influence both land management decisions and pollutant pressures. For example, peri-urban development can increase stormwater generation, and introduce new sources of nutrient and sediment runoff. In grazing areas, the move toward beef finishing systems increases fertiliser use and associated nitrogen risks.

Individual-Level Factors

While external factors set the context, this strategy focuses on individual-level drivers because it is at this scale that programs can be designed and targeted to support targeted adoption. At the micro scale, adoption can be understood through three interconnected domains that can enable or act as barriers to adoption:

- Capability – whether land managers are aware of the practices and have the knowledge and skills to implement
- Opportunity – whether they have access to necessary resources, equipment, and supportive social networks
- Motivation – whether they believe the practice is worthwhile and are driven to act

Research tools such as ADOPT, the Behaviour Change Wheel and Community-Based Social Marketing can help identify how these factors play out for specific practices and audiences, recognising that relative influences vary considerably across contexts. Local studies, including work by the Behavioural Insights team through the Paddock to Reef Human Dimensions program (Kanakakis et al., 2024), have explored landholder perceptions to better understand these barriers and enablers in our region.

Part B: Regional strategic framework and basin application

3 Mackay Whitsunday Regional Water Quality Strategy Development

3.1 Regional Water Quality Strategy Framework

3.1.1 Framework overview and purpose

The Regional Water Quality Strategy (RWQS) framework (Figure 5) has been developed to align with the Reef 2050 Catchment Water Quality Strategy (Reef 2050 CWQS) and the supporting GBR-wide Spatial Management Prioritisation (SMP) (Waterhouse et al., 2025). The purpose of the RWQS framework ('the Framework') is to provide a systematic and consistent approach for developing Basin-level Water Quality Improvement Strategies that have a clear pathway for achieving the GBR-wide Outcomes and Vision.

The hierarchical structure of the Framework aligns with and reinforces the Reef 2050 CWQS Vision, Outcomes and Priority Areas while tailoring the region-specific strategies to reflect local priorities, values, and implementation capacity. This approach ensures that the regional strategies are locally relevant and contribute effectively and collectively to the broader Vision of the Reef 2050 CWQS.

The RWQS framework is guided by the Reef 2050 CWQS framework, incorporating the following key elements to reflect regional priorities, operational contexts and implementation needs:

- Definition of a single Regional Outcome Statement and three Regional-scale Objectives that capture all elements of the Reef 2050 CWQS's Vision and Outcomes (with a shift in emphasis to reflect regional needs).
- Elements of the Reef 2050 CWQS Priority Areas are incorporated into three 'Strategic Action Areas' to garner clear lines of sight, across the spatial scales of the Framework, and between the objectives and the actions needed to achieve those objectives.
- The introduction of scaled and categorised basin-scale Management Responses, adopted from the SMP to address regionally specific landscape characteristics and ecosystem condition, pollutant exposure and local drivers.
- Definition of specific 'Action Strategies' and 'Delivery Strategies' for each Strategic Action Area to respond to regional- and basin-specific priorities and drivers within the scope of the Management Response. This introduces a level of detail beyond the current Reef 2050 CWQS, tailored specifically for the Region, its land uses, pollutant sources, water quality drivers and ecosystem conditions.
- Identification of Implementation requirements including 'Policy Instruments' (some of which are outside the scope of the RWQS) and 'Strategies to support implementation', both of which align with the Reef 2050 CWQS Enablers.
- Identification of key prerequisites for implementation that are relevant within and across all scales.

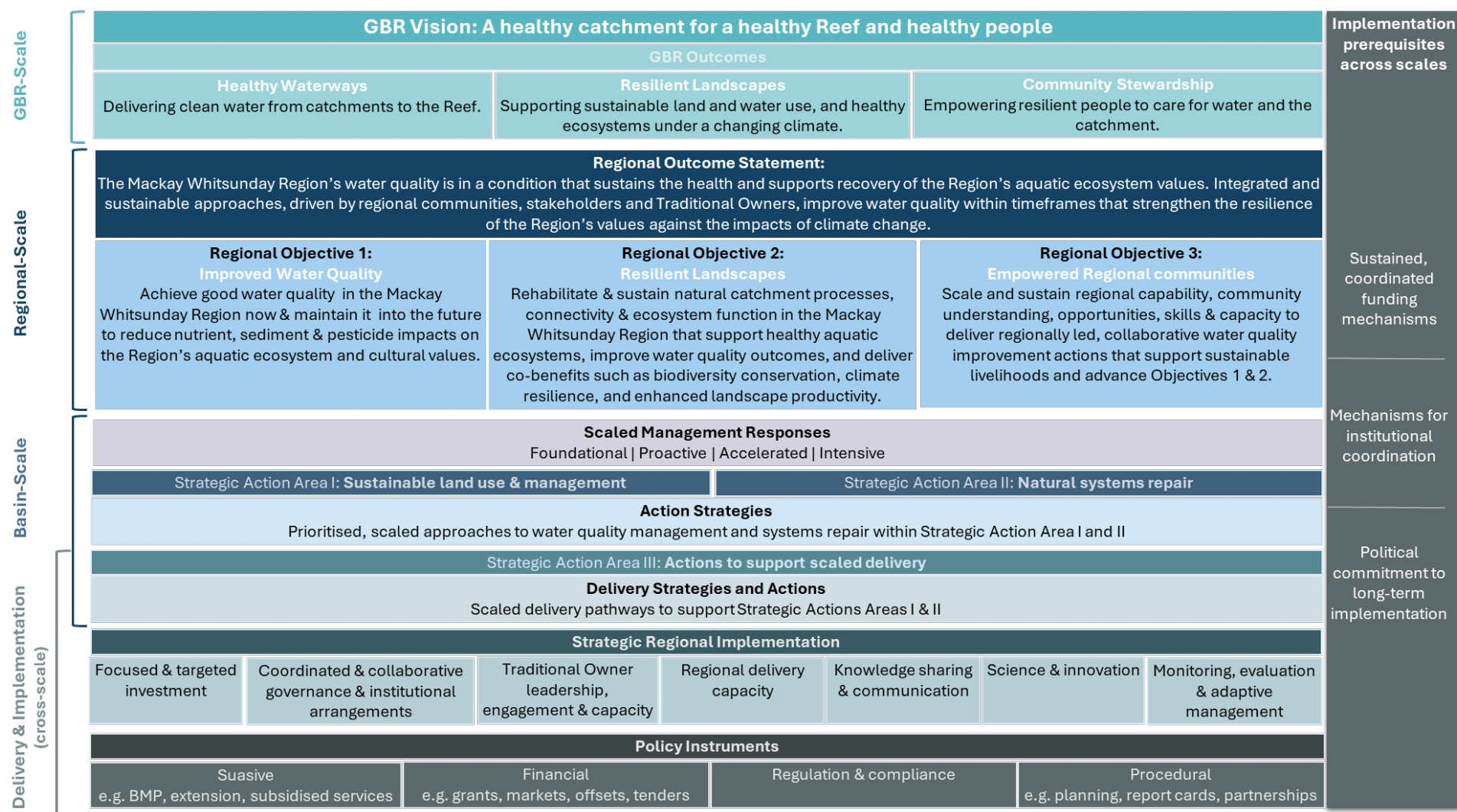


Figure 5. Mackay Whitsunday Regional Water Quality Strategy Framework.

3.1.2 Framework structure and spatial scaling

The Framework operates across three distinct scales, creating a clear line of sight between the **Why**, **What** and **How** of water quality management, from GBR- to regional- to basin-level scales. This logical flow shows how the actions that are implemented at the basin scale will lead to the outcome desired at the regional scale, which in turn support achievement of the outcomes at the GBR scale.

GBR scale

At the top level, the framework is anchored by the Reef 2050 CWQS Vision and three interconnected Outcomes:

GBR Vision: 'A healthy catchment for a healthy Reef and healthy people'

GBR Outcomes:

1. Healthy Waterways – delivering clean water from catchments to the Reef.
2. Resilient Landscapes – supporting sustainable land and water use, and healthy ecosystems under a changing climate.
3. Community Stewardship – empowering resilient people to care for water and the catchment.

Regional scale

The Regional Outcome Statement captures the elements of the Reef 2050 CWQS Outcomes and Objectives and translates them into a regionally specific aspiration. This includes improved water quality, sustainable land and water use, ecosystem function and climate resilience, connection to Country, and thriving communities and regional economies.

Regional Outcome Statement

The Mackay Whitsunday Region's water quality is in a condition that sustains the health and supports recovery of the Region's aquatic ecosystem values. Integrated and sustainable approaches, driven by regional communities, stakeholders and Traditional Owners, improve water quality within timeframes that strengthen the resilience of the Region's values against the impacts of climate change.

The Regional Outcome is supported by three Regional Objectives that capture elements of all Reef 2050 CWQS Objectives while being tailored to regional priorities:

1. **Improved Water Quality** – Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystem and cultural values.
2. **Resilient Landscapes** – Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Mackay Whitsunday Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.
- 9i **Empowered Regional Communities** – Scale and sustain regional capability, community understanding, opportunities, skills and capacity to deliver regionally led, collaborative water quality improvement actions that support sustainable livelihoods and advance Objectives 1 and 2.

Basin scale

The basin level translates the Regional Objectives into implementation strategies and actions.

Scaled Management Responses identify the scale, intensity and urgency of the management response required to address each pollutant within each basin, based on ecosystem condition and pollutant

exposure assessments. The Management Responses follow the four-scale Water Quality Management Response Decision Support Framework (Figure 8) developed by Waterhouse et al. (2025):

1. **Foundational Response** (minimal likelihood of pollutant exposure) – aims to maintain and protect ecosystems from water quality pressures into the future.
2. **Proactive Response** (low likelihood of pollutant exposure) – aims to prevent emerging pollutant issues before they become greater problems in the future.
3. **Accelerated Response** (moderate likelihood of pollutant exposure) – aims to actively reduce pollutant exposure with targeted actions.
4. **Intensive Response** (high likelihood of pollutant exposure) – aims to expedite reductions in pollutant exposure, recognising the large-scale, multi-land use interventions required.

Strategic Action Areas are the three main management approaches implemented together to achieve the Regional Objectives and Outcome, and include:

- I. Sustainable land use & management
- II. Natural Systems Repair
- III. Actions to support scaled delivery.

These action areas capture elements of the Reef 2050 CWQS Priority Areas - Improve the quality of water flowing to the Reef, Repair nature and landscapes to protect the Reef, Support sustainable practices across the Reef catchment, Strengthen capacity to Care for Country, Grow strong communities and regional economies while protecting the Reef, Enhance and share knowledge that drives action. Aspects of these Priority Areas are also addressed through Delivery and Implementation (see below).

Action and Delivery Strategies represent the most specific level of the hierarchy, translating the basin-scale management responses into actions. ‘Action Strategies’ provide basin-specific, prioritised and scaled management options for sustainable land use and systems repair within Strategic Action Areas I and II, tailored to the basin’s pollutant sources and water quality drivers. ‘Delivery Strategies’ within Strategic Action Area III provide scaled delivery pathways to support Strategic Action Areas I and II, reflecting the management response levels while also recognising that successful implementation depends on understanding and designing programs that meet and build on the capacity, opportunities, and motivations of the land managers being engaged (noting that the Strategic Action Area III is not specific to the basin scale, but the on-ground delivery/ implementation is). The language used to describe the strategies and actions gives direction towards the level of investment and effort that should be aimed for and includes examples of what management actions (both the management response and delivery method) might be implemented. Subsequent implementation plans or work plans would specify further detail.

Delivery and Implementation (cross-scale)

Several strategies are identified to support implementation of the Framework at the regional and basin scale.

Strategic regional implementation captures elements of the Reef 2050 CWQS Priority Areas (Support sustainable practices across the Reef catchment, Strengthen capacity to Care for Country, Grow strong communities and regional economies while protecting the Reef and Enhance and share knowledge that drives action), covering the key enabling activities:

- Focused and targeted investment
- Coordinated and collaborative governance and institutional arrangements
- Traditional Owner engagement and capacity
- Regional delivery capacity
- Knowledge sharing and communication

- Science and innovation
- Monitoring, evaluation and adaptive management

Policy Instruments can significantly influence achievement of the Regional Outcome and Objectives. These include:

- Suasive instruments (extension), for example, industry Best Management Practice programs, extension programs, subsidised private services
- Financial instruments, for example grants, market, offsets, and tenders
- Regulation and compliance
- Procedural instruments, such as planning, report cards and partnerships

While many of these instruments fall outside the direct scope of the RWQS, their influence remains critical - the Delivery Strategies and actions draw from these instruments, as well as their effects on the broader policy environment, enabling conditions and the effectiveness of regional implementation.

Implementation prerequisites are relevant within and across all scales of the Framework, and recognise the critical factors required to successfully translate the Framework from strategic intent into on-ground outcomes. Key prerequisites include:

1. Sustained, coordinated funding mechanisms that match with the identified management response requirements.
2. Mechanisms for institutional coordination to facilitate cross-jurisdictional collaboration and investment alignment.
3. Political commitment to long-term implementation.

3.2 Applying the regional framework to derive regional priorities and basin-scale Water Quality Improvement Strategies

The RWQS Framework guides how regional- and basin-level assessments and supporting evidence are integrated to develop a portfolio of prioritised and targeted Action and Delivery Strategies for each basin, collectively contributing to the achievement of the Regional Objectives and Outcome.

The assessments and supporting evidence are brought together in a hierarchical, stepwise approach (Figure 6 and Box 1). Steps 1 and 2 first establish regional priorities and Management Response needs by identifying ecosystem values, condition, and pollutant exposure across the Region. Steps 3–5 then translate this evidence, together with additional basin-specific information, into more directive basin-scale decisions about where management effort should be focused, which actions are most appropriate, the intensity at which they should be applied, and how delivery should be scaled and tailored to reflect the local context. Each of these steps are described below.

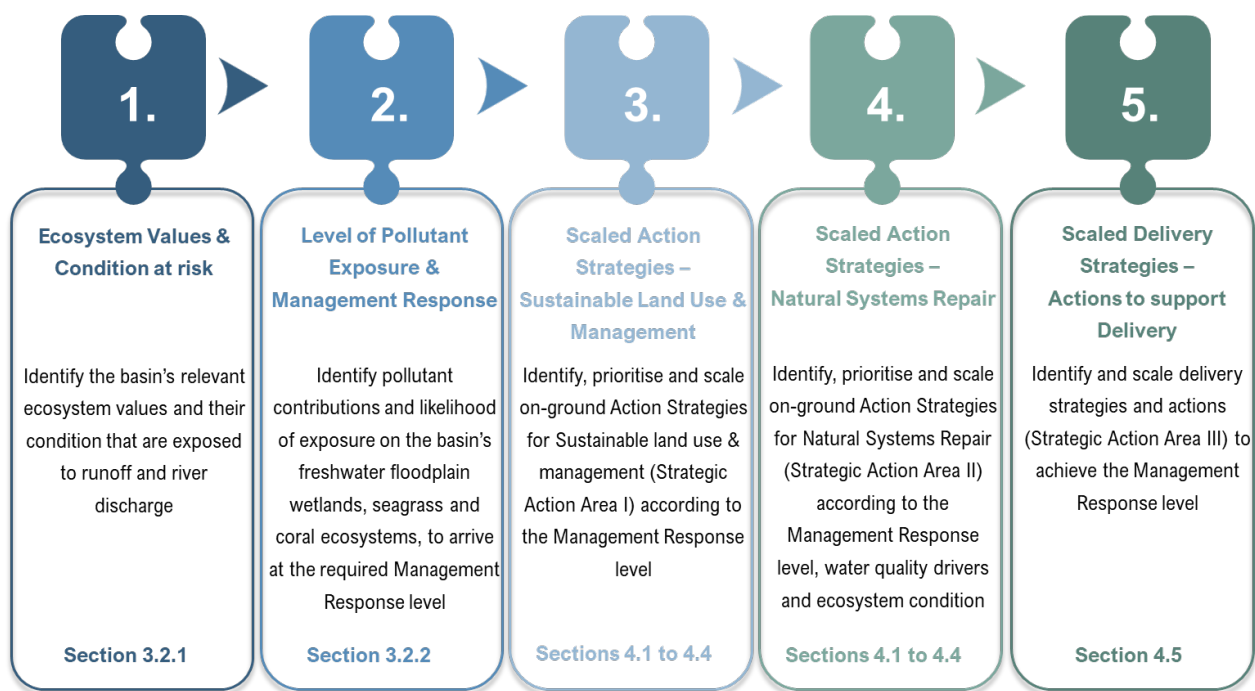


Figure 6. Applying the Framework for developing the Basin Water Quality Improvement Strategies.

Box 1: Underpinning evidence of the Regional Water Quality Strategy to identify priorities, strategies & actions

At the regional scale, ecosystem condition, pollutant exposure, modelled loads and pesticide risk inform basin-level Management Responses and regional priorities. At the basin scale, this information is combined with land use contributions, biophysical drivers, and social and economic considerations to identify focus areas, select appropriate Action Strategies, and design Delivery Strategies that are locally relevant and proportionate to risk.

This structured progression ensures that basin-level strategies are both **evidence-led and context-specific**, while remaining aligned with Regional Objectives and priorities.

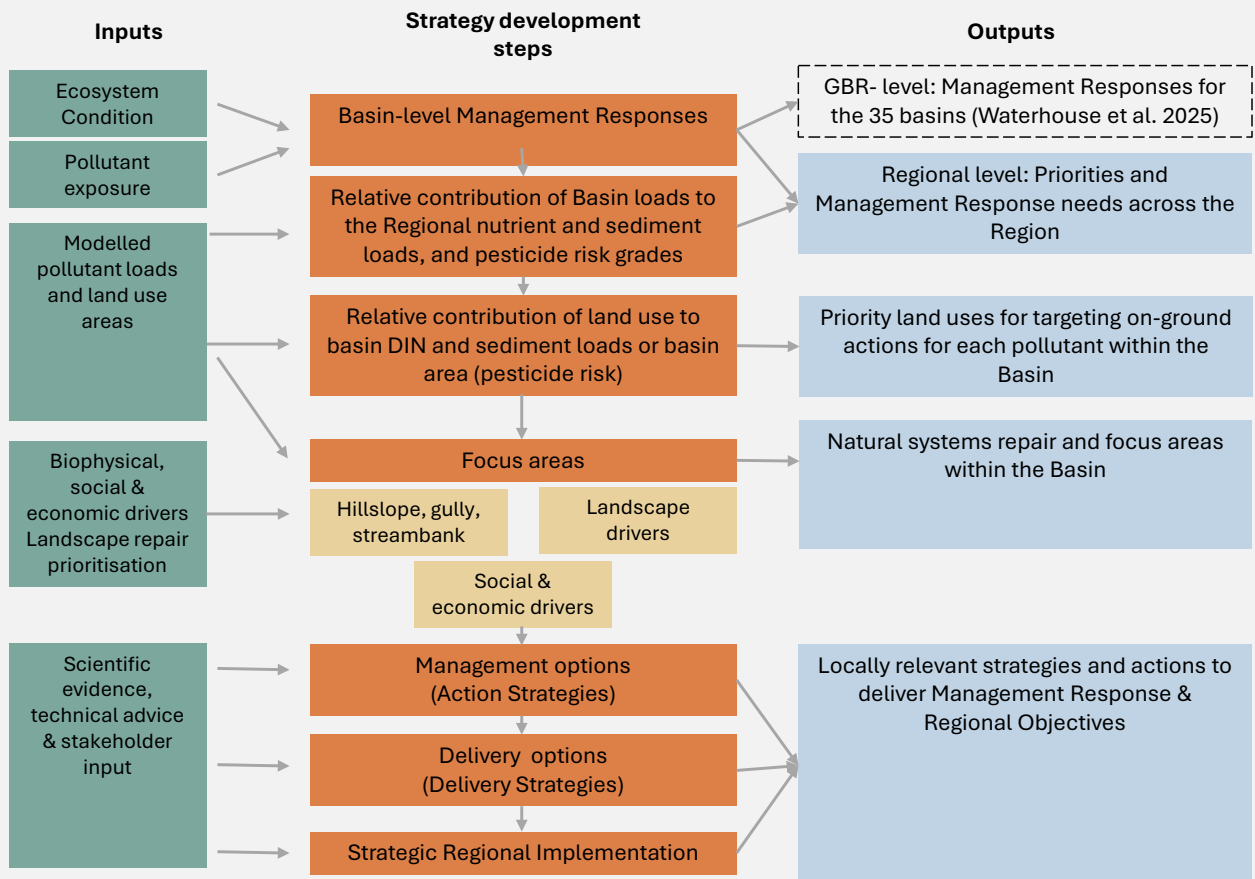


Figure 7. illustration of how multiple evidence streams are integrated to inform prioritisation and decision-making at different spatial scales.

3.2.1 Regional ecosystem values, condition and exposure to river discharge

Step 1 of the Strategy development establishes the ecosystem context of pollutant exposure. This involves identifying the Region's aquatic ecosystem values, determining which values are most vulnerable to and likely to be exposed to land-based runoff (sediment, nutrients and pesticides), and assessing their current condition. This step focuses the exposure assessment on key organisms and ecosystems, while also recognising broader regional values that may be indirectly affected.

Environmental values are defined by the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP 2019; State of Queensland, 2023) as *'the qualities that make water suitable for supporting aquatic ecosystems and human uses. These qualities need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use.'* The environmental values for surface and coastal waters of the Mackay Whitsunday Region are detailed in the EPP 2019 Schedule 1 documents (basins 122 – 126; State of Queensland, 2022a,b <https://environment.qld.gov.au/management/water/policy/>).

Of the environmental values identified under the EPP (2019), aquatic ecosystems in the Mackay Whitsunday Region are to be 'enhanced or protected', with the designated levels of protection ranging between high ecological value, slightly disturbed and moderately disturbed waters (State of Queensland, 2022a,b). Aquatic ecosystems as an environmental value are defined as *'the intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas, for example, biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water.'* The environmental values for wetlands to be enhanced or protected under the EPP (2019) are *'the qualities of a wetland that support and maintain the biodiversity of the wetland'*. In maintaining the health or improving the condition of aquatic ecosystem values, other values identified through the EPP (2019) will also be enhanced or protected, for example production of aquatic foods, aquaculture, agricultural purposes, cultural and spiritual values, and recreational use.

Other aquatic ecosystem values and ecologically important habitat protection areas are also identified for the Mackay Whitsunday Region, as described in more detail in the accompanying Synthesis Report (Section 3). These include species of conservation interest (e.g. marine turtles, dugongs, humpback whales, dolphins and shorebirds), connectivity/ fish passages in and between aquatic ecosystems, Dugong Protection Areas and Fish Habitat Areas.

The ecosystem values vulnerable to exposure from land-based runoff and critical for Reef ecosystem health more broadly include wetlands, estuaries, inshore coral reefs and seagrass. In focusing on these values, higher order interactions with other valued species (e.g. fish and species of conservation interest) will also be enhanced and protected from land-based runoff. Table 2 provides a regional overview of freshwater floodplain wetlands, estuary, seagrass and coral condition, and the spatial area and extent of ecosystems exposed to river discharge. This includes nearby zoned Dugong Protection and Fish Habitat Areas, critical for conserving fish, prawn and dugong populations, that are particularly dependent on seagrass ecosystems. The datasets in Table 2 are used to inform the Management Response Framework in Section 3.2.2 and target actions and interventions to protect and assist ecosystem recovery under Strategic Action Area II.

Table 2. Ecosystem assessments (condition and connectivity) and areas potentially exposed to nutrients, sediment and pesticides for basins within the Mackay Whitsunday Region. Gradings are based on the grading systems used from the sources of the data.

Basin	Ecosystem Assessments				Potentially exposed ecosystem and habitat areas											
	Freshwater floodplain wetlands (condition) ^A [2017–24] ¹ (Poor, Moderate or Good)	Estuary condition (Habitat & Hydrology) ^B [2022–23 data] (Very Poor, Poor, Moderate, Good, Very Good)		Seagrass condition ^C [2022–23] (Poor, Moderate or Good)	Coral condition ^D [2022–23] (Poor, Moderate or Good)	Natural & slightly modified freshwater floodplain wetlands extent (ha) ^A [2019]	Fish Habitat Areas	Dugong Protection Areas	Annual long term median river discharge (ML) ^E [1990/91 to 2019/20]	Modelled maximum river footprint area (km²) [2011–2022]	Area of habitat within maximum river footprint extent		Modelled area regularly influenced by river discharge (km²)	Area of habitat regularly exposed to river discharge		
											Seagrass (ha)	Coral reef (ha)		Seagrass (ha)	Coral reef (ha)	
Proserpine	Poor	Very Good (Gregory R)		Moderate	Poor	4,350	Edgecombe Bay, Repulse Bay	Edgecombe Bay, Repulse Bay	1,420,000	5,279	37,927	10,061	672	2,948	2,445	
O’Connell	No data*	Mod O’Connell	Good Helens/Murray C	Moderate	Poor	175	Midge, Repulse and Sand Bay	Repulse Bay, Stewart Peninsular-Newry Island-Ball Bay and Ball Bay-Sand Bay	1,380,000	6,870	39,684	11,917	1,643	6,097	2,949	
Pioneer	No data*	Moderate (Vines)		Moderate	Poor	228	Bassett Basin		825,000	8,936	40,919	13,126	1,754	9,231	1,756	
Plane	Poor	Mod Sandy, Plane,	Good Rocky Dam	V Good Carmila	Moderate	Poor	1,018	Broad Sound, Cape Palmerston-Rocky Dam, West Hill	Ince Bay	1,460,000	6,544	23,014	9,706	1,280	11,544	1,740

^A Waterhouse et al., 2025; ^B Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership (2024) results and colour-scale grading; ^C McKenzie et al., 2024; ^D Thompson et al., 2024; ^E Puignou-Lopez et al., 2025

* Low confidence due to insufficient data or observations – requires validation or investigation.

¹ Wetland condition assessed on an annual basis for a subset of aggregations, and for other aggregations every four years on a rotational basis. Results presented for most recent data.

3.2.2 Pollutant exposure and basin-specific Management Responses

Step 2 of the Strategy development establishes the context of pollutant exposure and sources for each basin to provide a clear basis for identifying where management effort needs to be focused. This assessment identifies each basin's contribution to regional nutrient and sediment loads, pesticide risk gradings, the dominant land use sources and the likelihood of pollutant exposure to freshwater floodplain wetlands, seagrass and coral ecosystems (Table 3 - Table 5). These results are then interpreted through a structured Management Response decision framework to determine the appropriate level of management response required for each pollutant, in each basin.

Management responses are applied at two spatial scales: whole-of-basin responses, which address pollutant loads discharging to marine ecosystems, and smaller scale responses, which address localised risks to freshwater floodplain wetlands. The likelihood of pollutant exposure at these scales is graded (Minimal–High) using two parallel assessments presented in Waterhouse et al. (2025) and adopted here:

- i. the freshwater floodplain wetland hazard assessment estimates potential exposure from surrounding and upstream land uses for wetland aggregations,
- ii. the marine exposure assessment describes the likelihood of exposure of vulnerable inshore ecosystems to land-based pollutants—sediment and pesticides for coral reefs and seagrass, and dissolved inorganic nitrogen (DIN) for coral reefs.

Together, these assessments derive a management response for each pollutant, at the basin-scale and smaller scales (e.g. catchment or sub-catchment scales), providing a clear basis for prioritising management effort and scaling investment across the Region:

Pollutants	Freshwater floodplain wetlands Small scale (e.g. catchment)	Marine ecosystems Basin scale
DIN/ nutrients	Management response level for nutrients based on likelihood of wetland exposure	Management response level for DIN based on likelihood of inshore coral reef exposure
Fine sediment	Management response level for fine sediment based on likelihood of wetland exposure	Management response level for fine sediment based on likelihood of seagrass and inshore coral reef exposure
Pesticides	Management response level for pesticides based on likelihood of wetland exposure	Management response level for pesticides based on likelihood of seagrass and inshore coral reef exposure

The Management Response levels are defined using the Management Response Decision Support Framework (the Management Response Framework; Figure 8), developed as part of the Spatial Management Prioritisation assessment (Waterhouse et al. 2025). The basis of the Management Response Framework is to integrate two complementary types of management goals: stressor-focused goals aimed at reducing pollutant pressures affecting aquatic ecosystems, and outcome-focused goals aimed at maintaining or improving ecosystem condition through comprehensive interventions – highlighting the importance of protecting ecosystems currently in good condition while taking action to reduce stressors causing poor ecosystem condition (Waterhouse et al. 2025). The Management Response Framework assigns an appropriate management response level based on the pollutant exposure levels, with additional actions informed by ecosystem condition.

		Pollutant Exposure			
		Minimal	Low	Moderate	High
Ecosystem Condition	Poor	Foundational response + Investigate	Proactive response + Investigate	Accelerated response + evaluate	Intensive response + evaluate
	Moderate	Foundational response + Investigate	Proactive response + Investigate	Accelerated response + further assessment	Intensive response + further assessment
	Good	Foundational response	Proactive response	Accelerated response + increased vigilance	Intensive response + increased vigilance
		Trust development, prepare for future developments	Small-scale intervention	Targeted intervention	Comprehensive intervention
Management approach					

Figure 8. GBR Water Quality Management Response Decision Support Framework (adopted from Waterhouse et al. 2025).

The Management Response levels are structured in a nested design beginning with the **Foundational** response, which applies across all GBR catchments as a minimum. As pollutant exposure increases, the responses build in scale, intensity and urgency. These response levels guide the scaling and prioritisation of Action and Delivery Strategies across the three Strategic Action Areas to achieve the Regional Objectives.

The language used to describe each Management Response level reflects this scaled approach to management intervention, which is carried through to describe the Action and Delivery Strategies:

- **Foundational Response – Minimal likelihood of pollutant exposure:** This is the minimum level of water quality management required broadly across the whole Region (and GBR catchment area). This response recognises the minimum standards (defined in policy and legislation) that should be implemented everywhere. It is an opportunity to actively maintain ecosystem values and services not impacted by water quality pressures and that are ecologically critical for other connected habitats, establish/strengthen engagement, communications, stakeholder relationships, and identify and prepare for future developments.
- **Proactive Response – Low likelihood of pollutant exposure:** The Strategy aims to support preventative actions to address emerging issues before they become significant problems, maintaining good water quality for ecosystem protection into the future. The focus is on smaller, local-scale activities within areas where there is opportunity to pre-emptively address emerging pollutant issues for the longer-term protection of ecosystem condition. These management responses typically have smaller investment costs and the potential for establishing/strengthening practices and processes with water quality benefits for now and for the long term.
- **Accelerated Response – Moderate likelihood of pollutant exposure:** The Strategy requires a targeted response that is smaller in scale than the Intensive response, generally at a sub-catchment scale, targeting and tailoring actions where they will have the greatest impact (recognising that many of these basins have already been a focus of investment). This approach focuses on the main sources of pollutants to address issues before they become of greater concern for exposed ecosystems. Additional actions for other pollutant sources provide a

diversity of management options within the basin, to pre-emptively address emerging pollutant issues. Management responses of this nature have the potential for faster environmental gains (now and for the longer term) with smaller investments.

- **Intensive Response – High likelihood of pollutant exposure:** The Strategy calls for a comprehensive management response that is generally large-scale and implemented across multiple land uses (recognising that many of these basins have already been a focus of investment in the past). The aim is to achieve widespread and fast uptake of interventions to reduce pollutant runoff rapidly and significantly. In these cases, the dominant contributing sources of the pollutants become the primary focus for targeting management, while the management of other sources and catchment processes are encouraged and supported to achieve further reductions toward ecologically relevant water quality targets.

Within each management response level, there are additional actions that are triggered according to the ecosystem condition (denoted by a + sign in Figure 8). These actions vary depending on the level of pollutant exposure and are used to inform the Natural Systems Repair Action Strategies (Strategic Action Area II). They are described in Waterhouse et al. (2025) as follows:

- **Good condition** ecosystems: Require routine and ongoing monitoring of ecosystem condition and water quality drivers, with reactive monitoring of large-scale disturbance events. Under Moderate and High pollutant exposure, additional responses are required for **increased vigilance** of changes in ecosystem condition to ensure condition does not decline.
- **Moderate condition** ecosystems: Under Minimal or Low pollutant exposure an **investigation** would be triggered to determine the other pressures driving the Moderate condition (assuming it is not related to nutrient, sediment or pesticide impacts) and to inform relevant managers of the need to act. Under Moderate or High pollutant exposure, a Moderate condition ecosystem would trigger **further assessment** to understand additional pressures on the ecosystem, to identify trends in ecosystem condition and to understand the role of pollutant impacts on the ecosystem's state to avoid further declines. **Tailored communications** on these ecosystems, drivers and pressure under threat should be developed and disseminated.
- **Poor condition** ecosystems: Under Minimal or Low pollutant exposure an **immediate investigation** would be triggered to determine the drivers of the condition and inform relevant managers of the need to act. Under Moderate or High pollutant exposure, a Poor condition ecosystem would trigger an **evaluation** of the ecosystem's ecological, social and cultural values, other potential drivers of the poor condition and the ecosystem's potential for recovery. Depending on the outcome of the evaluation, other intervention options may need to be considered. **Tailored communications** on these ecosystems under threat should be developed and disseminated.

Table 3. Scale of the management responses required for anthropogenic nutrients (including DIN) for basins in the Mackay Whitsunday Region. Pollutant sources indicate the extent of anthropogenic DIN loads transported from the catchment and the dominant land uses contributing to the load. See the Basin Water Quality Improvement Strategy tables in Section 4 for more detail on the recommended management actions for each land use. Basin-scale Management Response levels are determined by the likelihood of coral exposure to DIN in the marine exposure assessment. Smaller scale (e.g. catchment) Management Response levels represent localised variations to the basin-level marine-driven management response and are determined from the likelihood of freshwater floodplain wetland exposure to nutrient hazards (DIN plus other nutrients). (+) Additional management requirements based on ecosystem condition. Data from Waterhouse et al. (2025). Note that the pollutant loads presented here are an updated version (DETSI, 2025) of the pollutant load information presented in Waterhouse et al. (2025).

Basin	Pollutant sources		Basin-scale		Smaller scale (e.g. catchment)	
	Anthropogenic modelled annual average DIN load (tonnes) (% of total Regional anthropogenic load)	Dominant pollutant source for targeted management (ranked)	Marine Exposure Likelihood of coral exposure	Management Response level	Freshwater floodplain wetlands Hazard assessment	Management Response level
Proserpine	101 (21%)	Sugarcane, Urban	Moderate	Accelerated + evaluate	High	Intensive + evaluate
O'Connell	76 (16%)	Sugarcane, Urban	Moderate	Accelerated + evaluate	High	Intensive + evaluate
Pioneer	158 (33%)	Sugarcane, Urban	Moderate	Accelerated + evaluate	High	Intensive + evaluate
Plane	144 (30%)	Sugarcane, Urban	Moderate	Accelerated + evaluate	High	Intensive + evaluate

Table 4. Scale of the management responses required for anthropogenic fine sediment for the basins in the Mackay Whitsunday Region. Pollutant sources indicate the extent of anthropogenic fine sediment loads transported from the catchment and the dominant land uses contributing to the load. See the Basin Water Quality Improvement Strategy tables in Section 4 for more detail on the recommended management actions for each land use. Basin-scale Management Response levels are determined by the likelihood of seagrass and coral exposure to fine sediment in the marine exposure assessment. Smaller scale (e.g. catchment) Management Response levels represent localised variations to the basin-level marine-driven management response and are determined from the likelihood of freshwater floodplain wetland exposure to sediment hazards. (+) Additional management requirements based on ecosystem condition. Data from Waterhouse et al. (2025). Note that the pollutant loads presented here are an updated version (DETSI, 2025) of the pollutant load information presented in Waterhouse et al. (2025).

Basin	Pollutant sources		Basin-scale		Smaller scale (e.g. catchment scale)	
	Anthropogenic modelled annual average fine sediment load (kilotonnes) (% of total Regional anthropogenic load)	Dominant pollutant source for targeted management (ranked)	Marine Exposure Likelihood of coral exposure	Management Response level	Freshwater floodplain wetlands Hazard assessment	Management Response level
Proserpine	21 (6.2%)	Streambank in various land uses, Grazing	Minimal	Foundational + investigate	High	Intensive + evaluate
O'Connell	177 (53%)	Streambank in various land uses, Grazing, Sugarcane	Moderate	Accelerated + evaluate	High	Intensive + validate
Pioneer	74 (22%)	Streambank in various land uses	Moderate	Accelerated + evaluate	High	Intensive + validate
Plane	61 (18%)	Grazing, Streambank in various land uses, Sugarcane	Low	Proactive + investigate	Moderate	Accelerated + evaluate

Table 5. Scale of the management responses required for pesticides for the basins in the Mackay Whitsunday Region. Pollutant sources indicate the level of pesticide risk estimated at the catchment and basin scales and the land uses within the basin that have a higher potential for pesticide risk to aquatic ecosystems. See the Basin Water Quality Improvement Strategy tables in Section 4 for more detail on the recommended management actions for each land use. Basin-scale Management Response levels are determined by the likelihood of seagrass and coral exposure to pesticides in the marine exposure assessment. Smaller scale (e.g. catchment) Management Response levels represent localised variations to the basin-level marine-driven management response and are determined from the likelihood of freshwater floodplain wetland exposure to pesticide hazards. (+) Additional management requirements based on ecosystem condition. Data from Waterhouse et al. (2025).

Basin	Pollutant sources			Basin-scale		Smaller scale (e.g. catchment scale)	
	Catchment-level pesticide risk metric Very Low – Very High (% species protected) ^A	Basin-level pesticide risk Very Good – Very Poor ^B	Land uses with a higher potential for pesticide risk (ranked by land use area)	Marine Exposure Likelihood of coral exposure	Management Response level	Freshwater floodplain wetlands Hazard assessment	Management Response level
Proserpine	Very High (76.6 to 65.5%)	Poor	Sugarcane, horticulture, irrigated and dryland cropping	High	Intensive + evaluate	High	Intensive + evaluate
O'Connell	Moderate to High (92.3 to 87.1%)	Poor	Sugarcane, horticulture and irrigated cropping	High	Intensive + validate	High	Intensive + validate
Pioneer	High to Very High (85.5 to 75.1%)	Poor	Sugarcane, horticulture and dryland cropping	High	Intensive + validate	High	Intensive + validate
Plane	Sandy Creek: Very High (66.6 to 57.7%) Plane Creek: Low to Moderate (95.9 to 92.8%)	Very Poor	Sugarcane, horticulture, irrigated and dryland cropping	High	Intensive + evaluate	High	Intensive + evaluate

^A Water Quality & Investigations (2024); ^B Reef Water Quality Report Card 2021 and 2022.

Table 6 provides a cross-basin comparison of the management response levels required for DIN and other nutrients, fine sediment and pesticides across the Mackay Whitsunday region. Management responses are presented at the basin scale, reflecting exposure of marine ecosystems (coral reefs and seagrass), and smaller scale (e.g. catchment or sub-catchment scales) that reflects exposure of freshwater floodplain wetlands. In a number of basins, freshwater wetland hazard assessments trigger higher Management Responses than the basin's marine exposure assessment, highlighting the importance of localised, wetland-focused management alongside basin-scale management for marine protection.

The focus of DIN management in the Mackay Whitsunday region is to actively reduce the Moderate and High DIN exposure that is occurring on marine and freshwater floodplain wetland ecosystems from key sources—primarily sugarcane and urban. At the basin scale, this requires an Accelerated management response across all basins, where DIN exposure to coral reefs is Moderate. Within basins, the freshwater floodplain wetland hazard assessment indicates that Intensive nutrient management is required in areas surrounding and upstream of freshwater floodplain wetlands for all basins.

The focus of fine sediment management in the Mackay Whitsunday region is to actively reduce the Moderate and High fine sediment exposure to marine and freshwater floodplain wetland ecosystems, while also ensuring the Low and Minimal exposure is maintained in other areas; primarily through targeting streambank erosion and grazing sources, as well as sugarcane in some basins. This requires an Accelerated management response in the O'Connell and Pioneer basins to address Moderate fine sediment exposure to marine ecosystems, and Proactive management in the Plane Basin to prevent escalation of Low fine sediment exposure. Maintaining Minimal exposure to marine ecosystems from the Proserpine Basin will be supported through a Foundational management response. Within basins, Intensive management is required in areas surrounding and upstream of freshwater floodplain wetlands in the Proserpine, O'Connell and Pioneer basins, and Accelerated management in the Plane.

The focus of pesticide management in the Mackay Whitsunday region is to actively reduce the High pesticide exposure to marine and freshwater floodplain wetland ecosystems, primarily through targeting sugarcane sources, with secondary targeting of horticulture, dryland and irrigated cropping and non-agricultural sources. This requires an Intensive management response in all basins including areas surrounding and upstream of freshwater floodplain wetlands.

Table 6. Comparison of basin-scale and smaller-scale water quality management response levels for fine sediment, DIN and pesticides across the Mackay Whitsunday Region. *Basin-scale management response (i.e. Marine exposure assessment) is based only on DIN exposure, the smaller scale Management Response (i.e. the Freshwater wetland hazard assessment) is based on DIN plus other nutrients.

	DIN + other nutrients*	Fine sediment	Pesticides
Basin-scale Management response (based on Marine exposure assessment)			
Foundational		Proserpine	
Proactive		Plane	
Accelerated	Proserpine, O'Connell, Pioneer, Plane	O'Connell, Pioneer	
Intensive			Proserpine, O'Connell, Pioneer, Plane
Smaller scale Management response (based on Freshwater wetland hazard assessment)			
Foundational			
Proactive			
Accelerated		Plane	
Intensive	Proserpine, O'Connell, Pioneer, Plane	Proserpine, O'Connell, Pioneer	Proserpine, O'Connell, Pioneer, Plane

3.2.3 Identifying and prioritising Action and Delivery strategies for each pollutant

Building on the pollutant-specific Management Response levels derived in Steps 1 and 2, the next phase of Strategy development focuses on translating these responses into basin-level Action and Delivery Strategies. This phase moves from regional assessment to basin-specific actions, specifying what and where to target actions on the ground and how to effectively deliver those actions in line with the target audience.

Action Strategies define the priority on-ground actions required to reduce pollutant runoff where the greatest gains can be achieved, to maintain minimal pollutant exposure where exposure is currently low, or where interventions may be needed to assist natural systems repair or recovery. Delivery Strategies provide the enabling framework for program delivery, guiding the design of coordinated and targeted programs that are scaled to the Management Response level and tailored to local socio-economic contexts, including the capacity, opportunity and motivation of land managers and other stakeholders. This translation from Management Response to action and delivery occurs through the next three linked steps of the Strategy development:

- Step 3 – Identifying, prioritising and scaling on-ground Action Strategies for Sustainable land use & management (Strategic Action Area I) according to the Management Response level.
- Step 4 – Identifying, prioritising and scaling on-ground Action Strategies for Natural Systems Repair (Strategic Action Area II) according to the Management Response level, water quality drivers and ecosystem condition.
- Step 5 – Identifying and scaling delivery strategies and actions (Strategic Action Area III) to achieve the Management Response level.

Systems logic underpinning the development of Action and Delivery Strategies

The Action and Delivery Strategies are developed using a systems thinking approach that examines the complex and interconnected ecological, biophysical, social and management components within each basin. This approach helps to identify the most effective intervention points where targeted actions can deliver the greatest impact toward achieving Regional Objectives and fulfilling the Management Response requirements within each Strategic Action Area.

Underpinning the development of the Action and Delivery Strategies is a clear and structured systems logic (Figure 9). The logic operates in two connected parts, the upper section depicts the key system components and causal relationships driving pollutant exposure and impact on aquatic ecosystems, which were examined. Starting from the top, the condition of aquatic ecosystem values is driven by exposure to land-based pollutants. This exposure is influenced by two interconnected components: the dominant pollutant sources and pathways (specific to each pollutant), and the system drivers of pollutant runoff and transport (such as climate, land use and socio-economic factors). These two components also represent key leverage points where management interventions can be targeted. The bottom section of the logic demonstrates how management responses connect to these leverage points through the three Strategic Action Areas. The Action Areas work together to address the basin-specific drivers and pollutant sources, informing the areas of focus for the Basin-level Water Quality Improvement Strategies. At the base of the systems logic is Strategic Regional Implementation, which connects the basin-level strategies to the broader regional delivery system. While the Basin-level Water Quality Improvement Strategies identify what needs to occur within each basin, the Strategic Regional Implementation identifies the regional systems that turn the Action and Delivery Strategies into coordinated, long-term action. Successful implementation influences the pollutant sources, drivers and ultimately the condition of ecosystems – achieving the Mackay Whitsunday Regional Outcome.

While the systems logic is presented in a linear flow, it is important to acknowledge that in practice, interactions and feedback loops exist within the system. These complexities should be identified and considered as funding opportunities arise for specific project or programs, depending on the funding objectives.

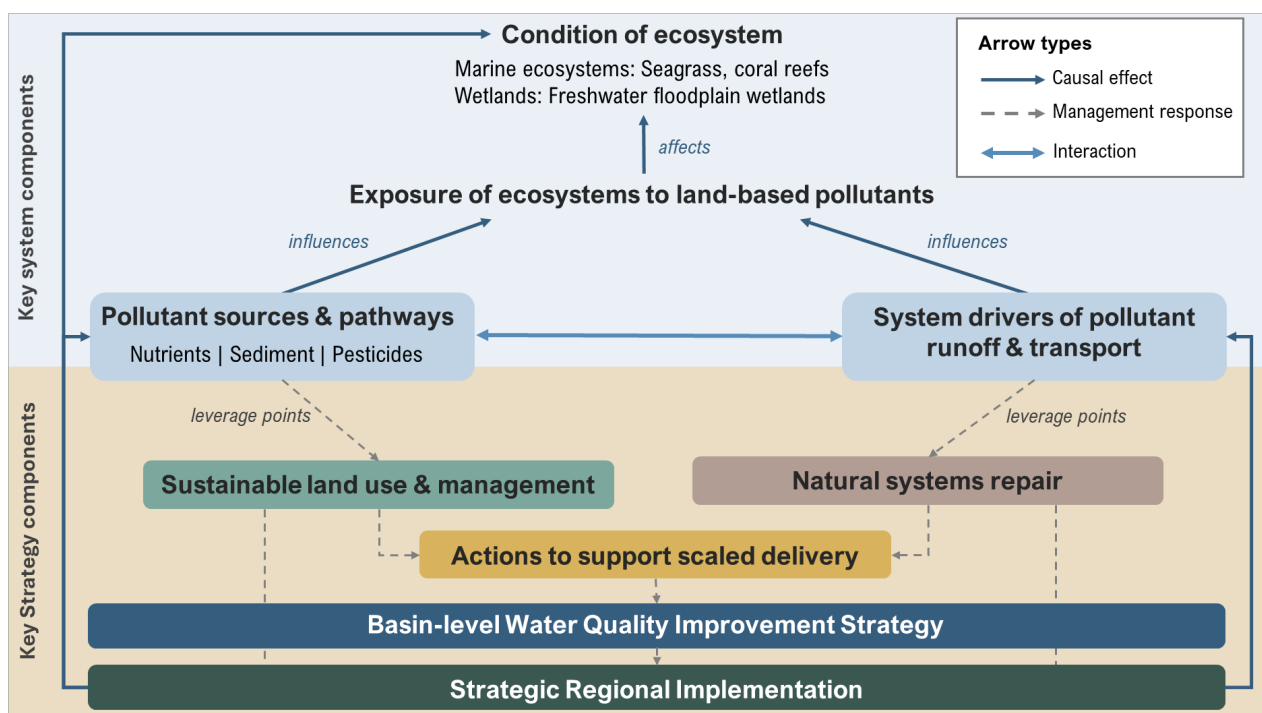


Figure 9. Systems logic framework for developing Basin-level Water Quality Improvement Strategies. Solid upward arrows indicate causal relationships between key system components where land-based pollutants drive ecosystem impacts on marine environments (seagrass, corals). Dotted downward arrows show how this understanding informs the development of the Strategy through three strategic action areas. The framework identifies key leverage points (pollutant sources/pathways and system drivers) where interventions can be targeted to improve water quality outcomes for the Great Barrier Reef.

The system components and their relationships are described quantitatively and qualitatively through data and information specific to each basin (detailed in the accompanying Synthesis Report). This evidence base is used to tailor the Action and Delivery Strategies for each basin to achieve the Regional Objectives. The tailored Action and Delivery Strategies are also scaled to align with the management response level for each pollutant.

Development of Action and Delivery Strategies

The Action Strategies for **Strategic Action Area I: Sustainable Land Use and Management**, aim to reduce the initial source of pollutants across a range of land uses, such as by reducing fertiliser inputs, minimising soil erosion and optimising pesticide application. It is essential to acknowledge the challenge of bridging the gap between current management practice adoption and what ecosystems require. In many basins, even accelerated uptake of recommended practices may be insufficient to meet ecosystem needs—particularly where ecosystems are affected by multiple stressors. Even under a ‘best-case’ scenario of widespread adoption, the water quality benefits from land management alone may not fully achieve the pollutant reductions needed to maintain or restore ecosystem health. This Strategy explicitly addresses these challenges by:

- Providing multiple pathways to reduce pollutants at their source, through a prioritised suite of Action Strategies targeting the dominant pollutant sources. These strategies are ranked according to each land use’s relative contribution to pollutant loads and primary loss pathways (for sediment), generally identifying the top three or four priority sources.
- Complementing sustainable land use strategies with Natural Systems Repair strategies, tailored to local drivers of pollutant exposure and ecosystem condition (e.g. streambank erosion, wetland condition, fish passage barriers).
- Aligning Action Strategies with targeted delivery tools that help to identify and respond to the enablers and barriers to increased and accelerated adoption. This includes identifying capability,

opportunity, and motivation constraints to inform the design of support systems that enable sustained, long-term practice change – see Section 4.5.

There are several important caveats to how pollutant sources are ranked:

- DIN and sediment rankings reflect the total annual load based on ‘manageable’ contributions (i.e. excludes conservation areas).
- DIN load from grazing is primarily linked with sediment erosion and therefore was treated as a co-benefit of sediment reduction actions. For this reason, grazing sources of DIN are acknowledged but ranked lower in the table.
- Data is unavailable to determine quantified land use contributions to pesticide risk, rather the land use’s relative potential for pesticide risk is noted (i.e. Higher or Lower potential for pesticide risk²) along with the proportion of the basin the land use occupies.

In addition to ranking land uses by their relative contribution to pollutant loads or risk, the Action Strategies use scaled delivery language that reflects the required intensity and urgency of effort. Land uses with higher contributions and higher pollutant exposure levels are paired with stronger language (e.g. “*rapidly maximise and sustain*” or “*actively encourage and support*”) to signal the need for accelerated, well-resourced and coordinated action. Lower-contributing sources and lower exposure levels use lighter-touch phrasing (e.g. “*encourage adoption*”) to indicate proportionate effort and investment. This approach guides delivery partners on where to prioritise resources while still promoting broad uptake of sustainable practices across all land uses. This is described further in Section 4.5.

The Action Strategies operate in addition to regulated minimum standards for land management. Minimum standards for managing nutrients and sediments in agriculture are regulated under the Reef Protection Regulations, while pesticide use is regulated by the *Chemical Usage (Agricultural and Veterinary) Control Act 1988*, which mandates adherence to label instructions. Achieving the water quality improvements necessary for ecosystem protection in Mackay Whitsunday basins will require adoption of *best practices* that go beyond these minimum standards to deliver stronger water quality outcomes. The Paddock to Reef (P2R) Water Quality Risk Frameworks, developed in 2016 for key agricultural industries, provide consistent, risk-based guidance of management practices across the GBR catchment. These frameworks underpinned progress reporting toward the previous land management targets of the Reef 2050 WQIP (i.e. 90% best practice adoption), which have recently been reviewed to assess their applicability at regional and catchment scales (see DPI, 2025).

As noted in Section 1.2, the Review of Land Management Targets (DPI, 2025) recommended discontinuing the GBR-wide voluntary land management targets in favour of more context-specific approaches, including consideration of local environmental and social factors. In the Mackay Whitsunday Region, the Review focused on nutrient and pesticide management in sugarcane and fine sediment management in grazing. The consultation process used ADOPT (Adoption and Diffusion Outcome Prediction Tool; <https://adopt.csiro.au/>) to assess and predict the likely peak adoption levels of specific agricultural management practices with defined target populations. The Review offers key insights into factors affecting current adoption trajectories and opportunities to increase adoption towards a best-case scenario, providing specific guidance for water quality improvement planning and program design. Following local stakeholder testing, the Review outcomes were integrated into the recommended priority actions for the Mackay Whitsunday Region for sugarcane and grazing land uses, which are presented in this Strategy through the grazing and sugarcane Action Strategies. For other land uses, action examples

² Sugarcane, bananas, horticulture, dryland and irrigated cropping have a higher potential for pesticide risk; forestry, urban, grazing (open grazing and forested grazing) and dairy have a lower potential for pesticide risk (see Synthesis Report for further information).

from the scientific literature and stakeholder engagement are provided. It is acknowledged that different actions suit some contexts better than others, and therefore the actions provided are not prescriptive – more extensive lists of actions that reduce pollutant runoff are provided in Appendix 1.

The Action Strategies for **Strategic Action Area II: Natural Systems Repair** are needed to strengthen natural catchment processes, support recovery of ecosystem function and condition, and to help close the gap between water quality improvements achieved by sustainable management practices and what is required to sustain aquatic ecosystem health. These strategies were developed using multiple lines of evidence that identify the key landscape-scale drivers of degraded water quality and ecosystem condition, including primary sediment loss pathways and the loss or degradation of critical natural systems such as gullies, streambanks, riparian zones and wetlands (Table 1). The resulting Action Strategies target rehabilitation of natural catchment processes and functions, which can help to capture and break down pollutants in runoff, and recovery of ecosystem condition and connectivity (e.g. wetlands, seagrass, fish barriers). Examples include large-scale gully or streambank remediation, landscape revegetation or hydrological modifications to restore connectivity.

The formulation of these Action Strategies were informed by basin-specific water quality biophysical drivers (including primary loss pathways and load contributions – see Table 1 to Table 4), ecosystem condition information (for freshwater floodplain wetlands, seagrass and coral), landscape repair prioritisation for fine sediment (Neilly Group Engineering, 2023) and actions in the Gully and Streambank Toolbox, guidance from the [Queensland River Rehabilitation Management \(QRRM\) Guideline](#) and Queensland Wetlands Program and the 2022 Scientific Consensus Statement. Relative contributions of different erosion pathways to sediment loads (where available) informed the rehabilitation priorities associated with sediment reduction, with the acknowledgement that some natural systems deliver multiple benefits across water quality, biodiversity and landscape resilience, not just sediment reduction.

Ecosystem condition Action Strategies were further shaped by the Management Response Decision Support Framework (Figure 8), which links management responses to ecosystem condition grades – e.g. under higher pollutant exposure scenarios, the framework calls for progressively more targeted investigation, evaluation and intervention, including assessment of ecological, social and cultural values, recovery potential and the role of land-based runoff in driving ecosystem decline.

The Action Strategies include a combination of smaller scale system repair actions and larger scale engineering solutions. Systems repair is defined in the Whole-of-System Values-Based Framework as *“improving processes or components of an ecosystem to a desired state that will deliver agreed ecosystem services and values, primarily through natural means”*³. Systems repair management options are relatively low risk compared to engineered solutions and may be adopted in instances where the ecosystem may be able to repair itself or do so with minimal engineering. In many cases systems repair requires reinstating or improving vegetation cover (e.g. through natural regeneration or active revegetation), removing some of the pressures on the system or changing minor hydrological flows (e.g. barrier removal). Larger scale engineering solutions may include gully and streambank reshaping and revegetation, bank stabilisation using rock chutes, pile fields and rock capping.

As with Strategic Action Area I, the language used in the Action Strategies reflects the relative scale, urgency and intensity of response required. This communicates where coordinated, targeted and well-resourced natural systems repair is most critical, while still promoting broad protection and maintenance of natural functions across the Region.

The strategies presented are not prescriptive. They provide examples of priority actions and hotspot areas where known, while allowing flexibility to tailor interventions based on local conditions, landholder

³ <https://wetlandinfo.des.qld.gov.au/wetlands/management/rehabilitation/rehab-process/step-4/systems-repair.html>

contexts, technical feasibility and evolving evidence. More detailed technical guidance is provided in referenced tools and guidelines, including gully and streambank repair toolboxes, riparian management frameworks and wetland and catchment rehabilitation strategies.

The **Delivery Strategies** identified in **Strategic Action Area III** are required to support the delivery of the Action Strategies. Management actions that relate to practice change vary in their likelihood of adoption, depending on the enablers and barriers to uptake. These enablers and barriers typically centre around motivations, capability and opportunity factors (e.g. Michie et al., 2011; Murray-Prior and Schultz, 2024; DPI, 2025). Further detail of Delivery Strategies is described in Section 4.5.

Strategies to support implementation

Underpinning the delivery of each Strategic Action Area are the broader Strategies to support regional implementation (Section 5) - including science and innovation, monitoring and evaluation, knowledge sharing and communication, and coordinated governance arrangements. These strategies create the enabling environment for effective delivery of actions at the regional scale. For example, investment in capacity building can equip delivery providers (such as extension officers, NRM bodies, and industry groups) with the skills and resources to support land managers in adopting targeted management responses. Similarly, stronger coordination and collaborative governance arrangements help align effort across multiple programs and funding sources, reducing duplication and ensuring that on-ground delivery is coherent and responsive to regional priorities.

Performance measures are also part of the implementation and include measurable indicators that track progress towards the objectives and assess whether outcomes are being achieved (see Section 5.7.1). Indicators that are already measured through existing programs are included where possible.

4 Basin Water Quality Improvement Strategies

The Basin Water Quality Improvement Strategies outline, prioritise, and scale the Action and Delivery strategies across the three Strategic Action Areas:

1. Basin-specific Sustainable Land Use and Management (Strategic Action Area I): On-ground Action Strategies for each pollutant, tailored to each basin, and scaled and prioritised according to the Management Response level and pollutant sources (Sections 4 and Appendix 1).
2. Basin-specific Natural Systems Repair (Strategic Action Area II): On-ground Action Strategies tailored to each basin, and scaled according to the Management Response level, water quality drivers, and ecosystem condition (Section 4 and Appendix 1).
3. Cross-basin Actions to Support Scaled Delivery (Strategic Action Area III): High-level strategies required to enable delivery of Actions I and II. These typically vary by land use rather than by basin (Section 4.5).

4.1 Proserpine Basin Water Quality Improvement Strategy

4.1.1 Basin Context

The Proserpine is the most northerly basin in the Mackay Whitsunday Region. It covers 2,513 km² or 28% of the NRM region. Grazing is the main land use (50% of the area), followed by conservation (23%), and sugarcane (9.8%). Urban centres account for 2.8% of the area, and small areas of horticulture are also present (0.3%). The basin has an average rainfall of 1,474 mm and a long-term (1990/91 to 2019/20) median river discharge of 859 gigalitres per year.

Historical native vegetation clearing and the loss and/or modification of freshwater floodplain wetlands are two landscape disturbance factors that may be influencing water quality in the Proserpine. By 2018, around 72% of native vegetation had been cleared from floodplains, along with 58% of the native vegetation in freshwater floodplain wetland riparian zones. Between 2019 and 2022, a further 1,219 hectares of vegetation was cleared. Over a third of freshwater floodplain wetlands in the basin have been modified or lost, with 4,089 hectares of natural unmodified wetlands remaining in 2017.

In terms of pollutants, the modelled total annual average loads coming from the Proserpine are 180 tonnes of DIN and 32 kilotonnes of fine sediments. Sugarcane areas are the dominant source of DIN (43%), and urban areas and sewage treatment plants contribute a further 12%. The main loss pathway for DIN is diffuse dissolved (55%). Streambank (40%) and grazing (24%) areas are the primary sources of fine sediments, and the dominant transport pathway is hillslope erosion (55%), followed by streambank erosion (40%). End-of-catchment monitoring shows that the pesticide risk is consistently Very High, and that imidacloprid and diuron are the biggest contributors. The largest land use area in the Proserpine with a higher potential for pesticide runoff is sugarcane, followed by horticulture.

Freshwater floodplain wetlands in the Proserpine Basin are in Poor condition. They face a number of pressures that could influence water quality including pest species, vegetation clearing, drainage and hydrological modifications, reduced landscape connectivity, and nutrient inputs. All of the 4,350 hectares of freshwater floodplain wetlands included in the hazard assessment are exposed to High or Very High nutrient and sediment hazard, and 58% of the area is exposed to Moderate, High, or Very High pesticide hazard.

In 2022–23, coral reefs adjacent to the Proserpine were in Poor condition and seagrass meadows were in Moderate condition. The marine DIN exposure score is Moderate, reflecting the proximity of coral reefs to the coast. Sediment exposure is Minimal, reflecting the low anthropogenic fine sediment load. Pesticide exposure is High.

4.1.2 Overall Management Response and focus areas

A coordinated, multi-pollutant management response is required across the Proserpine Basin. At the basin scale, this includes Intensive management of pesticides, Accelerated nutrient management in targeted sub-catchments, and Foundational sediment management to maintain minimal future exposure. Complementary to the basin-wide management response, freshwater floodplain wetland hazard exposed areas require Intensive management for all pollutants due to more localised exposure risks. All remaining areas of the basin should be managed through a broadscale Foundational response.

As coral reefs and wetlands are in Poor condition, an evaluation of the drivers of condition is required and to determine the need and feasibility of intervention options to support ecosystem recovery or rehabilitation.

4.1.3 Proserpine Sustainable land use & management

Table 7. **Proserpine Sustainable land use & management Action and Delivery Strategies** required to achieve Regional Objective 1. The **Basin-scale Strategic management response** aligns to the recommended Management Response for nutrients, fine sediment, and pesticides (Section 3.2.2). The **Action Strategies** are scaled according to the Management Response for each pollutant and ranked according to the pollutant's **Dominant land use sources** - the relative contributions of the basin's agricultural and non-agricultural land uses: DIN and fine sediment action strategies are ranked by the relative total annual loads of the top 'manageable' land use contributions (i.e. excludes conservation areas), and pesticide action strategies are ranked by the basin's highest land use areas and their potential (higher vs lower) for pesticide risk- see Section 3.2. Priority actions are described for each land use in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional Objective: Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.			
PROSERPINE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Nutrients Actively reduce Moderate DIN exposure on marine ecosystems through an Accelerated management response in targeted sub-catchments, including Intensive management of nutrients in wetland hazard exposed areas. <i>Primary focus is reducing sugarcane sources of DIN. Additional reductions could also be achieved through targeted interventions in urban areas and point source loads. Increasing adoption of soil erosion management practices in grazing lands may also reduce DIN further. Management includes a focus on DIN plus other nutrients from land use areas upstream and surrounding wetlands.</i>	Sugarcane 24,600 ha (43% of total annual average DIN load)	Increase and sustain adoption levels of best practices that reduce DIN export from sugarcane areas including: holistic, farm-specific DIN accounting; address soil constraints; improved soil health; address drainage and waterlogging issues; and on farm water management to support effective use of irrigation water.	Deliver coordinated and integrated programs that accelerate sustained adoption of target basin-scale management responses, tailored to local socio-economic and cultural contexts, land use types, and land managers' capacity, opportunities, and motivations, including: • Capacity, skills and expertise • Social norms and trust development • Decision support • Incentives and markets • Technology and equipment
	Urban + STP 7,047 ha (12% of total annual average DIN load)	Encourage and support adoption of actions to address emerging DIN issues in stormwater runoff and point source discharge through stormwater treatment interventions, strategically targeted implementation of Water Sensitive Urban Design, and sewage treatment plant (STP) upgrades, reuse and efficiencies in sewage system management.	
	Grazing 125,780 ha (30% of total annual average DIN load) ^B	Encourage and support adoption of best practices that reduce DIN export through reducing sediment runoff in grazing. Implement best practice nutrient management in finishing paddocks. <i>[This action is a co-benefit of erosion management actions – refer below]</i>	

Regional Objective: *Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.*

PROSERPINE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>Foundational management of nutrients in all other areas to prevent future sources of nutrients.</i>			<i>See example interventions in Section 4.5 of the Strategy</i>
<i>Elevated concentrations of phosphorus are characteristic of water quality conditions in the Mackay Whitsunday Region. There is currently insufficient information to recommend a definitive Management Response for different land uses for phosphorus. Current understanding indicates that sugarcane is the primary source of DIP in the Proserpine Basin.</i>	Sugarcane and other potential land use sources 24,600 ha (Sugarcane) (45% of total annual average DIP load)	Further investigation to better understand sources and drivers, potential ecological risks and where required, appropriate management actions. Increase and sustain adoption levels of best practices that reduce DIP export from sugarcane areas.	
Sediment Actively reduce sediment exposure on freshwater floodplain wetlands through an Intensive management response in wetland hazard exposed areas, while applying a Foundational management response across all other areas to maintain Minimal sediment exposure on marine ecosystems. <i>Focus is on protecting streambanks with supplementary actions to</i>	Streambank (40% of total annual average sediment load) Grazing 125,780 ha (24% of total annual average sediment load)	Encourage best practices in riparian zones that reduce streambank erosion across multiple land uses including, riparian fencing/excluding cattle from streambank access, managing weeds and pests, and revegetation in riparian zone. <i>[These actions are complementary to Natural Systems Repair actions]</i> For guidance, refer to The Mackay Whitsunday Isaac Riparian Management Handbook. Encourage and support adoption of best practices for sediment reduction, including land-condition assessment, matching stocking rates to available feed, pasture spelling and reseeding, selective grazing with fencing, restricted riparian access and improved herd management. Manage linear features including unsealed roads and implement feral animal control.	

Regional Objective: *Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.*

PROSERPINE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>minimise hillslope erosion in grazing, sugarcane and urban areas.</i>		<i>Focus area: Grazing in hillslope areas.</i>	
	Sugarcane 24,600 ha (5.5% of total annual average sediment load)	Encourage best practices that reduce sediment erosion in sugarcane, including minimum tillage, trash blanket, use of fallow crops, controlled traffic, installation of vegetated spoon drains, vegetated buffers, strategically located sediment traps and feral animal control.	
	Urban 7,047 ha (5.1% of total annual average sediment load)	Encourage best practices that reduce sediment erosion in urban areas including targeted erosion and sediment control, strategic implementation of Water Sensitive Urban Design and treatment train options (see Natural Systems Repair). <i>Potential hotspot areas: Cannonvale, Airlie Beach hillslopes</i>	
Pesticides Expedite reductions of High pesticide exposure on marine ecosystems and wetland hazard exposed areas through an Intensive, large-scale management response. <i>Action is required across multiple agricultural land uses, primarily focused on pesticide reduction in sugarcane. Additional reductions could also be achieved through horticulture, irrigated and dryland cropping, grazing and non-agricultural land uses.</i>	Sugarcane 24,600 ha (9.8% of basin area and a higher potential for pesticide risk)	Rapidly maximise and sustain widespread adoption of practices that minimise pesticide risk from sugarcane including reducing overall pesticide application rates, increasing uptake of precision technologies, switching to lower risk products, optimising application timing relative to rainfall, managing point sources, improved irrigation management practices and adopting integrated pest management.	
	Horticulture, irrigated and dryland cropping 976 ha (0.4% of basin area and a higher potential for pesticide risk)	Encourage and support adoption of best practices that minimise pesticide risk from horticulture and dryland cropping including product selection, rate, timing of application, precision technologies and integrated pest management.	
	Grazing 125,780 ha	Encourage adoption of best practices for weed management that minimise pesticide risk from grazing including product	

Regional Objective: *Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.*

PROSERPINE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>Management includes a focus on areas upstream and surrounding wetlands.</i>	(50% of basin area and a lower potential for pesticide risk)	selection, rate, timing of application, precision technologies, mechanical weed removal and integrated pest management.	
<i>Foundational management of pesticides in all other areas to prevent future sources of pesticides.</i>	Non-agricultural areas (e.g. urban, forestry) 20,601 ha (8% of basin area and lower potential for pesticide risk)	Encourage adoption of best practices that minimise pesticide risk from non-agricultural land uses including product selection, rate, timing of application, and improved wastewater treatment processes.	

^A Loads are presented as the Total Annual Average, not the Anthropogenic Load. Data is unavailable to determine quantified land use contributions to pesticide risk, rather the land use's relative potential for pesticide risk is noted along with the proportion of the basin the land use occupies.

^B DIN load from grazing is primarily linked with sediment erosion and therefore is treated as a co-benefit of sediment reduction actions. For this reason, grazing sources of DIN are acknowledged but ranked lower in the table.

4.1.4 Proserpine Natural Systems Repair

Table 8. **Proserpine Natural Systems Repair Action and Delivery Strategies** required to achieve Regional Objective 2. The **Basin-scale Strategic management response** aligns to the recommended pollutant Management Response levels and ecosystem condition assessments. The **Action Strategies** target natural system drivers of water quality risks (streambank and gully erosion¹, vegetation and wetland loss²) and the condition of ecosystems³ (freshwater floodplain wetlands, seagrass, coral, and ecosystem connectivity). ¹Streambank and gully action strategies are ranked and scaled based on their contributions to the basin's sediment load. ² Vegetation loss and wetland loss/or modification action strategies are scaled based on % losses and identified hotspot areas. ³ Ecosystem condition action strategies are based on ecosystem condition ratings – poor, moderate or good. Priority actions are described for each natural system in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional objective: Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.			
PROSERPINE Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III – Section 4.5)
Actively repair and rehabilitate natural systems in targeted and strategic locations to improve natural system processes for water quality outcomes and improve ecosystem condition.	Streambank rehabilitation (40% sediment load contribution)	Rehabilitate streambanks in priority locations through riparian vegetation restoration and installing structural and engineered interventions for bank reshaping and stabilisation such as rock protection or rock armouring, timber pile fields, log fillets and rock groynes. <i>[These actions are complementary to Sustainable Land use and Management actions for sediment reduction]</i> <i>Potential hotspot locations: Eden Lassie Creek and Thompson Creek^A</i> For guidance, refer to the Queensland River Rehabilitation Management (QRRM) Guideline^B.	Deliver coordinated and targeted natural systems and ecosystem rehabilitation programs that accelerate lasting restoration outcomes, tailored to local ecological contexts, and the capacity, opportunities, and motivation of diverse stakeholder groups (including landholders and land managers, community groups, and government agencies), including: • Capacity, skills and expertise • Incentives and markets • Decision support • Technology and equipment
	Gully rehabilitation (5.8% sediment load contribution)	Remediate gully areas in priority locations through revegetation of gullied area and stock exclusion with fencing as required, installation of temporary structures such as stick traps, porous check dams, contour banks and engineered check dams, and at larger scales, mechanical gully reshaping, earth works, rock capping and revegetation. <i>Potential hotspot areas: North of Proserpine</i> For guidance, refer to the Gully and Stream Bank Toolbox^C.	
	Woody vegetation loss (36%), Riparian vegetation loss (32%), and	Reduce vegetation clearing, riparian vegetation and wetland loss through promoting awareness of regulatory standards for vegetation clearing and other co-benefits. Establish and maintain buffer zones and weed control in riparian areas of waterways and wetlands.	See example interventions in Section 4.5 of the Strategy.

Regional objective: <i>Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.</i>			
PROSERPINE Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III – Section 4.5)
	Wetland modification and/or loss (35%)	Support actions and encourage incentives (e.g. eco-markets) to increase revegetation and wetland rehabilitation, including improving riparian connectivity in prioritised locations at Gregory River and Lethe Brook.^A For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly <i>Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands</i>) and Queensland River Rehabilitation Management (QRRM) Guideline.	
	Wetlands and Catchment treatment systems (Monitored wetland aggregations in poor condition) <i>High exposure to hazard from nutrients, sediments and pesticides</i>	Evaluate drivers of poor wetland condition and the need and potential for intervention options to assist ecosystem recovery/rehabilitation. Coordinate interventions and activities to enhance wetland values, condition, and water quality improvement and ecosystem service functions, such as: - Interventions that improve hydrological integrity, manage pest species and safeguard native vegetation, strengthen riparian buffers and minimise pollutant inflows to wetlands (see actions for DIN, fine sediment and pesticides), supported by site-based planning. Examples include management of Weeds of National Significance in ponded pastures. - Assessing the feasibility of using constructed wetlands or treatment systems (such as recycle pits, swales, wetlands, vegetated drains, sediment basins and bioreactors) to improve water quality while maintaining natural wetland values across a range of land use activities. Support cleaner waterways and more efficient on-farm water use through the construction of small-scale treatment systems that capture and reuse agricultural runoff for irrigation as part of the Proserpine Integrated Project. <i>Potential hotspot areas: Goorganga wetlands; issues associated with ponded pastures and management of Weeds of National Significance.</i> For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D	

Regional objective: <i>Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.</i>			
PROSERPINE Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III – Section 4.5)
	Marine ecosystems Seagrass (moderate) and Coral (poor)	Support research, development and implementation of coral and seagrass restoration activities, including understanding and protecting ecosystems in poor condition from additional pressures, where needed, and monitoring to assess ecosystem recovery over time – particularly for seagrass habitats and inshore coral reefs in pollutant hotspots (i.e. Repulse Bay and Whitsunday Islands), and in proximity to high value areas such as the Edgecombe Bay and Repulse Bay Fish Habitat and Dugong Protection Areas.	
	Connectivity	Support interventions to enhance hydrological connectivity and improve habitat linkage and corridors such as removing barriers to fish passage, and restoration and rehabilitation activities. Undertake an updated assessment of priorities for strategic location of activities. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands).	

^A Refer to the Mackay Whitsunday Regional Erosion Identification, Prioritisation And Remediation Study (Neilly Group Engineering, 2023); ^B Department of Environment and Science (2022); ^C Wilkinson et al., 2022. ^D Department of Environment, Science and Innovation (2023).

4.2 O'Connell Basin Water Quality Improvement Strategy

4.2.1 Basin Context

The O'Connell Basin covers an area of 2,305 km² or 26% of the Mackay Whitsunday Region. Grazing is the main land use (50% of the catchment area), which is primarily in the north of the basin, with conservation (20%) and forestry (6.7%) lands primarily in the inland areas. Sugarcane farming is spread along the waterways, accounting for 13% of the land use. The basin has an average rainfall of 1,705 mm and a long-term median river discharge of 835 gigalitres per year.

Historical native vegetation clearing and significant freshwater floodplain wetland loss and/or modification are two landscape disturbance factors that may be influencing water quality in the O'Connell. By 2018, almost half of its native vegetation has been cleared (47%), with particularly severe floodplain vegetation losses (84%). Between 2019 and 2022, a further 1,540 hectares was cleared including 2.6% of the floodplain vegetation extent. Freshwater floodplain wetlands have been extensively modified and/or lost, with only 132 hectares of the original 751 hectares of natural unmodified wetlands remaining in 2017.

In terms of pollutants, the modelled total annual average loads from the O'Connell are 166 tonnes of DIN and 214 kilotonnes of fine sediment. Grazing (39%) and sugarcane (38%) areas are the dominant source of DIN. Urban areas contribute a further 8.6% of the DIN load. The main DIN loss pathway is diffuse dissolved (62%). Streambank (85%) areas are the primary source of fine sediments, with smaller contributions from grazing (8.4%) and sugarcane (2.8%). Fine sediments are transported via streambank (85%) and hillslope (15%) erosion. End-of-catchment monitoring shows that the pesticide risk is Moderate to High, and imidacloprid and diuron are the major contributors to the risk. The largest land use area in the O'Connell with a higher potential for pesticide runoff is sugarcane, followed by horticulture and irrigated cropping.

The condition of freshwater floodplain wetland condition needs to be investigated. Based on the 175 hectares of natural and slightly modified freshwater floodplain wetlands included in the hazard assessment, 52% are exposed to High or Very High nutrient hazard, 52% are exposed to High or Very High sediment hazard, and 26% are exposed to Moderate, High, or Very High pesticide hazard.

In 2022–23, coral reefs adjacent to the O'Connell were in Poor condition and seagrass meadows were in Moderate condition. The marine exposure score for DIN is Moderate, reflecting the close proximity of coral reefs to the coast. Sediment exposure is also Moderate, reflecting the anthropogenic fine sediment load and proximity of seagrass meadows to areas more frequently influenced by river discharge. Pesticide exposure is High.

4.2.2 Overall Management Response and focus areas

A coordinated, multi-pollutant management response is required across the O'Connell Basin. At the basin scale, this includes large-scale intensive management of pesticides and accelerated nutrient and sediment management in targeted sub-catchment areas. All remaining areas of the basin require a broadscale Foundational response to maintain low future exposure.

Complementary to the basin-wide management response, validation of freshwater floodplain wetland hazard assessments for nutrients, sediment and pesticides are required and, where appropriate, implement management for wetlands in hazard exposed areas. As monitored wetland condition data are not available for the O'Connell Basin, further investigation is required to determine current wetland condition and appropriate management needs. As coral reefs are in Poor condition, an evaluation of the drivers of condition is required and to determine the need and feasibility of intervention options to support ecosystem recovery or rehabilitation is required.

4.2.3 O'Connell Sustainable land use & management

Table 9. **O'Connell Sustainable land use & management Action and Delivery Strategies** required to achieve Regional Objective 1. The **Basin-scale Strategic management response** aligns to the recommended Management Response for nutrients, fine sediment, and pesticides (Section 3.2.2). The **Action Strategies** are scaled according to the Management Response for each pollutant and ranked according to the pollutant's **Dominant land use sources** - the relative contributions of the basin's agricultural and non-agricultural land uses: DIN and fine sediment action strategies are ranked by the relative total annual loads of the top 'manageable' land use contributions (i.e. excludes conservation areas), and pesticide action strategies are ranked by the basin's highest land use areas and their potential (higher vs lower) for pesticide risk- see Section 3.2. Priority actions are described for each land use in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional Objective: Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.			
O'CONNELL Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Nutrients Actively reduce Moderate DIN exposure on marine ecosystems through an Accelerated management response in targeted sub-catchments, including management of nutrients in wetland hazard exposed areas. <i>Primary focus is reducing sugarcane sources of DIN. Additional reductions could also be achieved through targeted interventions in urban areas and point source loads. Increasing adoption of soil erosion management practices in grazing lands may also reduce DIN further. Validate the wetland nutrient hazard assessment and where required, implement sustainable land management in hazard exposed areas. Foundational management of nutrients in all other areas to prevent future sources of anthropogenic nutrients.</i>	Sugarcane 30,493 ha (38% of total annual average DIN load)	Increase and sustain adoption levels of best practices that reduce DIN export from sugarcane areas including: holistic, farm-specific DIN accounting; address soil constraints; improved soil health; address drainage and waterlogging issues; and on farm water management to support effective use of irrigation water. Improve mill scheduling and harvest timing to prevent late-season fertiliser applications close to the wet season, reducing nutrient runoff to the reef.	Deliver coordinated and integrated programs that accelerates sustained adoption of target basin-scale management responses, tailored to local socio-economic and cultural contexts, land use types, and land managers' capacity, opportunities, and motivations, including: • Capacity, skills and expertise • Social norms and trust development • Decision support • Incentives and markets • Technology and equipment
	Urban + STP 5,001 ha (8.6% of total annual average DIN load)	Encourage and support adoption of actions to address emerging DIN issues in stormwater runoff and point source discharge through stormwater treatment interventions, strategically targeted implementation of Water Sensitive Urban Design, and sewage treatment plant (STP) upgrades, reuse and efficiencies in sewage system management.	
	Grazing 115,924 ha (39% of total annual average DIN load) ^B	Encourage and support adoption of best practices that reduce DIN export through reducing sediment runoff in grazing. <i>[This action is a co-benefit of erosion management actions – refer below]</i>	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region’s aquatic ecosystems.</i>			
O’CONNELL Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>Elevated concentrations of phosphorus are characteristic of water quality conditions in the Mackay Whitsunday Region. There is currently insufficient information to recommend a definitive Management Response for different land uses for phosphorus. Current understanding indicates that sugarcane is the primary source of DIP in the O’Connell Basin.</i>	Sugarcane and other potential land use sources 30,493 ha (Sugarcane) (34% of total annual average DIP load)	Further investigation to better understand sources and drivers, potential ecological risks and where required, appropriate management actions. Increase and sustain adoption levels of best practices that reduce DIP export from sugarcane areas.	• Innovative solutions & markets <i>See example interventions in Section 4.5 of the Strategy.</i>
Sediment Actively reduce Moderate sediment exposure on marine ecosystems through an Accelerated management response in targeted sub-catchments, including management of sediment in wetland hazard exposed areas. <i>Primary focus is on protection and repair of streambanks. Additional reductions could also be achieved through reduction in hillslope erosion in grazing and sugarcane. Validate the wetland sediment hazard assessment and where required, implement sustainable land management in hazard exposed areas.</i> <i>Foundational management of sediments in all other areas to prevent future sources of sediments.</i>	Streambank (85% of total annual average sediment load)	Increase and sustain adoption of management best practices in riparian zones that reduce streambank erosion across multiple land uses including, riparian fencing/excluding cattle from streambank access, managing weeds and pests, and revegetation in riparian zone. <i>[These actions are complementary to Natural Systems Repair actions]</i> For guidance, refer to The Mackay Whitsunday Isaac Riparian Management Handbook.	
	Grazing 115,924 ha (8.5% of total annual average sediment load)	Encourage and support adoption of best practices that reduce sediment erosion in grazing following a holistic approach that includes assessing land condition, matching stocking rate to available feed, removing livestock to allow recovery and reseeding, restricting riparian access and herd management. Manage linear features including unsealed roads and implement feral animal control. <i>Focus Areas: Hillslope areas in the Upper O’Connell catchment.</i>	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.</i>			
O'CONNELL Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
	Sugarcane 30,493 ha (3.0% of total annual average sediment load)	Encourage adoption of practices that reduce sediment erosion in sugarcane, including minimum tillage, trash blanket, use of fallow crops, controlled traffic, installation of vegetated spoon drains, vegetated buffers, strategically located sediment traps and feral animal control.	
	Urban 5,001 ha (<1% of total annual average sediment load)	Encourage best practices that reduce sediment erosion in urban areas including targeted erosion and sediment control, strategic implementation of Water Sensitive Urban Design and treatment train options (see Natural Systems Repair).	
Pesticides Expedite reductions in High pesticide exposure on marine ecosystems and wetland hazard exposed area through an Intensive, large-scale management response. <i>Action is required across multiple agricultural land uses, primarily focused on pesticide reduction in sugarcane. Additional reductions could also be achieved through horticulture and irrigated cropping, grazing and non-agricultural land uses. Management includes a focus on areas upstream and surrounding wetlands.</i>	Sugarcane 30,493 ha (13% of basin area and a higher potential for pesticide risk)	Rapidly maximise and sustain widespread adoption of practices that minimises pesticide risk from sugarcane including reducing overall pesticide application rates and uptake precision technologies, switching to lower risk alternative products, optimise application timing relative to rainfall, managing point sources, improved irrigation management practices and adopting integrated pest management. Improve mill scheduling and harvest timing to prevent late-season fertiliser applications close to the wet season, reducing nutrient runoff to the reef.	
	Horticulture and irrigated cropping 145 ha (0.06% of basin area and a higher potential for pesticide risk)	Encourage and support adoption of best practices that minimises pesticide risk from horticulture and irrigated cropping including product selection, rate, timing of application, precision technologies and integrated pest management.	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystems.</i>			
O'CONNELL Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>Foundational management of pesticides in all other areas to prevent future sources of pesticides.</i>	Grazing 115,924 ha (50% of basin area and a lower potential for pesticide risk)	Encourage adoption of best practices for weed management that minimises pesticide risk from grazing including product selection, rate, timing of application, precision technologies, mechanical weed removal and integrated pest management.	
	Non-agricultural areas (e.g. urban, forestry) 10,247 ha (9% of basin area and lower potential for pesticide risk)	Encourage adoption of best practices that minimises pesticide risk from non-agricultural land uses including product selection, rate, timing of application, and improved wastewater treatment processes.	

^A Loads are presented as the Total Annual Average, not the Anthropogenic Load. Data is unavailable to determine quantified land use contributions to pesticide risk, rather the land use's relative potential for pesticide risk is noted along with the proportion of the basin the land use occupies.

^B DIN load from grazing is primarily linked with sediment erosion and therefore is treated as a co-benefit of sediment reduction actions. For this reason, grazing sources of DIN are acknowledged but ranked lower in the table.

4.2.4 O’Connell Natural Systems Repair

Table 10. **O’Connell Natural Systems Repair Action and Delivery Strategies** required to achieve Regional Objective 2. The **Basin-scale Strategic management response** aligns to the recommended pollutant Management Response levels and ecosystem condition assessments. The **Action Strategies** target natural system drivers of water quality risks (streambank and gully erosion¹, vegetation and wetland loss²) and the condition of ecosystems³ (freshwater floodplain wetlands, seagrass, coral, and ecosystem connectivity). ¹Streambank and gully action strategies are ranked and scaled based on their contributions to the basin’s sediment load. ² Vegetation loss and wetland loss/or modification action strategies are scaled based on % losses and identified hotspot areas. ³ Ecosystem condition action strategies are based on ecosystem condition ratings – poor, moderate or good. Priority actions are described for each natural system in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional objective: <i>Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.</i>			
O’CONNELL Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Actively repair and rehabilitate natural systems in targeted and strategic locations to improve natural system processes for water quality outcomes and improve ecosystem condition.	Streambank rehabilitation (85% sediment load contribution)	Actively rehabilitate streambanks in priority locations through riparian vegetation rehabilitation and installing structural and engineered interventions, interventions for bank reshaping and stabilisation such as rock protection or rock armouring, timber pile fields, log fillets and rock groynes. Include focused remediation at six prioritised locations at Murray Creek and St Helens Creek. ^A <i>[These actions are complementary to Sustainable Land use and Management actions for sediment reduction]</i> For guidance, refer to the Queensland River Rehabilitation Management (QRRM) Guideline^B.	Deliver coordinated and targeted natural systems and ecosystem rehabilitation programs that accelerates lasting restoration outcomes, tailored to local ecological contexts, and the capacity, opportunities, and motivation of diverse stakeholder groups (including landholders and land managers, community groups, and government agencies), including: Capacity, skills and expertise
	Woody vegetation loss (47%), Riparian vegetation loss (44%), and Wetland modification and/or loss (82%)	Reduce vegetation clearing and riparian vegetation and wetland modification/loss through promoting awareness of regulatory standards for vegetation clearing and other co-benefits. Establish and maintain buffer zones and weed control in riparian areas of waterways and wetlands. Support actions and encourage incentives (e.g. eco-markets) to increase revegetation and wetland rehabilitation, including improving riparian connectivity in prioritised locations at Andromache River. ^A For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands) and Queensland River Rehabilitation Management (QRRM) Guideline^B	
	Wetlands	Survey wetland condition and validate wetland pollutant hazard assessments and where required, apply appropriate management response. This may include coordinating interventions and activities to enhance wetland values, condition, and water quality improvement and ecosystem service functions, for example:	

Regional objective: <i>Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.</i>			
O'CONNELL Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
	(No monitored wetland aggregations) <i>High exposure from nutrients, sediments and pesticides</i>	- Interventions that improve hydrological integrity, manage pest species and safeguard native vegetation, strengthen riparian buffers and minimise pollutant inflows to wetlands (see actions for DIN, fine sediment and pesticides), supported by site-based planning. Examples include management of Weeds of National Significance in ponded pastures. - Assessing the feasibility of using constructed wetlands or treatment systems (such as recycle pits, swales, wetlands, vegetated drains, sediment basins and bioreactors) to improve water quality while maintaining natural wetland values across a range of land use activities. <i>Potential focus areas: Sugarcane growing areas</i> For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D	- Incentives and markets - Decision support - Technology and equipment <i>See example interventions in Section 4.5 of the Strategy.</i>
	Marine ecosystems Seagrass (moderate) and Coral (poor)	Evaluate coral ecological, social and cultural values, other potential drivers of the Poor condition and the ecosystem's potential for recovery. Prioritise further investigation and development of targeted interventions for seagrass and coral ecosystems in identified pollutant hotspots (i.e. seagrass habitats and inshore coral reefs in Repulse Bay and the Whitsunday Islands) and in proximity to high value areas such as the Midge, Repulse and Sand Bay Fish Habitat Areas, and the Repulse Bay, Stewart Peninsular-Newry Island-Ball Bay and Ball Bay-Sand Bay Dugong Protection Areas.	
	Connectivity	Support interventions to enhance hydrological connectivity and improve habitat linkage and corridors such as removing barriers to fish passage, and restoration and rehabilitation activities. Undertake an updated assessment of priorities for strategic location of rehabilitation activities. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly <i>Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands</i>).	

^A Refer to the Mackay Whitsunday Regional Erosion Identification, Prioritisation And Remediation Study (Neilly Group Engineering, 2023); ^B Department of Environment and Science (2022); ^C Wilkinson et al., 2022); ^D Department of Environment, Science and Innovation (2023).

4.3 Pioneer Basin Water Quality Improvement Strategy

4.3.1 Basin Context

The Pioneer Basin is the smallest in the Mackay Whitsunday Region covering an area of 1,664 km² (18% of the NRM region). Grazing is the main land use in the catchment (31%), and there are also large areas of conservation (20%) and forestry (18%) primarily found inland. Sugarcane and urban areas are primarily distributed across the lower reaches of the basin with sugarcane accounting for 19% of the basin's land use and 3.9% is urbanised, particularly around the river mouth. The Pioneer has an average rainfall of 1,578 mm and a long-term median river discharge of 616 gigalitres per year.

Historical freshwater floodplain wetland modification and/or loss, along with the loss of floodplain vegetation are two landscape disturbance factors that may be influencing water quality in the Pioneer Basin. Most (92%) of the estimated historical freshwater floodplain wetlands had been lost or modified by 2017, with only 227 hectares of natural unmodified wetlands remaining. The clearing of native vegetation from floodplains has also been significant, with 77% lost by 2018.

In terms of pollutants, the modelled total annual average loads coming from the Pioneer are 203 tonnes of DIN, and 104 kilotonnes of fine sediments. Sugarcane (68%) is the dominant source of DIN, followed by grazing (10%) and urban and STP (12%) areas, with seepage being the main loss pathway (46%). Streambank areas (82%) are the primary sources of fine sediments and sediments are mainly transported by streambank erosion (82%). End-of-catchment monitoring shows that the pesticide risk is High to Very High, and diuron and imidacloprid are major contributors. The largest land use area in the Pioneer Basin with a higher potential for pesticide runoff is sugarcane, followed by horticulture.

Of the 228 hectares of freshwater floodplain wetlands included in the hazard assessment, 71% are exposed to High or Very High nutrient hazard, 57% to High or Very High sediment hazard, and 87% to Moderate, High or Very High pesticide hazard. Although wetland condition is not currently monitored in this basin, the extent of these pollutant hazards indicates an urgent need to investigate their condition and understand the pressures affecting wetland health.

In 2022–23, coral reefs adjacent to the Pioneer were in Poor condition and seagrass meadows were in Moderate condition. The marine exposure score is Moderate for DIN, reflecting the proximity of coral reefs to the coast and Moderate for sediments, reflecting the proximity of seagrass meadows to areas more frequently influenced by river discharge. Pesticide exposure is High.

4.3.2 Overall Management Response and focus areas

A coordinated, multi-pollutant management response is required across the Pioneer Basin. At the basin scale, this includes large-scale intensive management of pesticides, accelerated nutrient and sediment management in targeted sub-catchment areas, and foundational management across all remaining areas to maintain low future exposure.

Complementary to the basin-wide management response, validation of freshwater floodplain wetland hazard assessments for nutrients, sediment and pesticides are required and, where appropriate, implement management for wetlands in hazard exposed areas. As monitored wetland condition data are not available for the Pioneer Basin, further investigation is required to determine current wetland condition and appropriate management needs.

As coral reefs are in Poor condition, evaluate the drivers of condition and determine the need and feasibility of intervention options to support ecosystem recovery or rehabilitation.

4.3.3 Pioneer Sustainable land use & management

Table 11. **Pioneer Sustainable land use & management Action and Delivery Strategies** required to achieve Regional Objective 1. The **Basin-scale Strategic management response** aligns to the recommended Management Response for nutrients, fine sediment, and pesticides (Section 3.2.2). The **Action Strategies** are scaled according to the Management Response for each pollutant and ranked according to the pollutant's **Dominant land use sources** - the relative contributions of the basin's agricultural and non-agricultural land uses: DIN and fine sediment action strategies are ranked by the relative total annual loads of the top 'manageable' land use contributions (i.e. excludes conservation areas), and pesticide action strategies are ranked by the basin's highest land use areas and their potential (higher vs lower) for pesticide risk – see Section 3.2. Priority actions are described for each land use in Appendix 1. Delivery Strategies to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional Objective: Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.			
PIONEER Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Nutrients Actively reduce Moderate DIN exposure on marine ecosystems through an Accelerated management response in targeted sub-catchments, including management of nutrients in wetland hazard exposed areas. <i>Primary focus is reducing sugarcane sources of DIN. Additional reductions could also be achieved through targeted interventions in urban areas and point source loads. Increasing adoption of soil erosion management practices in grazing lands may also reduce DIN further. Validate the wetland nutrient hazard assessment and where required, implement sustainable land management in hazard exposed areas. Foundational management of nutrients in all other areas to prevent future sources of nutrients.</i>	Sugarcane 31,917 ha (68% of total annual average DIN load)	Increase and sustain adoption levels of best practices that reduce DIN export from sugarcane areas including: holistic, farm-specific DIN accounting; address soil constraints; improved soil health; address drainage and waterlogging issues; and on farm water management to support effective use of irrigation water. Improve mill scheduling and harvest timing to prevent late-season fertiliser applications close to the wet season, reducing nutrient runoff to the reef.	Deliver coordinated and integrated programs that accelerate sustained adoption of target basin-scale management responses, tailored to local socio-economic and cultural contexts, land use types, and land managers' capacity, opportunities, and motivations, including: • Capacity, skills and expertise • Social norms and trust development • Decision support • Incentives and markets • Technology and equipment
	Urban + STP 6,556 ha (12% of total annual average DIN load)	Encourage and support adoption of actions to address emerging DIN issues in stormwater runoff and point source discharge through stormwater treatment interventions, strategically targeted implementation of Water Sensitive Urban Design, and sewage treatment plant (STP) upgrades, reuse and efficiencies in sewage system management.	
	Grazing 52,072 ha (10% of total annual average DIN load) ^B	Encourage and support adoption of best practices that reduce DIN export through reducing sediment runoff in grazing. <i>[This action is a co-benefit of sediment erosion management actions – refer below]</i>	

Regional Objective: Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.			
PIONEER Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Elevated concentrations of phosphorus are characteristic of water quality conditions in the Mackay Whitsunday Region. There is currently insufficient information to recommend a definitive Management Response for different land uses for phosphorus. Current understanding indicates that sugarcane is the primary source of DIP in the Pioneer Basin.	Sugarcane and other potential land use sources 24,600 ha (Sugarcane) (63% of total annual average DIP load	Further investigation to better understand sources and drivers, potential ecological risks and where required, appropriate management actions. Increase and sustain adoption levels of best practices that reduce DIP export from sugarcane areas.	See example interventions in Section 4.5 of the Strategy.
Sediment Actively reduce Moderate sediment exposure on marine ecosystems through an Accelerated management response in targeted sub-catchments, including management of sediment in wetland hazard exposed areas. Primary focus is on streambank protection and repair. Additional reductions could also be achieved through reduction in hillslope erosion in sugarcane and grazing. Validate the wetland sediment hazard assessment and where required, implement sustainable land management in hazard exposed areas. Foundational management of sediments in all other areas to prevent future sources of sediments.	Streambank (82% of total annual average sediment load)	Increase and sustain adoption of management best practices in riparian zones that reduce streambank erosion across multiple land uses including, riparian fencing/excluding cattle from streambank access, managing weeds and pests, and revegetation in riparian zone. [These actions are complementary to Natural Systems Repair actions] For guidance, refer to The Mackay Whitsunday Isaac Riparian Management Handbook^B .	
	Sugarcane 31,917 ha (5.6% of total annual average sediment load)	Encourage adoption of best practices that reduce sediment erosion in sugarcane, including minimal tillage, trash blanket, use of fallow crops, controlled traffic, installation of vegetated spoon drains, vegetated buffers and feral animal control.	
	Grazing 52,072 ha (5.0% of total annual average sediment load)	Encourage and support adoption of best practices that reduce sediment erosion in grazing following a holistic approach that includes assessing land condition, matching stocking rate to available feed, removing livestock to allow recovery and reseeding, restricting riparian access and herd management. Manage	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.</i>			
PIONEER Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Pesticides Expedite reductions in High pesticide exposure on marine ecosystems and wetland hazard exposed area through an Intensive, large-scale management response. <i>Action is required across multiple agricultural land uses, primarily focused on pesticide reduction in sugarcane. Additional reductions could also be achieved through horticulture and dryland cropping, grazing and non-agricultural land uses. Management includes a focus on land use areas upstream and surrounding wetlands.</i> <i>Foundational management of pesticides in all other areas to prevent future sources of pesticides.</i>		linear features including unsealed roads and implement feral animal control.	
	Urban 6,556 ha (2.1% of total annual average sediment load)	Encourage best practices that reduce sediment erosion in urban areas including targeted erosion and sediment control, strategic implementation of Water Sensitive Urban Design and treatment train options (see Natural Systems Repair). <i>Potential hotspot areas: Mackay and surrounding suburbs</i>	
	Sugarcane 31,917 ha (19% of basin area and a higher potential for pesticide risk)	Rapidly maximise and sustain widespread adoption of practices that minimises pesticide risk from sugarcane including reducing overall pesticide application rates and uptake precision technologies, switching to lower risk alternative products, optimise application timing relative to rainfall, managing point sources, improved irrigation management practices and adopting integrated pest management. Improve mill scheduling and harvest timing to prevent late-season fertiliser applications close to the wet season, reducing nutrient runoff to the reef.	
	Horticulture and dryland cropping 169 ha (0.1% of basin area and a higher potential for pesticide risk)	Encourage and support adoption of best practices that minimises pesticide risk from horticulture and dryland cropping including product selection, rate, timing of application, precision technologies and integrated pest management.	
	Grazing 52,072 ha	Encourage adoption of best practices for weed management that minimises pesticide risk from grazing including product	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.</i>			
PIONEER Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
	(31% of basin area and a lower potential for pesticide risk)	selection, rate, timing of application, precision technologies, mechanical weed removal and integrated pest management.	
	Non-agricultural areas (urban and forestry) 36,256 ha (22% of basin area and lower potential for pesticide risk)	Encourage adoption of best practices that minimises pesticide risk from non-agricultural land uses including product selection, rate, timing of application, and improved wastewater treatment processes.	

^A Loads are presented as the Total Annual Average, not the Anthropogenic Load. Data is unavailable to determine quantified land use contributions to pesticide risk, rather the land use's relative potential for pesticide risk is noted along with the proportion of the basin the land use occupies.

^B DIN load from grazing is primarily linked with sediment erosion and therefore is treated as a co-benefit of sediment reduction actions. For this reason, grazing sources of DIN are acknowledged but ranked lower in the table.

4.3.4 Pioneer Natural Systems Repair

Table 12. **Pioneer Natural Systems Repair Action and Delivery Strategies** required to achieve Regional Objective 2. The **Basin-scale Strategic management response** aligns to the recommended pollutant Management Response levels and ecosystem condition assessments. The **Action Strategies** target natural system drivers of water quality risks (streambank and gully erosion¹, vegetation and wetland loss²) and the condition of ecosystems³ (freshwater floodplain wetlands, seagrass, coral, and ecosystem connectivity). ¹Streambank and gully action strategies are ranked and scaled based on their contributions to the basin's sediment load. ² Vegetation loss and wetland loss/or modification action strategies are scaled based on % losses and identified hotspot areas. ³ Ecosystem condition action strategies are based on ecosystem condition ratings – poor, moderate or good. Priority actions are described for each natural system in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional objective: Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.			
PIONEER Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III - Section 4.5)
Actively repair and rehabilitate natural systems in targeted and strategic locations to improve natural system processes for water quality outcomes and improve ecosystem condition.	Streambank repair (82% sediment load contribution)	Actively rehabilitate streambanks in priority locations through riparian vegetation rehabilitation and installing structural and engineered interventions, for bank reshaping and stabilisation such as rock protection or rock armouring, timber pile fields, log fillets and rock groynes. Include focused remediation at eight locations in Upper Cattle Creek. ^A [These actions are complementary to Sustainable Land use and Management actions for sediment reduction] For guidance, refer to the Queensland River Rehabilitation Management (QRRM) Guideline ^B .	Deliver coordinated and targeted natural systems and ecosystem rehabilitation programs that accelerates lasting restoration outcomes, tailored to local ecological contexts, and the capacity, opportunities, and motivation of diverse stakeholder groups (including landholders and land managers, community groups, and government agencies), including: • Capacity, skills and expertise • Incentives and markets • Decision support • Technology and equipment
	Woody vegetation loss (36%), Riparian vegetation loss (27%), and Freshwater floodplain wetland modification and/or loss (92%)	Reduce vegetation clearing, riparian vegetation and wetland modification/loss through promoting awareness of regulatory standards for vegetation clearing and other co-benefits. Establish and maintain buffer zones and weed control in riparian areas of waterways and wetlands. Actively support actions and encourage incentives (e.g. environmental markets) to increase revegetation and wetland rehabilitation at strategic locations in the landscape that improve connectivity, water quality and ecosystem service functions. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy ^D (particularly <i>Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands</i>) and Queensland River Rehabilitation Management (QRRM) Guideline .	
	Wetlands (No monitored wetland aggregations)	Survey wetland condition and validate wetland pollutant hazard assessments and where required, apply appropriate management response. This may include coordinating interventions and activities to enhance wetland values, condition, and water quality improvement and ecosystem service functions, for example:	

Regional objective: <i>Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.</i>			
PIONEER Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III - Section 4.5)
	<i>High exposure to hazard from nutrients, sediments and pesticides</i>	- Interventions that improve hydrological integrity, manage pest species and safeguard native vegetation, strengthen riparian buffers and minimise pollutant inflows to wetlands (see actions for DIN, fine sediment and pesticides), supported by site-based planning. - Assessing the feasibility of using constructed wetlands or treatment systems (such as recycle pits, swales, wetlands, vegetated drains, sediment basins and bioreactors) to improve water quality while maintaining natural wetland values across a range of land use activities. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D	<i>See example interventions in Section 4.5 of the Strategy.</i>
	Marine ecosystems – seagrass (moderate) and coral (poor)	Evaluate the ecological, social and cultural values of coral reef ecosystems, assess drivers of poor condition and determine recovery potential. Prioritise further investigation and development of targeted interventions for seagrass and coral ecosystems in identified pollutant hotspots (i.e. seagrass habitats and inshore coral reefs adjacent to the Plane, Pioneer and O’Connell basins, and within Repulse Bay and the Whitsunday Islands) and in proximity to high value areas such as the Bassett Basin Fish Habitat Area.	
	Connectivity	Support interventions to enhance hydrological connectivity and improve habitat linkage and corridors, such as removing barriers to fish passage, and restoration and rehabilitation activities. Undertake an updated assessment of priorities for strategic location of rehabilitation activities. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands).	

^A Refer to the Mackay Whitsunday Regional Erosion Identification, Prioritisation And Remediation Study (Neilly Group Engineering, 2023); ^B Department of Environment and Science (2022); ^C Wilkinson et al., 2022); ^D Department of Environment, Science and Innovation (2023).

4.4 Plane Basin Water Quality Improvement Strategy

4.4.1 Basin Context

The Plane Basin is the largest and most southerly basin in the Mackay Whitsunday Region covering an area of 2,547 km² (28% of the NRM region). It has the highest area of sugarcane farming (64,944 ha) across the Mackay Whitsunday Region accounting for 26% of the catchment area. Grazing lands cover the 38% of the basin area, and there are smaller areas of conservation (15%), forestry (5.9%), as well as urban centres (3.9%). Average annual rainfall in the Plane is 1,526 mm and it has a long-term median river discharge of 1,059 gigalitres per year.

Historical native vegetation clearing and the loss and/or modification of its freshwater floodplain wetlands are two landscape disturbance factors that may be influencing water quality in the Plane Basin. The loss of native vegetation has been substantial (52%), including clearing of 86% of the Plane Basin's floodplain vegetation. Between 2019 and 2022, a further 1,030 hectares of native vegetation had been cleared. Over three-quarters (78%) of the estimated original freshwater floodplain wetlands had been either modified or lost by 2017, with only 975 hectares of natural unmodified wetlands remaining.

In terms of pollutants, the modelled total annual average loads coming from the Plane Basin are 230 tonnes of DIN and 79 kilotonnes of fine sediments. Sugarcane (52%) is the dominant source of DIN followed by grazing (24%) and urban areas and STPs (14%), with diffuse dissolved (44%) and hillslope erosion (28%) the main loss pathways. Streambank (66%) and grazing areas (17%) are the primary sources of fine sediments, followed by sugarcane (8.1%), with most of the sediment transported via streambank erosion (66%) and hillslope erosion (34%). End-of-catchment monitoring shows that the pesticide risk is consistently Very High at Sandy Creek but ranges from Low to Moderate at Plane Creek. Major contributors to the risk at Sandy Creek are diuron and imidacloprid and in Plane Creek, the biggest contributors are metsulfuron-methyl and diuron.

Freshwater floodplain wetlands in the Plane Basin are in Poor condition. They face several pressures including pest species, vegetation clearing, drainage modifications, changes to surface flow and connectivity. Of the 1,018 hectares of natural and slightly modified freshwater floodplain wetlands included in the hazard assessment, 40% are exposed to High or Very High nutrient hazard, whereas 13% are exposed to High or Very High sediment hazard. Around 53% are exposed to Moderate, High, or Very High pesticide hazard.

In 2022–23, coral reefs adjacent to the Plane were in Poor condition and seagrass meadows were in Moderate condition. The marine exposure score for DIN is Moderate, reflecting the anthropogenic DIN load and proximity of coral reefs to the coast, and the sediment exposure is Low, reflecting the low anthropogenic fine sediment load. Pesticide exposure is High.

4.4.2 Overall Management Response and focus areas

A coordinated, multi-pollutant management response is required across the Plane Basin. At the basin scale, this includes large-scale intensive management of pesticides, accelerated nutrient management in targeted sub-catchment areas, and localised proactive management of sediment. All remaining areas should be managed through a broadscale Foundational response to maintain low future exposure. Complementary to the basin-wide response, freshwater floodplain wetland hazard-exposed areas require intensive management of pesticides and nutrients, and accelerated management of sediment due to more localised exposure risks. As coral reefs and wetlands are in Poor condition, evaluate the drivers of condition and determine the need and feasibility of intervention options to support ecosystem recovery or rehabilitation.

4.4.3 Plane Sustainable land use & management

Table 13. **Plane Sustainable land use & management Action and Delivery Strategies** required to achieve Regional Objective 1. The **Basin-scale Strategic management response** aligns to the recommended Management Response for nutrients, fine sediment, and pesticides (Section 3.2.2). The **Action Strategies** are scaled according to the Management Response for each pollutant and ranked according to the pollutant's **Dominant land use sources** - the relative contributions of the basin's agricultural and non-agricultural land uses: DIN and fine sediment action strategies are ranked by the relative total annual loads of the top 'manageable' land use contributions (i.e. excludes conservation areas), and pesticide action strategies are ranked by the basin's highest land use areas and their potential (higher vs lower) for pesticide risk- see Section 3.2. Priority actions are described for each land use in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5.

Regional Objective: Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.			
PLANE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
Nutrients Actively reduce Moderate DIN exposure on marine ecosystems through an Accelerated management response in targeted sub-catchments, including Intensive management of nutrients in wetland hazard exposed areas. <i>Primary focus is reducing sugarcane sources of DIN. Additional reductions could also be achieved through targeted interventions in urban areas and point source loads. Increasing adoption of soil erosion management practices in grazing lands may also reduce DIN further. Management includes a focus on DIN plus other nutrients from land use areas upstream and surrounding wetlands.</i>	Sugarcane 64,944 ha (52% of total annual average DIN load)	Increase and sustain adoption levels of best practices that reduce DIN export from sugarcane areas including: holistic, farm-specific DIN accounting; address soil constraints; improved soil health; address drainage and waterlogging issues; and on farm water management to support effective use of irrigation water. Improve mill scheduling and harvest timing to prevent late-season fertiliser applications close to the wet season, reducing nutrient runoff to the reef.	Deliver coordinated and integrated programs that accelerates sustained adoption of target basin-scale management responses, tailored to local socio-economic and cultural contexts, land use types, and land managers' capacity, opportunities, and motivations, including: • Capacity, skills and expertise • Social norms and trust development • Decision support • Incentives and markets • Technology and equipment
	Urban + STP 9,848 ha (14% of total annual average DIN load)	Encourage and support adoption of actions to address emerging DIN issues in stormwater runoff and point source discharge through stormwater treatment interventions, strategically targeted implementation of Water Sensitive Urban Design, and sewage treatment plant (STP) upgrades, reuse and efficiencies in sewage system management.	
	Grazing 97,060 ha (24% of total annual average DIN load) ^B	Encourage and support adoption of best practices that reduce DIN export through reducing sediment runoff in grazing. Implement best practice nutrient management in finishing paddocks.	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.</i>			
PLANE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>Foundational management of nutrients in all other areas to prevent future sources of nutrients.</i>		<i>[This action is a co-benefit of erosion management actions – refer below]</i>	<i>See example interventions in Section 4.5 of the Strategy.</i>
<i>Elevated concentrations of phosphorus are characteristic of water quality conditions in the Mackay Whitsunday Region, with the highest loads in the Plane basin. There is currently insufficient information to recommend a definitive Management Response for different land uses for phosphorus. Current understanding indicates that sugarcane is the primary source of DIP in the Plane Basin.</i>	Sugarcane and other potential land use sources 24,600 ha (Sugarcane) (78% of total annual average DIP load)	Further investigation to better understand sources and drivers, potential ecological risks and where required, appropriate management actions. Increase and sustain adoption levels of best practices that reduce DIP export from sugarcane areas.	
Sediment Actively reduce sediment exposure on freshwater floodplain wetlands through an Accelerated management response in wetland hazard exposed areas, while applying a Proactive management response in localised areas to address emerging sediment issues in the basin. <i>Focus is on protecting streambanks with supplementary actions to</i>	Streambank (66% of total annual average sediment load)	Encourage best practices in riparian zones that reduce streambank erosion across multiple land uses including, riparian fencing/excluding cattle from streambank access, managing weeds and pests, and revegetation in riparian zone. <i>[These actions are complementary to Natural Systems Repair actions]</i> For guidance, refer to The Mackay Whitsunday Isaac Riparian Management Handbook^B.	
	Grazing 97,060 ha	Encourage and support adoption of best practices that reduce sediment erosion in grazing following a holistic approach that includes assessing land condition, matching stocking rate to available feed, removing livestock to allow recovery and reseeding, restricting	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.</i>			
PLANE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>minimise hillslope erosion in grazing, sugarcane and urban.</i>	(17% of total annual average sediment load)	riparian access and herd management. Manage linear features including unsealed roads and implement feral animal control. <i>Focus areas: South of Sarina</i>	
	Sugarcane 64,944 ha (8.1% of total annual average sediment load)	Encourage best practices that reduce sediment erosion in sugarcane, including zero tillage, trash blanket, use of fallow crops, controlled traffic, implementation of vegetated spoon drains, matching land use to soil capability and vegetated buffers.	
	Urban 9,848 ha (3.3% of total annual average sediment load)	Encourage best practices that reduce sediment erosion in urban areas including targeted erosion and sediment control, strategic implementation of Water Sensitive Urban Design and treatment train options (see Natural Systems Repair).	
Pesticides Expedite reductions of High pesticide exposure on marine ecosystems and wetland hazard exposed areas through an Intensive, large-scale management response. <i>Action is required across multiple agricultural land uses, primarily focused on pesticide reduction in sugarcane. Additional reductions could also be achieved through horticulture, irrigated and dryland cropping, grazing and non-agricultural land uses. Management</i>	Sugarcane 64,944 ha (25.5% of basin area and a higher potential for pesticide risk)	Rapidly maximise and sustain widespread adoption of practices that minimises pesticide risk from sugarcane including reducing overall pesticide application rates, increasing uptake of precision technologies, switching to lower risk products, optimising application timing relative to rainfall, managing point sources, improved irrigation management practices and adopting integrated pest management. Improve mill scheduling and harvest timing to prevent late-season fertiliser applications close to the wet season, reducing nutrient runoff to the reef.	
	Horticulture, irrigated and dryland cropping 1,150 ha (0.45% of basin area and a higher potential for pesticide risk)	Encourage and support adoption of best practices that minimises pesticide risk from horticulture, irrigated and dryland cropping including product selection, rate, timing of application, precision technologies and integrated pest management.	

Regional Objective: <i>Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Mackay Whitsundays aquatic ecosystems.</i>			
PLANE Basin-scale strategic management response	Dominant land use sources Land use area (Contribution to total basin load or pesticide risk) ^A	Action Strategy Action Strategies are in addition to the adoption of Minimum Standards. For examples see Appendix 1.	Delivery Strategy (linked to Strategic Action Area III - Section 4.5)
<i>includes a focus on areas upstream and surrounding wetlands.</i> <i>Foundational management of pesticides in all other areas to prevent future sources of pesticides.</i>	Grazing 97,060 ha (38% of basin area and a lower potential for pesticide risk)	Encourage adoption of best practices for weed management that minimises pesticide risk from grazing including product selection, rate, timing of application, precision technologies, mechanical weed removal and integrated pest management.	
	Non-agricultural areas (urban and forestry) 24,829 ha (10% of basin area and lower potential for pesticide risk)	Encourage adoption of best practices that minimises pesticide risk from non-agricultural land uses including product selection, rate, timing of application, and improved wastewater treatment processes.	

^A Loads are presented as the Total Annual Average, not the Anthropogenic Load. Data is unavailable to determine quantified land use contributions to pesticide risk, rather the land use's relative potential for pesticide risk is noted along with the proportion of the basin the land use occupies. ^B DIN load from grazing is primarily linked with sediment erosion and therefore is treated as a co-benefit of sediment reduction actions. For this reason, grazing sources of DIN are acknowledged but ranked lower in the table.

4.4.4 Plane Natural Systems Repair

Table 14. **Plane Natural Systems Repair Action and Delivery Strategies** required to achieve Regional Objective 2. The **Basin-scale Strategic management response** aligns to the recommended pollutant Management Response levels and ecosystem condition assessments. The **Action Strategies** target natural system drivers of water quality risks (streambank and gully erosion¹, vegetation and wetland loss²) and the condition of ecosystems³ (freshwater floodplain wetlands, seagrass, coral, and ecosystem connectivity). ¹Streambank and gully action strategies are ranked and scaled based on their contributions to the basin's sediment load. ² Vegetation loss and wetland loss/or modification action strategies are scaled based on % losses and identified hotspot areas. ³ Ecosystem condition action strategies are based on ecosystem condition ratings – poor, moderate or good. Priority actions are described for each natural system in Appendix 1. **Delivery Strategies** to support scaled delivery (Action Area III) are explained further in Section 4.5..

Regional objective: Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.			
PLANE Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III - Section 4.5)
Actively repair and rehabilitate natural systems in targeted and strategic locations to improve natural system processes for water quality outcomes and improve ecosystem condition.	Streambank repair (66% sediment load contribution)	Proactively rehabilitate streambanks in priority locations through riparian vegetation restoration and installing structural and engineered interventions for bank reshaping and stabilisation such as rock protection or rock armouring, timber pile fields, log fillets and rock groynes. ^A <i>[These actions are complementary to Sustainable Land use and Management actions for sediment reduction]</i> For guidance, refer to the Queensland River Rehabilitation Management (QRRM) Guideline^B.	Deliver coordinated and targeted natural systems and ecosystem rehabilitation programs that accelerates lasting restoration outcomes, tailored to local ecological contexts, and the capacity, opportunities, and motivation of diverse stakeholder groups (including landholders and land managers, community groups, and government agencies), including: • Capacity, skills and expertise • Incentives and markets • Decision support • Technology and equipment
	Woody vegetation loss (36%), Riparian vegetation loss (45%), and Freshwater floodplain wetland modification and/or loss (78%)	Reduce vegetation clearing, riparian vegetation and wetland modification/loss through promoting awareness of regulatory standards for vegetation clearing and other co-benefits. Establish and maintain buffer zones and weed control in riparian areas of waterways and wetlands. Support actions and encourage incentives (e.g. eco-markets) to increase revegetation and wetland rehabilitation. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands) and Queensland River Rehabilitation Management (QRRM) Guideline	
	Wetlands (Monitored aggregations in poor condition) <i>High exposure to hazard from nutrients,</i>	Evaluate drivers of poor wetland condition and the need and potential for intervention options to assist ecosystem recovery/rehabilitation. Coordinate interventions and activities to enhance wetland values, condition, and water quality improvement and ecosystem service functions, such as: • Interventions that improve hydrological integrity, manage pest species and safeguard native vegetation, strengthen riparian buffers and minimise pollutant	

Regional objective: *Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.*

PLANE Basin-scale strategic management response	Natural Systems	Action Strategy (For examples see Appendix 1)	Delivery Focus (linked to Strategic Action Area III - Section 4.5)
	<i>sediments and pesticides</i>	inflows to wetlands (see actions for DIN, fine sediment and pesticides), supported by site-based planning. Assessing the feasibility of using constructed wetlands or treatment systems (such as recycle pits, swales, wetlands, vegetated drains, sediment basins and bioreactors) to improve water quality while maintaining natural wetland values across a range of land use activities. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D	<i>See example interventions in Section 4.5 of the Strategy.</i>
	Marine ecosystems Seagrass (moderate) and Coral (poor)	Evaluate coral ecological, social and cultural values, other potential drivers of the Poor condition and the ecosystem's potential for recovery. Prioritise further investigation and development of targeted interventions for seagrass and coral ecosystems in identified pollutant hotspots (i.e. seagrass habitats and inshore coral reefs adjacent to the Plane, Pioneer and O'Connell basins, and within Repulse Bay and the Whitsunday Islands) and in proximity to high value areas such as the Broad Sound, Cape Palmerston-Rocky Dam and West Hill Fish Habitat Areas and Ince Bay Dugong Protection Area.	
	Connectivity	Support interventions to enhance hydrological connectivity and improve habitat linkage and corridors such as removing barriers to fish passage, and restoration and rehabilitation activities. Undertake an updated assessment of priorities for strategic location of rehabilitation activities. For guidance, refer to the goals, objectives and activities in the Reef 2050 Wetlands Strategy^D (particularly <i>Theme 3: On-ground activities to protect, manage, rehabilitate and restore wetlands</i>).	

^A Refer to the Mackay Whitsunday Regional Erosion Identification, Prioritisation and Remediation Study (Neilly Group Engineering, 2023); ^B Department of Environment and Science (2022); ^C Wilkinson et al., 2022); ^D Department of Environment, Science and Innovation (2023).

4.5 Strategic Action Area III: Actions to support scaled delivery

Achieving widespread adoption of management responses requires more than identifying the right management response (as described in Strategic Areas I and II), it requires designing programs and initiatives that account for the socio-economic context, and the capacity, opportunity and motivation of the land managers being engaged. A synthesis of evidence conducted for the 2022 Scientific Consensus Statement found that factors influencing uptake of management practices operate at multiple levels, from macro (governance, policy, economics) through to meso (industry, community) and micro (individual landholders and relationships), and that context and the processes used to engage with land managers are critical considerations for program design (Murray-Prior et al., 2024).

A range of policy instruments can be used to support adoption, including suasive approaches (e.g. capacity and skills and decision support tools), financial mechanisms (e.g. incentives and markets), regulatory tools⁴ (e.g. compliance requirements), and procedural instruments (e.g. planning frameworks, partnerships). The choice of instrument - and the intensity of investment - should be tailored to both the target management response level (Foundational, Proactive, Accelerated, or Intensive) and the identified barriers and enablers (i.e. capacities, opportunities and motivations) within the target audience.

Effective program design, therefore, must consider land use type, existing capacity, and the motivations and opportunities for influencing land manager decision-making. This aligns with established behavioural science frameworks, including the COM-B model (Michie et al., 2011) as well as past research in agricultural land management practice adoption (DPI, 2025; Coggan et al., 2021).

Agricultural extension research and broader behavioural science demonstrate a suite of delivery strategies and actions that can support scaled delivery. Guidance on selecting the right mix of delivery strategies and actions is based on land manager context and the targeted management response level. In essence, delivery methods should be chosen to meet and build on identified barriers and enablers, while the level of effort and investment should align with the intensity of the management response being sought.

4.5.1 Coordinated and targeted program design and delivery

The following section describes a range of delivery strategies and actions that can be used to build coordinated and targeted programs that support Strategic Action Areas I and II. These include strategies relating to: capacity, skills and expertise; social norms and trust development; decision support; incentives and markets; and technology and equipment.

While these strategies and actions are presented generically, their selection and intensity should be tailored to both the management response level and the barriers preventing adoption within the target audience. This approach draws on the Behaviour Change Wheel (Michie et al., 2011), which uses the COM-B model to match delivery strategies to diagnosed barriers. The COM-B model identifies three components that can enable or be a barrier to adoption:

- Capability – the physical and psychological ability to perform the behaviour, including having the necessary knowledge, skills, and confidence.
- Opportunity – the physical and social environment that enables the behaviour, including access to resources, infrastructure, time, and supportive social norms.

⁴ Regulatory instruments are not covered in this Strategy. However, regulation plays an important role in establishing minimum standards and providing a baseline from which voluntary programs can encourage further improvement. The interaction between regulatory and non-regulatory instruments should be considered in program design.

- Motivation – the reflective and automatic mechanisms that activate or inhibit behaviour, including beliefs about consequences, intentions, goals, habits, and emotional responses.

For a land manager to adopt a management response, all three components must be sufficiently present. Understanding which component(s) represent the primary barrier enables program designers to select the most appropriate delivery strategy and action for program design and delivery.

Note: This framework provides general guidance only and should be used in conjunction with local knowledge and direct engagement with target land managers wherever possible.

If direct engagement with the target audience to assess their current capabilities, opportunities and motivations in relation to the target management action is not feasible, program designers can draw on existing research and monitoring. The social monitoring program, coordinated through the Office of the Great Barrier Reef and World Heritage (DETSI), collects data through standardised surveys administered to landholders participating in state and federally funded water quality improvement projects. From 2019 to 2024 the survey was referred to as the 'social monitoring survey'. In 2022-23, following a rigorous review process, the survey was updated to the Perceptions of Practices (or PoP) Survey. Both the historical social monitoring survey and the updated Perceptions of Practices survey (Paddock to Reef program) measure components of capacity, opportunity, and motivations of landholders engaged in water quality programs to adopt targeted practices as described in the Water Quality Risk Frameworks. Detailed reports on the outcomes of the social monitoring program are provided directly to the delivery providers to support their program implementation and to track progress towards outcomes. In addition to the PoP surveys (Office of the Great Barrier Reef, DETSI) a biennial survey that benchmarks the broader regional agricultural community, including both program participants and non-participants, using constructs aligned with the Perceptions of Practices survey is conducted. This survey seeks to provide the additional understanding of the capabilities, motivations and opportunities of producers not actively engaged in Reef water quality funded programs. These surveys are administered across the six Great Barrier Reef catchment areas. The surveys target producers in commodities subject to Reef Water Quality regulations, including grazing, sugarcane, grains, bananas and horticulture. The first wave of this quantitative research was conducted in 2023, with the second wave undertaken in 2025 to identify changes over time (MCR, 2023, 2025).

The social monitoring program is ongoing, with surveys conducted periodically to track changes over time. Delivery providers designing or refining their programs should refer to the latest available report cards for the Paddock to Reef program (www.reportcard.reefplan.qld.gov.au/), or ideally conduct their own research into their target audience.

For the urban sector, very little is known about the factors influencing adoption of improved practices (Murray-Prior et al., 2024). Direct engagement with urban land managers and stakeholders will be essential to inform program design in this context.

4.5.2 Delivery Strategy Design Process

There are several factors that need to be considered for program design, and selection of Delivery Strategies. A process to design an effective, evidence-based delivery program is proposed in Figure 10. Additional guidance is presented in Appendix 2.

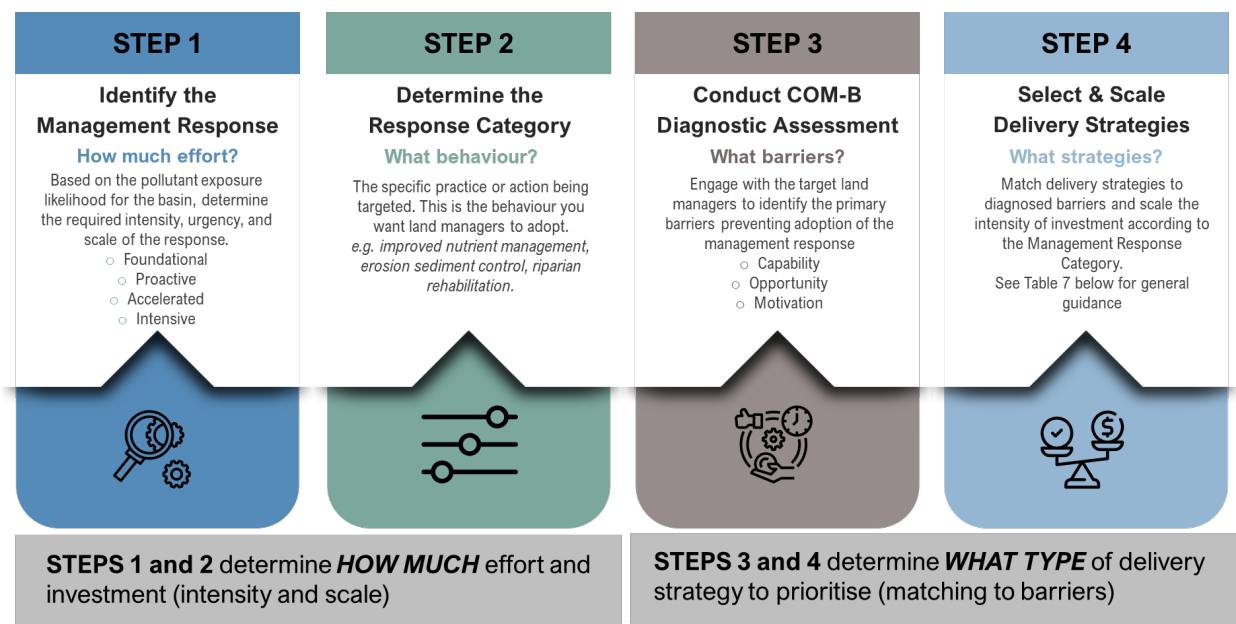


Figure 10. Proposed process for designing an effective, evidence-based delivery program.

Table 14 provides an example of the application of the design process showing how to integrate Management Response Categories with COM-B Diagnostic Assessment to inform the selection of Delivery Strategies.

Table 15. Scaled Delivery Strategy selection.

Response Category	Strategic Intent & Scale	COM-B Focus	Typical Pathways	Delivery Strategy Mix & Intensity
FOUNDATIONAL <i>Minimal pollutant exposure</i>	Maintain baseline regional capability and readiness to protect water quality and ecosystem health. Scale: Region-wide minimum standards	Identify primary barrier: <i>Typically limited to:</i> • Lack of awareness • Limited engagement/relationships	Minimum practice support, baseline skills development, community awareness, relationship building (if needed).	Lower intensity, 1–2 strategies: • Basic education & awareness • + Social norms & trust (if needed)
PROACTIVE <i>Low pollutant exposure</i>	Build localised capacity and early action pathways to prevent emerging risks. Scale: Local-scale, preventative	Identify primary barrier: <i>May include:</i> • Skills gaps (Capability) • Limited peer support (Social opportunity) • Uncertainty about options (Motivation)	Targeted extension, early-adopter support, local pilot projects, peer networks, localised coordination.	Low–medium intensity; 2–3 strategies. • Capacity, skills & expertise • Social norms & trust
ACCELERATED <i>Moderate pollutant exposure</i>	Rapidly scale coordinated delivery to reduce pollutant exposure and improve ecosystem condition. Scale: Sub-catchment targeted	Diagnose primary barrier: <i>Often includes:</i> • Technical skills gaps (Capability) • Resource/cost constraints (Physical opportunity) • Economic concerns (Motivation) • Negative norms or low trust (Social opportunity)	Regional partnerships, coordinated program delivery, industry-led initiatives, workforce strengthening, targeted incentives.	Medium intensity; 3–5 integrated strategies. • Skills: Capacity + Decision support • Economic: Incentives + Decision support • Social: Social norms + Capacity
INTENSIVE <i>High pollutant exposure</i>	Mobilise large-scale, cross-sector delivery capability for urgent and sustained improvements. Scale: Large-scale, multiple land use	Address ALL barriers: <i>Address all barriers across:</i> • Capability (knowledge, skills, confidence) • Physical opportunity (resources, infrastructure) • Social opportunity (norms, trust) • Motivation (economic, habits, risk aversion)	Whole-of-system coordination, large-scale deployment, multi-sector governance, intensive investment, real-time adaptive management. Maximum intensity; sustained, multi-year engagement.	Deploy ALL strategies: • Capacity, skills & expertise • Social norms & trust • Decision support • Incentives & markets • Technology & equipment

A more detailed list of delivery strategies, along with recommended actions and examples of existing initiatives, has been provided below. See also Appendix 2 for a Diagnostic Tool for guiding the selection and design of targeted, evidence-based delivery strategies.

Delivery Strategy: Support for Strategic Action Area I – Sustainable land use & management

Deliver coordinated and targeted programs that foster sustained adoption of management responses, tailored to local socio-economic and cultural contexts, land use types, and land managers' (both agricultural and urban) capacity, opportunities, and motivation.

Supported by Regional Implementation Strategies (Section 5).

Investors and delivery providers scale implementation effort based on pollutant management response levels, with highest intensity for Accelerated and Intensive responses. The mix of delivery strategy actions (i.e., knowledge, capacity, social norms, decision tools, incentives) are tailored based on local socio-economic contexts and land manager characteristics (capacity, opportunities, motivation) – as described above.

Capacity, skills and expertise

- Build and sustain technical and practical capability to implement management responses through targeted skills programs, intensive one-on-one mentoring, peer learning networks, and sustained practice-change support systems.

Example actions:

- Provide training and skill development through one-on-one, peer-group, technical and agronomic support.
- Resource local forums and small events to initiate engagement and share knowledge with a range of local participants.
- Expand the current extension network, particularly for sugarcane extension in the Proserpine Basin, and facilitate cross-organisational experience.
- Build technical and geospatial capability for maximising the application of spatial datasets and technical information.
- Target new and transitioning landholders expanding into peri-urban areas to build knowledge and technical capacity. Aim for targeted extension, early. For example, information packs for new landholders – e.g. information about vegetation clearing, general farm practices, Weeds of National Significance. Engage intermediaries such as real estate agents, solicitors, and local councils to ensure new landholders receive timely and relevant support.
- Encourage continuous improvement in resource efficiency and land management.
- Deliver sustained mentoring and peer coaching programs that support land managers through initial implementation, refinement, and long-term maintenance of practice changes.
- Develop local capacity for new recruits by encouraging graduate programs and high school work experience programs, create incentives for technical experts to stay in the Region (across all land uses).
- Update the regional resources for grazing extension, e.g. Sustainable Grazing Guide.
- Increase local awareness of the value and role of wetlands in the landscape.

Social norms and trust development

- Accelerate positive stewardship norm shifts for management responses and build trust between land managers, delivery organisations, and scientists through peer-to-peer networks, programs

that empower individuals as change leaders, and collaborative partnerships where all stakeholders co-create solutions together.

Example actions:

- Promote social recognition and storytelling that reinforce stewardship norms.
- Facilitate peer-to-peer networks, producer groups and locally based forums to support learning and social reinforcement. For example, maintain existing peer to peer groups in sugarcane and establish an annual grazing forum for extension officers and landholders to share information.
- Promote inclusive and equitable engagement, recognising diverse roles in decision-making and stewardship.
- Support stewardship leaders to influence their peers and the broader community to adopt improved practices.
- Foster trust through collaborative monitoring and trials where land managers, scientists, and delivery staff co-design and evaluate solutions together.
- Encourage long-term projects and provide specific support for legacy work (refer also to Section 5).

Decision support

- Encourage and support the development and use of place-based decision-support systems, monitoring and modelling that enable land managers and partners to select the most effective management responses in priority sub-catchments.

Example actions:

- Expand the availability and usability of existing nutrient, chemical and water management tools.
- Provide digital-literacy training and support for spatial and data platforms.
- Establish central data and spatial resources to improve accessibility and coordination.
- Support property-level economic and environmental analysis to inform investment.
- Support enterprise and property planning that links environmental outcomes with business goals.
- Support succession and legacy planning that maintains environmental stewardship across transitions.
- Integrate behavioural insights and adoption research into tool design and deployment.
- Promote increased application of herd management and pasture utilisation tools.

Incentives and markets

- Encourage and support the growth of innovative incentive mechanisms and environmental markets that reduce barriers, improve co-benefits and support sustainable livelihoods.

Example actions:

- Identify and trial innovative financing models and engagement approaches.
- Provide flexible, tailored funding incentives (e.g. grants, rebates).
- Support participation in emerging environmental markets and payment for ecosystem services schemes.
- Explore alternative finance and natural-capital accounting frameworks.

Technology and equipment

- Improve access to precision technologies, equipment and monitoring tools that support efficient, scalable implementation of Accelerated and Intensive actions.

Example actions:

- Support adoption of existing precision application, variable-rate and monitoring technologies.
- Promote efficient irrigation and runoff management systems suited to local soils and conditions.
- Facilitate co-investment in infrastructure upgrades, e.g. local mills, STPs, stormwater management systems.
- Encourage trials of emerging technologies in local areas.
- Provide shared-cost incentives to support technology transition.

Delivery Strategy: Support for Strategic Action Area II

Deliver coordinated and targeted natural systems repair and ecosystem rehabilitation programs that achieve lasting restoration outcomes, tailored to local ecological contexts, and the capacity, opportunities, and motivation of diverse stakeholder groups (including landholders and land managers, community groups, non-government and government agencies).

Supported by Regional Implementation Strategies (Section 5).

Design and tailor a selection of actions appropriate for the basin and pollutant management response level. Level of effort should be most intensive for Accelerated and Intensive Management responses.

Capacity, skills and expertise

- Enable access to appropriate equipment, techniques, and technical support for effective restoration activities.

Example actions:

- Provide technical training in restoration techniques (erosion control, revegetation, wetland construction).
- Support community groups with tool libraries and shared resources.
- Build capacity in restoration planning, site assessment, and monitoring techniques.
- Train local contractors and workers in specialised restoration techniques.

Decision support

- Encourage and support the development and use of place-based decision-support systems, monitoring and modelling that enable land managers and partners to select the most effective natural systems repair and ecosystem rehabilitation approach in priority sub-catchments.

Example actions:

- Provide digital-literacy training and support for spatial and data platforms.
- Establish central data and spatial resources to improve accessibility and coordination.
- Support property-level economic and environmental analysis to inform investment.
- Support enterprise and property planning that links environmental outcomes with business goals.
- Support succession and legacy planning that maintains environmental stewardship across transitions.
- Integrate behavioural insights and adoption research into tool design and deployment.

Technology and equipment

- Improve access to specialised restoration technologies, monitoring tools, and equipment that enable efficient, effective ecosystem rehabilitation at scale.

Example actions:

- Facilitate shared access to specialised restoration equipment.
- Promote innovative restoration techniques suited to local conditions.

- Enable access to monitoring technologies to track restoration success.
- Encourage trials of emerging technologies.

Incentives and markets

- ▶ Support diverse funding mechanisms and market opportunities that enable restoration activities across different land tenure and stakeholder groups.

Example actions:

- Provide grants and subsidies for restoration activities.
- Support participation in biodiversity and carbon credit schemes linked to restoration.
- Facilitate cost-sharing arrangements between councils, land managers, and community groups.
- Develop restoration stewardship payments for ongoing maintenance.
- Link restoration activities to emerging nature-positive market opportunities.

Part C: Regional Implementation

5 Strategic Regional Implementation

Effective implementation of the Strategy requires several actions to be undertaken at the Regional scale. It is important to note that these actions are not currently resourced and will depend heavily on alignment with existing initiatives, projects and programs. This emphasises the need to build on and improve what is already in place, leveraging partnerships and collaborating with ongoing programs to ensure that delivery is both practical and achievable within the Region.

5.1 Focused and targeted investment

- **Build on the Basin Water Quality Improvement Strategies by developing smaller scale implementation plans** that direct resources to the highest-impact actions. These plans should be guided by basin-specific management responses and targeted to high-impact sub-catchments, and informed by relevant social information.

Recommended actions:

- Develop a collaborative implementation plan based on target-basin specific priorities, using co-design approaches with regional partners and communities to identify and build on co-benefits.
- Identify the co-benefits of management actions, which could be leveraged to drive adoption while delivering simultaneous economic, environmental or community benefits – helping to maintain sustained, long-term change.
- Align and coordinate delivery across all programs, regions and partners to ensure integrated implementation.
- Apply cost-effectiveness analysis (including accounting for natural capital and ecosystem service benefits) to prioritise investments in high-impact areas, filling knowledge gaps where required.
- Align public and private investment frameworks with land management actions that deliver both water quality and broader environmental benefits (e.g. biodiversity, carbon, climate resilience).
- Provide flexible, tailored funding mechanisms and incentives (e.g. grants, rebates, credits).

5.2 Coordinated and collaborative governance and institutional arrangements

5.2.1 Enhanced coordination and collaboration

- Establish a strong, **region-wide coordination framework with clear governance** that aligns partners, programs, governance arrangements and community groups to support large-scale, collaborative delivery.

Recommended actions:

- Facilitate peer-to-peer networks and locally based forums to support learning and social reinforcement.
- Coordinate extension networks to facilitate strategic, tailored, and repetitive support with consistent messaging from staff, specialists, and peers for landholders.

- Promote inclusive and equitable engagement, recognising diverse roles in decision-making and stewardship.
- Build cross-sector partnerships to align planning, funding and monitoring efforts.
- Encourage shared delivery models that integrate local, regional and industry expertise.
- Promote longer-term project timelines to support trust, learning and continuity.
- Identifying opportunities to coordinate and integrate actions and initiatives to maximise impacts, reduce duplication and promote larger and long-term benefits.
- Encourage representation of the grazing industry in Healthy Waters Partnership.
- Explore mechanisms to support ongoing maintenance of natural system repair works, including resolution of issues of ownership and liability for on-going maintenance and restoration works.

5.2.2 Fit for purpose governance

- **Facilitate alignment of project governance with the overarching Strategy.** Establish processes to ensure that individual project and program governance structures formally recognise the Strategy and contribute to its objectives through aligned planning, reporting, and adaptive delivery.

Recommended actions:

- Address policy and regulatory barriers to implementation.
- Build adaptive, outcome-focused governance systems that respond to changing conditions.

5.3 Traditional Owner engagement and capacity

- **Strengthen Traditional Owner engagement and capacity** in the Region by supporting and securing traditional knowledge and aspirations, fostering meaningful engagement and partnerships, and expanding on-Country education and employment opportunities to deliver culturally grounded, inclusive, and sustainable outcomes.

Recommended actions:

- Incorporate Traditional Owner knowledge and aspirations in water quality planning and implementation, recognising the deep cultural connections to waterways and the desire of First Nations peoples to be more involved in caring for Country.
- Increase direct engagement with Traditional Owners and stakeholders to ensure knowledge is contextually meaningful and empowers informed decision-making.
- Support Traditional Owners to protect and retain traditional knowledge, including through increased capacity to record, manage and securely store this information.
- Expand on-Country education and employment opportunities for Traditional Owners.

5.4 Regional delivery capacity

- **Build and sustain the specialist** technical, cultural and delivery capability required by expanding training, mentoring, extension and institutional capacity.

Recommended actions:

- Build on existing regional delivery capacity by investing in local organisations to retain skilled personnel, strengthen local and technical knowledge, and support integration of works across programs to achieve cumulative catchment-scale outcomes.
- Maintain and build a coordinated extension community with trusted, skilled advisors and practitioners.

- Address regional skills shortages and maintain a skilled extension and advisory workforce.
- Provide ongoing professional development and certification pathways for delivery staff
- Strengthen extension and support services that build trust, recognise local knowledge, and provide practical assistance to land managers.

5.5 Knowledge sharing & communication

- ▶ **Strengthen community understanding and shared awareness among diverse stakeholders (e.g. Councils, community groups, land managers)** of locally specific water quality issues, natural systems processes and the co-benefits of practice change and natural systems repair through clear, accessible and evidence-based communication.
- ▶ **Continue to build long-term trust through adaptive communication and ongoing evaluation of communication impact.**
- ▶ **(Linked to) Strengthen extension and support services** that build trust, recognise local knowledge, and provide practical assistance to landholders.

Recommended actions:

- Develop and implement an integrated Communication and Engagement Strategy that establishes clear and consistent communication across programs, industries and delivery partners and supports awareness, understanding, and informed participation.
- Support trusted messengers and local champions and proactively address misinformation.
- Tailor communication for diverse stakeholders, translating technical findings into accessible materials, and using culturally appropriate, values-based messaging.
- Increase knowledge and awareness of the benefits, co-benefits, costs and risks of practice change through on-farm demonstrations, long-term trial sites, case studies, monitoring and evaluation.
- Establish and maintain demonstration and trial sites to validate evidence of the effectiveness and profitability of actions at a local level, and demonstrate science understanding and local application.
- Support economic awareness, analysis and financial solutions to encourage adoption of practices.
- Deliver targeted workshops to engage and educate resellers.
- Share outcomes demonstrated through case studies and monitoring and evaluation data.
- Communicate water-quality science and the link to local land management and ecosystem health.
- Provide education and outreach for producers, advisors, students and the community (e.g. STEM / school-based education).
- Embed feedback mechanisms to evaluate communication efforts and continuously adapt strategies to stakeholder needs and effectiveness over time.

5.6 Science and innovation

- ▶ **Foster stronger research-practice partnerships** with sustained investment in collaborative research programs where scientists and practitioners identify priorities, co-develop solutions, and rapidly test and scale innovations together.
- ▶ **Continue to invest in innovative technologies, methods and interventions** that can achieve land management improvements and water quality outcomes more efficiently.
- ▶ **Improve understanding of ecological and social drivers** to identify management levers and opportunities for intervention.

- **Support applied research at local scales to enable management solutions that are effective under local conditions.**

Recommended Actions:

- Establish formal research-practice partnerships with defined roles and shared priorities.
- Invest in trials and demonstrations of innovative technologies and methods.
- Establish and maintain demonstration and trial sites that validate science at the local level.
- Create pathways to scale successful innovations into mainstream delivery.
- Support research into key knowledge gaps such as:
 - Understanding of the sources and impacts of phosphorus on local aquatic ecosystems and identification of effective management options.
 - Investigate the effectiveness of Enhanced Efficiency Fertilisers in the Region.
 - Understanding pollutant loss pathways, particularly through groundwater.
 - Evaluate and validate co-benefits across different land uses and bioregions to strengthen the evidence base.
 - Understanding emerging risks and opportunities to inform climate resilience and future management approaches.
- Investigate options for nature-based solutions including aquaculture facilities in the treatment of land-based runoff.
- Develop programs that share research and solutions across regions.

5.7 Monitoring, evaluation and adaptive management

- **Collaborate with existing monitoring and evaluation programs** including the Regional Report Card Partnership and Paddock to Reef program to support evaluation of the Strategy.
- **Strengthen integrated monitoring and adaptive management systems** to track progress, demonstrate effectiveness, and inform adaptive management of land and water quality outcomes through establishment of a regional coordination role that consolidates ecological, biophysical, and management indicators—such as pollutant loads, pesticide risk, and ecosystem condition—across catchment, estuarine, and marine environments.
- **Prioritise spatially representative reporting** to detect change, identify hotspots, and assess management effectiveness in the Region. This data should directly inform adaptive planning cycles and guide investment in management practice adoption and rehabilitation of natural systems.

Recommended actions:

- Extend monitoring at on-farm, sub-catchment and end-of-catchment scales.
- Improve baseline information for water quality conditions across larger areas, with expansion to existing monitoring programs to include a range of 'other pollutants' particularly in urban areas where baseline data is limited.
- Build local capacity, including citizen-science programs, to enhance engagement and data quality.
- Share monitoring and evaluation results and case studies widely among government, industry and community partners, for example, through the Queensland Government Data Portal.
- Ensure timely and equitable access to all relevant datasets to support informed decision-making, enable adaptive management and maintain transparency in the prioritisation and delivery of program outcomes.
- Continue to build long-term trust through adaptive and ongoing monitoring and evaluation.
- Embed feedback mechanisms to evaluate efforts and continuously adapt strategies to stakeholder needs and effectiveness over time.

5.7.1 Measuring success

As the Strategy itself is not specifically resourced, information from existing monitoring and evaluation programs and frameworks for related programs, plans and strategies will be required to measure progress towards the regional objectives and outcomes. Therefore, a collaborative approach to monitoring and evaluation will be essential. There are several relevant monitoring and evaluation activities that are already in place that could be used to measure the success of the Strategy. It is not within the scope of the Strategy to present the detail of these monitoring programs, however, relevant indicators and tools are presented below and identified in the basin strategies.

Of greatest relevance, the [Paddock to Reef Integrated Monitoring Modelling and Reporting program](#) (Paddock to Reef program) is the most comprehensive program in place across the GBR for measuring and reporting water quality and management outcomes across the catchment to reef landscape. The scope is represented in Figure 11. All program components are actively represented in the Mackay Whitsunday Region, and therefore provide a strong foundation for measuring the success of the Strategy.

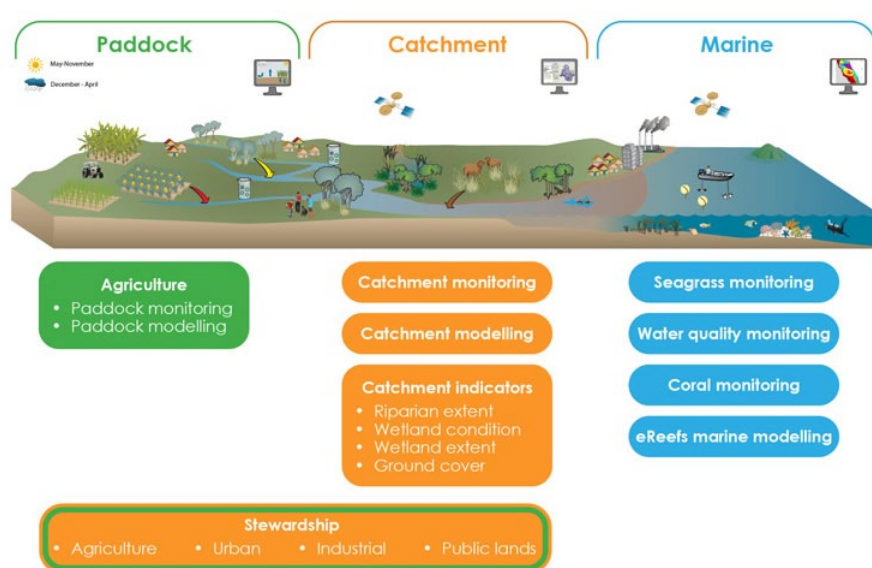


Figure 11. The scope and main components of the Paddock to Reef program.

There are also other well-established monitoring programs that collect and/or collate information in the Region relevant to the Strategy. Many of these are presented in the Regional Report Card led by the Healthy Rivers to Reef Partnership, and were used in the Synthesis Report. Table 15 summarises examples of the key indicators and potential information sources that could be considered for the Strategy. This does not include detailed indicators that would be required to demonstrate success of individual actions or projects, such as analysis of LiDAR imagery to evaluate streambank or gully rehabilitation works. These indicators are defined in detailed monitoring and evaluation programs for individual projects and programs and are outside the scope of this Strategy.

Table 16. Examples of performance measures for the outcomes and objectives of the Mackay Whitsunday Regional Water Quality Strategy.

Objectives	Relevant indicators	Information source	Reporting tool (where relevant)	Frequency
Strategy Objective 1: Achieve good water quality in the Mackay Whitsunday Region now and maintain it into the future to reduce nutrient, sediment and pesticide impacts on the Region's aquatic ecosystem and cultural values.				
Strategy Objective 2: Rehabilitate and sustain natural catchment processes, connectivity and ecosystem function in the Mackay Whitsunday Region that support healthy aquatic ecosystems, improve water quality outcomes, and deliver co-benefits such as biodiversity conservation, climate resilience, and enhanced landscape productivity.				

Objectives	Relevant indicators	Information source	Reporting tool (where relevant)	Frequency
Ecosystem condition				
Catchment (freshwater floodplain wetlands)	Freshwater floodplain wetland condition	P2R Wetland Condition Monitoring Healthy Rivers to Reef Partnership	Reef Report Card	Annual
Estuarine	Water quality parameter concentrations	Healthy Rivers to Reef Partnership	Regional Report Card	Annual
Marine (coral reefs, seagrass)	Coral & seagrass condition	MMP	Reef Report Card Regional Report Card	Annual
Water quality measures				
Catchment water quality	Water quality parameter concentrations	P2R Catchment Loads Monitoring Program Healthy Rivers to Reef Partnership	Regional Report Card	Annual
End of catchment pollutant loads	Fine sediment, particulate nutrient and DIN loads	P2R Catchment Modelling Program	Reef Report Card	Annual
Pesticide risk	End-of-catchment Pesticide Risk Metric	P2R Catchment Modelling Program	Reef Report Card and Regional Report Card	
Marine water quality & pollutant exposure	WQ parameter concentrations & modelled exposure	MMP, eReefs modelling Marine exposure assessment	Reef Report Card Regional Report Card GBR Spatial Management Prioritisation	Annual 5 yearly
Biophysical drivers				
River discharge, rainfall & climate		MMP (& sources within)		Annual
Freshwater floodplain wetland extent & loss	Current extent, historical & recent loss	Wetland/Info	Reef Report Card	Every 2 years
Riparian vegetation loss & remaining extent	Current extent, historical & recent loss	P2R (SLATS)	Reef Report Card	Every 3 to 4 years
Groundcover	Annual late dry season cover of grazing land compared to long term median (1988–2023)	P2R (SLATS)	Reef Report Card	Annual
Vegetation clearing	Current & historical rates	SLATS		Annual
Landscape connectivity	Hydrological connectivity	Wetland/Info	Regional Report Card	Annual

Objectives	Relevant indicators	Information source	Reporting tool (where relevant)	Frequency
	Fish Barriers	Healthy Rivers to Reef Partnership		
Management adoption				
Agricultural management practice improvements receiving funding	Adoption of priority management practices	P2R Management Practice Adoption	P2R Projector Tool Reef Report Card	Before and after Project delivery
Level of practice applied to urban water management related activities	Infrastructure management and maintenance	Urban Water Stewardship Framework	Regional Report Card	Biennial
Water quality benefits				
Agricultural management practice improvements	Tonnes of fine sediment, particulate nutrients & DIN saved from entering the GBR Pesticide Risk Metric		P2R Project Tool LCAT	Before and after Project delivery
Systems repair	Tonnes of fine sediment, particulate nutrients & DIN saved from entering the GBR Pesticide Risk Metric	Gully and Streambank Toolbox, P2R	VegCAT StreambankCAT LCAT	Before and after Project delivery Annual monitoring
Strategy Objective 3: Build a lasting legacy of enhanced community understanding, opportunities, skills & capacity to deliver regionally led, collaborative water quality improvement actions that support sustainable livelihoods and advance Objectives 1 & 2.				
Increased capacity, opportunity and motivation of agricultural land managers to adopt targeted management responses	Knowledge Confidence Expectations Additionality Group Norms Motivations Barriers Aspirations	Within Program - P2R Perceptions of Practices	P2R Projector Tool – P2R	Before and after Project delivery
		Outside of Program Delivery – Social Monitoring	DETSI Social Monitoring Benchmark Research Report	Biennial
Increased capacity, opportunity and motivation of non-agricultural land managers to adopt Reef stewardship actions	Knowledge Confidence Response Efficacy Motivation Social Capital Reef connection	PROTECT Stewardship Framework & Toolkit	PROTECT Platform	After project delivery
People and communities to take individual and collective action to	Reef 2050 Stewardship Indicators	SELTMP	Regional Report Cards	Biennial

Objectives	Relevant indicators	Information source	Reporting tool (where relevant)	Frequency
maintain the health and resilience of the Great Barrier Reef (Reef 2050 Objective) (Community Stewardship)				
Level of practice applied to urban water management related activities	Policy, planning and governance Social Approaches MERI	Urban Water Stewardship Framework	Regional Report Cards	Biennial
Preserve and strengthen Traditional Owner connections to Country and Sea Country.				
<i>Seek advice from local representatives</i>				

5.8 Strategic opportunities

- ▶ **Link the Reef 2050 Wetlands Strategy with Catchment Action Plans** to facilitate a whole-of-systems approach to management, ensuring that guidance provided in the Strategy is reflected in the Plans—and vice versa—to maximise investment efficiencies, enhance co-benefits, ensure consistency, and strengthen collaboration.
- ▶ **Accelerate progress toward Reef 2050 water quality targets by integrating co-benefits and expanding ecosystem market mechanisms** to help ensure that investment delivers not only measurable water quality improvements but also broader ecological and economic gains, fostering sustained landholder engagement.
- ▶ **Harness emerging agricultural technologies (AgTech)** (e.g. including automated weed detection, AI-enabled mapping, remote sensing, precision spray systems, and digital decision-support tools) to accelerate adoption, improve precision, and reduce pollutant runoff across agricultural and peri-urban landscapes.

Example actions:

- Align the Proserpine Catchment Action Plan and any future plans in the Region with the guidance provided in the Strategy, and update the Strategy as required to reflect their progress.
- Prioritise and promote practices with demonstrated water quality outcomes and proven co-benefits (e.g. soil health, biodiversity, carbon reduction, on-farm productivity).
- Promote and expand participation in ecosystem market mechanisms such as Reef Credits Scheme and the Australian Carbon Credit Unit scheme, providing long-term financial incentives to land managers for water quality, carbon and biodiversity benefits.
- Support targeted research to evaluate and validate co-benefits across different land uses and bioregions to strengthen the evidence base.
- Align public and private investment frameworks with land management actions that deliver both primary and secondary environmental benefits.
- Support the development and adoption of precision weed-management technologies, such as automated spot-spraying systems (e.g. [AutoWeed](#)), drone-based weed mapping and AI-assisted detection to reduce pesticide loads and improve chemical-use efficiency.
- Develop or expand digital farm portals and decision-support platforms that help land managers identify vegetation types, select appropriate chemicals, understand buffer zones, and optimise application.
- Promote advanced spray-rig technologies and precision application systems.
- Establish industry-led AgTech training and support programs to help land managers keep pace with regulatory changes, label updates and safe, effective use of newer technologies.
- Encourage research, trials and validation that quantify the water quality benefits of AgTech and decision support tools, enabling adaptive management.
- Build on existing regional delivery capacity by investing in local organisations to retain skilled personnel, create pathways for young people, and strengthen local and technical knowledge. This long-term capability will support integrated program delivery and generate cumulative outcomes over time.

5.9 Constraints, risks and limitations

Progress toward Reef 2050 WQIP targets varies by pollutant type. The Mackay Whitsunday Region achieved 'moderate' progress toward the 20% fine sediment reduction target with a 14.3% cumulative reduction to June 2022. Particulate phosphorus showed the most improvement with a 16.8% cumulative

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reduction, while particulate nitrogen achieved a 14.8% reduction. Progress toward the 70% DIN reduction target was limited, with only a 29.1% cumulative reduction achieved. Pesticide risk continues to show the highest risk levels in the Mackay Whitsundays out of all GBR Regions, however recent trend analysis indicates engagement programs in Sandy Creek have resulted in some reductions (Rass, 2023).

Key challenges have been identified throughout the Strategy and include:

- **Adoption barriers** including financial constraints and costs of some management actions, distrust of government agencies and scientific information, conflicting advice, and complexity of funding applications all hinder adoption of improved practices.
- **Regional capacity to support program delivery**, particularly with regard to extension staff with specialist expertise relevant to the adoption of practices with water quality benefits.
- **Economic considerations** such as the perceived economic risks of practice change, particularly in the context of other market pressures and uncertainties, limit willingness to change.
- **Legacy issues** associated with extensive historical land modification has created ongoing sources of pollution (e.g. gullies) that require substantial resources to address.
- **Short-term funding cycles**, start/stop nature of program funding and program fragmentation leads to discontinuity in engagement, risks to maintaining regional capacity, the inability to maximise benefits of legacy work and disrupted motivation to participate across the full range of participants including landholders, delivery providers and scientists.
- **Gaps in technical capacity** in some locations and specialist areas including those catchments where water quality investment has historically been quite low (e.g. Proserpine Catchment).
- **Complex approval processes** for some restoration activities leading to lengthy delays, increases in project costs and potential barriers for landholder engagement.
- **Time lags** between management actions and measurable water quality improvements which makes it difficult to demonstrate local benefits to landholders, decision makers and investors in the shorter-term to secure confidence in ongoing programs.
- **Increasing climate variability** including more variable and intense rainfall patterns affect both the implementation of management practices and their effectiveness.
- **Marine ecosystem recovery** faces ongoing challenges. Coral reefs remain in 'poor' condition following Cyclone Debbie impacts in 2017, with the Coral Index score remaining poor in 2024 despite some site-specific improvements. Seagrass conditions declined slightly in 2023–24 compared to the previous reporting period but the Seagrass Index score remained 'moderate'. Marine modelling shows that pesticide exposure extends into inshore marine environments, with diuron hotspots covering areas containing important seagrass habitats, inshore coral reefs, and designated Dugong Protection Areas.

The following **emerging issues** were also identified through stakeholder consultation and may have implications for future program design:

- **Land use change**, e.g. conversion from sugarcane to grazing and expansion of peri-urban areas with limited landholder knowledge of management requirements. *Facilitate early interventions/ training / or toolkit to support landholders when changing commodities particularly related to lack of experience/knowledge.*
- **Planning for the risk of removal of the use of the residual pesticide Paraquat in the sugarcane industry** which may lead to a shift in greater use of alternative, higher risk residual pesticides. Understanding soil type variation is essential for residuals as they can impact sugarcane growth if not applied correctly and influence nutrient use efficiency. *Implement a more targeted extension and education campaign on residual management and targeted application. Assess human health issues including chemical contamination in bores and rainwater tanks to prioritise and facilitate local stewardship.*

5.10 Future directions

To accelerate progress toward water quality targets and improve ecosystem outcomes, several strategic directions are recommended:

1. **Support targeted investment in highest-priority areas** by focusing on the areas that contribute disproportionately to pollutant loads and pesticide risk, which may require smaller scale prioritisation in smaller sub-catchments informed by water quality, social and economic drivers of water quality outcomes.
2. Resource and implement an **integrated approach to management** by combining sustainable land use and management actions with strategic natural system repair actions to achieve multiple benefits.
3. Encourage a **diverse mix of validated management actions** that can be tailored to landholder and stakeholder needs, building on successful projects that have demonstrated water quality improvements alongside social and economic outcomes.
4. Recognise and facilitate **greater community stewardship** by broadening community engagement in NRM delivery, including meaningful involvement of landholders and Traditional Owners to support collective action and enduring outcomes.
5. **Engage a combination of delivery mechanisms** such as regulation, incentives, market-based approaches, and extension to create a comprehensive approach to implementation that recognises the diversity of landholder capabilities, opportunities and motivations.
6. **Increase Traditional Owner knowledge and engagement** in delivery activities and strengthen Traditional Owner leadership, engagement and capacity by resourcing, supporting and strengthening the knowledge and aspirations of Traditional Owners, fostering meaningful engagement and partnerships, and expanding on-Country education and employment opportunities.
7. **Build on successful engagement and extension models** like Project Bluewater and the Jane's Creek pesticide projects to establish trust and provide tailored, consistent support to landholders. Design programs that acknowledge and address the barriers and enablers identified through social research and evaluation.
8. Expand efforts to **restore wetland function** in the Region, building on successful projects that have demonstrated ecological and water quality benefits such as the Beyond Barriers: Mackay and Isaac Coastal Wetland Rehabilitation project.
9. **Strengthen integrated monitoring and adaptive management** by collaborating with existing programs, formalising a regional coordination role to consolidate environmental, social and management data and information, and prioritising spatially relevant reporting that informs adaptive planning and guides investment in management practices and natural systems repair.
10. **Integrate climate change considerations into management planning**, recognising the increasing pressures from more variable and intense rainfall events, severe weather events, increased hot days, and wildfire risks.

By implementing these strategic directions through a collaborative approach that engages landholders, industry, government, Traditional Owners, and the broader community, the Mackay Whitsunday Region can make significant progress toward improving water quality outcomes for the GBR while supporting sustainable and productive land uses.

6 References

- Australian & Queensland governments (2024) Reef Water Quality Report Card 2021 and 2022. State of Queensland. <https://www.reefplan.qld.gov.au/tracking-progress/reef-report-card/2021-22>
- Australian & Queensland governments (2026) Reef 2050 Catchment Water Quality Strategy Healthy catchment for a healthy Reef and healthy people. State of Queensland, 2026. https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0031/427837/reef-2050-catchment-water-quality-strategy.pdf
- Chariton A, Hejl N (2024) Question 6.1 What is the spatial and temporal distribution and risk of other pollutants in the Great Barrier Reef ecosystems, and what are the primary sources? In Waterhouse J, Pineda M-C, Sambrook K (Eds) 2022 Scientific Consensus Statement on land-based impacts on Great Barrier Reef water quality and ecosystem condition. Commonwealth of Australia and Queensland Government.
- Coggan A, Thorburn P, Fielke S, Hay R, Smart JC (2021) Motivators and barriers to adoption of Improved Land Management Practices. A focus on practice change for water quality improvement in Great Barrier Reef catchments. *Marine Pollution Bulletin*, 170. 112628. <https://www.sciencedirect.com/science/article/pii/S0025326X21006627>
- Department of Environment and Science (2020) Department of Environment, Science and Innovation (DESI) (2020) Plane Catchment Story, *WetlandInfo* website, accessed 3 June 2025. Available at: <https://wetlandinfo.des.qld.gov.au/wetlands/ecology/processes-systems/water/catchment-stories/transcript-plane.html>
- Department of Environment and Science (2022) Queensland River Rehabilitation Management Guideline, Version 1.0, DES, Brisbane, Queensland.
- Department of Environment, Science and Innovation (2022) Whole-of-System, Values-Based Framework, *WetlandInfo* website, accessed 14 May 2025. Queensland Government, Brisbane, Queensland. Available at: <https://wetlandinfo.des.qld.gov.au/wetlands/management/whole-system-values-framework/>
- Department of Environment, Science and Innovation (DESI) (2023) Reef 2050 Wetlands Strategy, A strategy to manage wetlands in the Great Barrier Reef and its catchments. Brisbane: Queensland Wetlands Program, Queensland Government.
- Department of the Environment, Tourism, Science and Innovation (DETSI) (2025) Modelled estimates of dissolved inorganic nitrogen, fine sediment and particulate nutrients delivered from the Great Barrier Reef catchments. Reef Report Card 2023/24 baseline loads. Version supplied December 2025.
- Department of Primary Industries (DPI) (2025) Review of Land Management Targets Reef 2050 Water Quality Improvement Plan. Summary Report. Management Practice Adoption of Rural Economic Development—Central, the State of Queensland, June 2025.
- Kanakis K, Bickle M, Erbacher J (2024) Understanding the perceptions of producers: A tool for the extension toolbelt. *Rural Extension & Innovation Systems Journal*, 2024 20(1) – Field notes.
- Michie S, van Stralen, MM and West R (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(42). <https://doi.org/10.1186/1748-5908-6-42>
- Murray-Prior R, Schultz T, Long P (2024) Question 7.2 What are the behavioural (attitudinal), economic, social and cultural factors that hinder or enable the uptake of management practices that aim to improve water quality outcomes for the Great Barrier Reef? In Waterhouse J, Pineda M-C, Sambrook K (Eds) 2022 Scientific Consensus Statement on land-based impacts on Great Barrier Reef water quality and ecosystem condition. Commonwealth of Australia and Queensland Government.

- Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership (2024) *Mackay-Whitsunday-Isaac 2024 Report Card Results Technical Report*. Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership, Mackay, QLD.
- McKenzie LJ, Collier CJ, Langlois LA, Yoshida RL (2024) Marine Monitoring Program: Annual Report for Inshore Seagrass Monitoring 2022–23. Great Barrier Reef Marine Park Authority.
- MCR (2023) Social Monitoring Benchmark Research Report. A report prepared for the Queensland Department of Environment and Science, 30 June 2023, Spring Hill.
- MCR (2025) Social Monitoring – Wave 2 Research Report. A report prepared for the Queensland Department of Environment, Tourism, Science and Innovation, 30 May 2025, Spring Hill.
- MWI TORG (2017) Mackay Whitsunday Isaac Traditional Owner Strategic Plan 2017–2027. Mackay Whitsunday Isaac Traditional Owner Reference Group. 18 pp. Accessed 28 May 2025: https://reefcatchments.com.au/files/2013/02/TORG_Strategic-Plan_ELECTRONIC_17Apr2018.pdf
- Neilly Group Engineering (2023) Mackay Whitsunday Regional Erosion Identification, Prioritisation and Remediation Study, prepared by Neilly Group for Reef Catchments.
- Puignou-Lopez O, Lewis SE, James CS, Davis AM, Mackay SJ (2025) Hydrology of the Great Barrier Reef catchment area along a latitudinal gradient: implications for estimating discharge. *Journal of Hydrology: regional studies*, 61, 102603.
- Queensland Government (2021) Land use data. Queensland Land Use Mapping Program. https://www.data.qld.gov.au/dataset/2021_great_barrier_reef_land_use/resource/3e72d679-8126-488a-bc7f-c2fbf42c0455
- Queensland Government (2022) Wetland extent monitoring results (Version 6.0, 2001 – 2019). Queensland Herbarium and Biodiversity Science. 131 pp. <https://wetlandinfo.des.qld.gov.au/resources/static/pdf/resources/reports/wetland-extent-monitoring-report-v3.pdf>
- Rass, H (2023) *Are Pesticides Concentrations Increasing or Decreasing in Waterways that Discharge to the Great Barrier Reef Lagoon?* Honours Thesis, Reef Catchments Science Partnership, The University of Queensland. <https://doi.org/10.14264/a362448>
- Reef Catchments (2014) Natural Resource Management Plan: Mackay Whitsunday Isaac. Reef Catchments, 88pp. Accessed on 1 April 2025: <https://reefcatchments.com.au/natural-resource-management-plan-2014-2024/>
- Sambrook K, Smith R, Waterhouse J, Schultz T, Molinari B (2026) Mackay Whitsunday Regional Water Quality Strategy: Synthesis Report. Version 1.0, February 2026.
- State of Queensland (2023) Environmental Protection (Water and Wetland Biodiversity) Policy 2019. Queensland Government, October 2023. Available at: <https://environment.qld.gov.au/management/water/policy/>
- State of Queensland (2022a) Environmental Protection (Water and Wetland Biodiversity) Policy 2019, Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives Basins 122, 123 and 124, including all surface waters of the Proserpine River, Whitsunday Island and O'Connell River Basins, and adjacent coastal waters. Queensland Government, June 2022.
- State of Queensland (2022b) Environmental Protection (Water and Wetland Biodiversity) Policy 2019 Pioneer River and Plane Creek Basins Environmental Values and Water Quality Objectives Basins 125 and 126, including all surface waters of the Pioneer River and Plane Creek Basins, and adjacent coastal waters. Queensland Government, June 2022.
- Thompson AA, Davidson J, Logan M, Thompson C (2024) Marine Monitoring Program Annual Report for Inshore Coral Reef Monitoring: 2022–23. Great Barrier Reef Marine Park Authority, Townsville. 149 pp.
- Water Quality & Investigations (2024) Tahbil - Water Quality Data Portal. [website]. Queensland Government, Brisbane. <https://apps.des.qld.gov.au/water-data-portal/>
- Waterhouse J, Star M, Molinari B, Sambrook K, Vandergragt M, Leigh C, Sutcliffe T, Smith R, Choukroun S, Tracey D, Lewis S. (2025) Decision framework for management options to maintain and improve water

quality in the Great Barrier Reef catchment area. Analysis of key spatial factors impacting water quality and the condition of wetlands, corals and seagrass in the Great Barrier Reef. Commonwealth of Australia and Queensland Government.

Wilkinson S, Hairsine PB, Bartley R, Brooks A, Pietsch T, Hawdon A, Shepherd R (2022) Gully and Stream Bank Toolbox. A technical guide for gully and stream bank erosion control programs in Great Barrier Reef catchments. 3rd Edition. Commonwealth of Australia.

Appendix 1: Further detail of relevant actions to operationalise the Action Strategies

This Appendix provides further detail of the Action Strategies for Strategic Action Areas I and II.

The Basin Water Quality Improvement Strategies in Section 4 identify the overarching direction in the form of Action and Delivery Strategies for each basin. Further detail of the actions that are likely to be most effective in delivering these Strategies is presented here. This includes on-ground actions grouped by land use (for Strategic Action Area I Action Strategies) and landscape components (for Strategic Action Area II Action Strategies). These actions are generally consistent across the four basins in the Region, with differences highlighted where relevant. The scale of implementation and intensity of effort, however, will differ between basins in line with the recommended Management Response in the Basin Water Quality Improvement Strategies.

Evidence from on-ground experience and published studies shows that the most effective way to achieve water quality outcomes is through a combination of actions tailored to local conditions and social dynamics. The relative priority of actions will also vary spatially and may shift over time in response to climate, social and economic factors. As the Strategy extends to 2035, it is acknowledged that these actions may evolve to reflect changing circumstances.

The actions have been derived from published literature including the 2022 Scientific Consensus Statement, locally relevant studies, stakeholder consultation and additional advice from technical experts. Further detail of the actions is provided in the Synthesis Report (Sambrook et al., 2026; primarily in Section 7 and 8). The practices identified as part of the process for the [Review of Land Management Targets](#) for the Mackay Whitsunday Region are highlighted with an asterisk (*). Current adoption has been considered for these practices (refer DPI, 2025) and is reported below in italics, however the detailed findings of the Review should be consulted for a more detailed understanding of the barriers to adoption (see also Section 5 of the Strategy). Additional actions were added from evidence presented in the RWQS Synthesis Report and stakeholder consultation.

Sugarcane

Sugarcane occupies approximately 17% of the Mackay Whitsunday Region, with the largest area in the Plane Basin (~65,000 ha) followed by the Pioneer (~32,000 ha), O'Connell (30,500 ha) and Proserpine (24,600 ha) basins.

Dissolved Inorganic Nitrogen

Sugarcane is a major contributor (51%) to the DIN loads in the Mackay Whitsunday Region.

Actions for reducing DIN loads, noting that these are in addition to the minimum Regulated standards:

- ***Effective use of available irrigation water to increase crop yield with similar crop inputs.** 60% of growers have irrigation access. Irrigation water allocations often *underutilised*. Scope for considerable yield improvement if available water is used to maximise early crop growth and increase crop uptake of applied nutrients prior to wet season. *Current adoption is low (7%).*
- ***Address drainage and waterlogging problems to improve yield and nutrient use efficiency.** Crop growth and yield is often impeded by saturation of the soil profile in the root zone which limits root function (and crop nutrient uptake) and results in elevated DIN losses through denitrification and leaching. *Current adoption is low (10%).*
- ***Address soil constraints to improve yield.** e.g. sodic soils, enhanced soakage, addressing compaction. *Current adoption is relatively high (75%).*
- **Holistic, farm-specific DIN accounting:**
 - ***Accounting for N from legume break crops.** Legume crops can contribute nitrogen to following sugarcane crops (grown in rotation). The Six Easy Steps Toolbox provides guidelines for possible reduction in rates of N fertiliser applied to sugarcane following legume crops. *Current adoption is low (5%).*

- ***Accounting for nitrogen from mill mud when applied at rates less than 100 wet tonnes per hectare.** When mill mud is applied at rates below 100 t/ha there is no regulated requirement to factor the N and P into nutrient management plans. There is opportunity however for applied fertiliser rates to factor in N and P contributions from mill mud applications. *Current adoption is moderate (64%).*
- **Nutrient use efficiency**, particularly as a complementary practice to the above actions – rate, timing, placement and cover (burial, surface etc).
- **Improved soil health through adoption of improved farming system**, also related to the above actions.
- **On farm water management** – infrastructure, management and maintenance plans.
- **Maintaining and upgrading industry infrastructure** to support the above management actions. This relates to the sugarcane mills and equipment breakdown which can lead to delays in harvesting and late season application of fertiliser.

There are also several considerations for grouping actions to maximise outcomes, for example:

- Optimising N rates can be complementary to the other practices through:
 - Accounting for nitrogen from legume crops grown in rotation with sugarcane.
 - Accounting for nitrogen from mill mud when applied at rates less than 100 wet tonnes per hectare.
- Addressing drainage and waterlogging problems and soil chemical constraints together can also improve yield and nutrient use efficiency.

Pesticides

Sugarcane is the dominant land use contributing to pesticide risk in the Mackay Whitsunday Region. The basins with the highest risk include Proserpine, Pioneer and Plane (specifically Sandy Creek).

- ***Reducing pesticide risk through optimising application and chemistry selection.** Aquatic risk of pesticides can be reduced through optimising application rates, selecting products of lower risk (toxicity and mobility) where possible, avoiding application close to rainfall, using appropriate equipment, technologies and methods (e.g. at mixing/loading sites). *Current adoption is low (10%).*
 - **Reducing overall pesticide application rates.** Reducing application rate and improving application methods to reduce the total amount of pesticide applied through lower application rates (within label recommendations), e.g. banded/shielded/spot spray applications and using appropriate nozzles, pressure settings, tracking legs and application technologies such as dual herbicide sprayers.
 - **Switching to alternative products with lower aquatic risk with consideration of local conditions.** Supported by the Pesticide Decision Support Tool and understanding of specific soil characteristics and their influence on pesticide behaviour.
 - ***The top 5 pesticides contributing to the risk (across all land uses) (on average over last 9 years): Imidacloprid and diuron (>65% of risk combined), atrazine, imazapic, and metolachlor (<35% of risk combined). The exception is for the Plane catchment where the top 5 are metsulfuron-methyl diuron, imidacloprid, atrazine, MCPA.***
 - Plan for potential changes in the registered use and label conditions of Paraquat in Australia. For example, understanding soil type variation is essential for residuals as they can impact sugarcane growth if not applied correctly and influence nutrient use efficiency. More targeted extension and education campaign on residual management and targeted application.
 - Assess human health issues including chemical contamination in bores and rainwater tanks to prioritise and facilitate local stewardship.
- **Reducing high acute peaks in pesticide risk.** Target reductions through timing of application and optimisation of application according to the physico-chemical properties of the pesticide, e.g. soil-half life, water solubility, soil characteristics including carbon content and moisture levels. Apply more persistent and mobile pesticides earlier in the season to avoid rainfall runoff events, and switch

to products with lower aquatic risk rankings closer to wet season if applications are required. *Note that some of these factors are recognised as being outside of the landholder's control.*

- Managing point-source risks, e.g. mixing/loading sites.
- Adopting Integrated pest management holistically across the basin.
- Research into resistant sugarcane varieties for pest management.

Fine Sediment

Sugarcane contributes around 4.8% of the fine sediment load in the Mackay Whitsunday Region.

Actions for reducing fine sediment loads:

- Crop residue cover and use of fallow cover crops.
- Controlled traffic including matching machine wheel spacings to row spacing, with GPS guidance.
- Zero, or minimum, tillage in preparing land for planting.
- Installation of vegetated spoon drains.
- Vegetated buffers and strategically located sediment traps.

Grazing

Grazing occupies approximately 43% of the Mackay Whitsunday region, with the largest area in the Proserpine (125,780 ha) followed by O'Connell (115,924 ha), Plane (97,060 ha) and Pioneer (52,072 ha) basins.

Fine sediment

Streambank erosion (across all land uses, including grazing) contributes approximately 77% of the total fine sediment load, and grazing lands specifically contribute approximately 10% of the fine sediment load in the Region. In addition to streambank sources, hillslope erosion contributes around 22% and only a small proportion (<1%) is from gully erosion.

Actions for reducing fine sediment loads:

- ***Assessment of land condition twice annually; recording, and monitoring land condition and addressing decline.** Capacity of land to respond to rain and produce useful forage. Land is managed to maintain 'B' condition and >2500kg DM/ha of pasture all year. Required knowledge: What is land condition (ABCD framework); Erosion processes; tree and grass balance; pasture condition & biomass; biodiversity; soil condition; ground cover; composition of pasture (3Ps vs weeds); Early identification of declining land condition trends and management options to address decline. *Current adoption is low (5%).*
- ***Matching stocking rate to available feed, quality and quantity.** Knowledge required: Paddock sizes, numbers of stock and how they relate to Adult Equivalent (AE) for feed requirements; Understanding of changing nutritional requirements over time for growth and reproduction; Measurement of pasture biomass (usable) to adjust stock numbers and how long they can be carried for; Assessment of pasture before and after graze. *Current adoption is moderate (45%).*
- ***Planned removal of livestock to allow recovery and reseed of 3Ps.** Length or duration of pasture spelling is determined (where possible) based on land condition (B condition), pasture residual, seasonal conditions. Set a minimum length of rest and all stock excluded. Paddocks need to be spelled to allow adequate recovery. *Current adoption is low (5%).*
- ***Management of stock access to riparian areas through infrastructure.** Remove grazing pressure during the wet season and grazed during the dry in these areas. These areas are managed independently of the rest of the property. Allow area to rehabilitate and revegetate. Allowing animals to graze these areas in the dry season reduces biomass which in turn, reduces the risk of wildfires in spring/ summer. *Current adoption is moderate (45%).*
- ***Commit to continuous improvement of animal and herd management, GLM, and business management within the Mackay Whitsundays environment.** Rapid upskilling of management for small/large landholders that want to upskill. Address the lack of extension support for small landholders. Directly link to the ABCD MW Grazing Management framework. Limited one-on-one

follow-up and support. Assume implementation of practices following upskilling. *Current adoption is low (15%).*

- **Gully management** (grazing practices, not gully remediation – see Natural Systems Repair) (*specifically relevant within grazing lands for drier areas – north of Proserpine and south of Sarina*):
 - Undertake fencing in stable locations.
 - Establish fencing and water to exclude livestock.
 - Managing grazing impacts in high gully density catchments.
 - Gully management and management of linear features are foundational practices in gully prone landscapes.
- Manage **linear features** by managing impacts from roads, firebreaks, track, fence lines, pipes. E.g. Property planning, road/track repair or realignment, installation and maintenance of whoa boys and drains, culverts or other built crossings.
- Manage erosion from **unsealed roads**:
 - Baseline data established, and monitoring and data sharing processes in place for understanding the contributions from unsealed roads.
 - Minimum best practice standards for road construction, erosion control from unsealed roads are in place.
- **Stabilise and protect frontage country** with actions including riparian area fencing, off-stream watering, streambank remediation (see Natural Systems Repair actions). Riparian revegetation provides additional co-benefits such as shade for animal welfare in intensive heatwaves, shelter belts, landscape connectivity (improved) across land uses – linked to cattle productivity. Minimise erosion when installing infrastructure e.g. fences.
- Vegetated drains, on-farm wetlands, sediment basins and treatment systems (see Natural Systems Repair).

Additional actions related to managing groundcover:

- Managing woody plants to prevent increased density of shrubs and trees, particularly on productive soil types. Increase tree cover on hillslopes.
- Reducing grazing pressure in selectively grazed areas, e.g. fencing, locating water points to even out grazing, and address feral animal control (deer and pigs).
- Fire Management including development and maintenance of fire breaks, and grazing or spelling to manage fuel load.

Dissolved Inorganic Nitrogen

- *See management intervention options for sediment.*
- Undertake best management nutrient management in finishing paddocks as high input paddocks are becoming more common (fattening and fertilised pastures) in the Region. Provide more guidance for nutrient use efficiency in pasture management, e.g. soil testing etc. Current gap in extension and knowledge.
- Potential for increasing use of fertiliser in grazing areas to control (outcompete) [weedy sporobolous grasses](#) (WSG, e.g. rats tail grass). Other management options include holistic weed control including mechanical options (slashing).

Pesticides

- Focus on product selection, rate, and timing of application.
- Adopt an integrated pest management approach.
- Holistic weed control utilising alternative methods not just chemical control e.g. mechanical (slashing).

Urban

Urban areas occupy approximately 3% of the Mackay Whitsunday Region, with the largest area in the Plane Basin (~9,848 ha) followed by the Proserpine (7,047 ha), Pioneer (6,556 ha) and O'Connell (5,001 ha) basins.

Dissolved Inorganic Nitrogen

Urban areas and sewage treatment plants (STPs) are a minor contributor (12%) to the DIN loads in the Mackay Whitsunday region. However, they can contribute disproportionately high levels of pollutants to the local environment per unit area.

Actions for reducing DIN loads:

STP Management options

- Operational improvements through enhanced management practices, staff training, and regular maintenance at existing facilities).
- Potential for failure reduced through effective planning of sewerage network asset management and maintenance activities.
- Technology upgrades offer potential for some facilities, though advanced treatment systems using membrane bioreactor technology may have limited potential for additional nutrient reduction through technology upgrades alone.
- Wastewater recycling and reuse represents a significant opportunity, with increasing treated wastewater reuse potentially reducing dry weather releases and associated nutrient loads. There are large, recycled water storage tanks at Mirani Wastewater Treatment Plant (WWTP), Sarina Water Recycling Facility (WRF) and Mackay South WRF. Treated wastewater is re-used for irrigation during periods of dry weather. Increasing treated wastewater reuse can potentially reduce dry weather releases and associated nutrient loads and reducing demand on groundwater resources.
- Infiltration and Illegal connection management.
- Treatment plant residue management, e.g. reuse of biosolids (dried).
- Ensure new and emerging point source issues are identified and addressed in a timely manner.

Stormwater management

Note that the following actions for stormwater management are also relevant to fine sediment management.

- 'Improved practices in the Urban Water Stewardship Framework are identified for 'Established urban' category. Add stormwater and catchment management in developed urban areas.
- Strategically targeted implementation of Water Sensitive Urban Design including primary treatment measures such as sediment traps, secondary treatment measures such as buffer strips, swales, sand filters and infiltration systems and tertiary treatment measures such as bioretention systems and constructed wetlands. Include source controls for runoff such as rainwater tanks and porous pavement.
- Structural measures:
 - Urban stormwater treatment trains e.g. constructed wetlands, biofilters, vegetated swales, riparian vegetation restoration (see also Natural Systems Repair).
 - Integration with urban development and redevelopment activities.
 - Maintenance of existing infrastructure.
- Non-structural measures, e.g. policy reforms, urban planning regulations and compliance
 - Strategic land use planning and development controls, vegetation retention policies and riparian buffer requirements, and education and capacity building programs for industry and community.
 - Total water cycle management plan (TWCMP) -> Integrated Catchment Management Plan and urban stormwater quality management plan (working together) (into development approval stage for designers to consider reuse and drainage etc.)
 - Site-based stormwater management plans for development

- Integration into treatment trains.
- Retrofitting treatment systems in existing urban areas.
- Riparian vegetation restoration (see Natural Systems Repair)
- Best practice road construction.

Fine Sediment

Urban areas are a minor contributor (1.9%) to fine sediment loads in the Mackay Whitsunday Region. However, they can contribute disproportionately high levels of fine sediments to the local environment per unit area.

Actions for reducing fine sediment loads:

Stormwater management

Refer to DIN actions for stormwater management.

Pesticides

Urban land use is generally considered a lower risk for pesticides compared to other land uses e.g. sugarcane.

Actions for reducing localised pesticide risk:

- ***Reducing pesticide risk through optimising application and chemistry selection.** Aquatic risk of pesticides can be reduced through selecting products of lower toxicity (where possible) and through optimising application timing, equipment and methods.
- Improved wastewater treatment processes, for example, membrane bioreactors, reverse osmosis.

Streambank repair

Streambank is a major contributing erosion process in the Mackay Whitsunday Region, accounting for 77% of the total fine sediment load. The greatest sources of streambank erosion are in the O'Connell Basin (182 kt/yr) followed by the Pioneer (86 kt/yr), and to a lesser extent, the Plane (52 kt/yr) and Proserpine (13 kt/yr) basins.

Streambank rehabilitation activities will be guided by the Neilly Group Report, targeting river reaches that contribute disproportionately high fine sediment yields.

Example actions:

- Riparian vegetation enhancement and planting.
- Buffer zone establishment and weed control.
- Structural interventions such as stream bank fencing.
- Engineered stream bank protection and revegetation, or bed protection and revegetation.
 - Cut/Fill
 - Rock Protection or rock armouring - suited to preventing scour of the bank face in higher energy situations.
 - Timber Pile Fields - involves driving wooden pile (pole) structures to divert fast moving flows away from the bank and provide shelter for vegetation establishment (Figure 105). This reduces riverbank erosion and promotes sediment deposition at the bank toe. Revegetation is then employed to solidify the deposited sediments and increase hydraulic roughness, further slowing down the water velocity against the bank.
 - Log Fillets - trap sediment and reduce near-bank flow velocity, encouraging natural deposition and bank rebuilding.
 - Rock Groynes - are sometimes used in high-energy situations, to deflect high velocity flow away from the bank toe. These also tend to create scour pool habitat adjacent to the end of each groyne.

- Large Wood Placement and Log Jams - involves the placement of large native timber (at least 0.1 meter in diameter and one meter in length) into a river, typically to deflect flow away from the bank. The placement of large wood can enhance habitat, increase hydraulic roughness, and accelerate the increase in geomorphic complexity and diversity beyond the natural rate.

These actions should be guided by the [Queensland River Rehabilitation Management \(QRRM\) Guideline](#) and Gully and Streambank Toolbox.

Gully repair

Gully erosion is a relatively small contributing erosion process in the Mackay Whitsunday Region, accounting for <1% of the total fine sediment load. The greatest sources of gully erosion are in the Proserpine and O'Connell basins.

- Gully erosion control measures will follow best practices, focusing on cost-effective treatments in sub-catchments with the high sediment yield and the potential to implement complementary land management practices. Where economically feasible, a cluster approach will be used to treat multiple gullies simultaneously, ensuring landscape-scale impact.
- These actions should be guided by the [Gully and Stream Bank Toolbox](#)^c

Example actions:

- Improving grazing management in gully catchments
- Fence to control livestock access to gully sites
- Porous check dams
- Gully runoff diversion banks and drainage management
- Gully head rock chutes
- Gully reshaping and revegetation
- Gully reshaping and rock capping

Wetlands

Survey wetland condition and validate wetland pollutant hazard assessments and where required, apply appropriate management response. This may include coordinating interventions and activities to enhance wetland values, condition, and water quality improvement and ecosystem service functions, for example:

- Interventions that improve hydrological integrity, manage pest species and safeguard native vegetation, strengthen riparian buffers and minimise pollutant inflows (see actions for DIN, fine sediment and pesticides).
- Assessing the feasibility of using constructed wetlands or treatment systems to improve water quality while maintaining natural wetland values across a range of land use activities.
- These actions should be guided by the goals, objectives and activities in the [Reef 2050 Wetlands Strategy](#).
- Manage the potential risks to natural wetland areas from ponded pastures which are a significant issue for management of Weeds of National Significance (e.g. hymenachne and elephant grass). Common problem in Goorganga wetlands and Tedlands.

Management actions for wetlands include:

- **Safeguarding or re-establishing native vegetation:** Protect existing native vegetation and /or re-establish vegetation, including grasslands, woody grasslands, and other woody vegetation, both within wetlands and their buffer zones. This also involves maintaining the structure and composition of the remnant regional ecosystems and preventing the introduction, establishment, or spread of exotic vegetation, re-establishing connectivity from wetlands extending to the broader landscape and avoiding vegetation clearing in and near wetlands.
- **Maintaining or reinstating hydrological integrity:** Preserve or reinstate the natural flow of floodplains, the hydrological connectivity of wetlands, and their natural water regimes. This includes

minimising or reducing water abstraction for human or animal use and preventing further hydrological modifications such as bunding, excavation, drainage, and irrigation activities. Additionally, impacts from existing hydrological modifications should be mitigated, and the development of linear infrastructure of wetlands avoided or mitigated where it can impact a wetland.

- **Preventing, controlling and reducing spread of exotic and invasive species:** Protect wetlands and their buffer zones from the introduction, establishment, and spread of plant and animal pest species, as well as exotic plants.
- **Minimising and controlling pollution:** Safeguard against anthropogenic sedimentation, pesticide inflows, and excessive nutrient inflows. Prevent the introduction of stormwater and other point source inflows into natural wetlands, regularly maintaining existing septic systems and new septic installations should avoid proximity to wetlands.
- **Minimising and/or reducing soil disturbance:** Minimise, control and reduce ungulate access and human activities that disturb and expose the soil surface in wetlands and their buffer areas. Ensure that groundcover is maintained to protect the soil. Based on these foci, more specific management actions aligned with the condition indicators used in the wetland assessment are detailed in Appendix 8.
- Other intervention options to **improve wetland condition** for water quality improvement and other ecosystem services may need to be considered (based on condition and values assessment).
 - Plan and implement programs to safeguard against introduction of stormwater and /or other point source inflows to wetlands within monitored aggregations.
 - Plan and implement programs to safeguard against anthropogenic nutrient and pesticide inflows into wetlands within monitored aggregations, for example through best management practices
 - Safeguard against anthropogenic sedimentation of wetlands within monitored aggregations, for example through retention of vegetated buffers and prevention and management of soil erosion.
 - Reduce and/or prevent ungulate access and human activities that disturb and expose the soil surface in wetlands and their 200 m buffers.
 - Reduce and/or prevent ungulate access to wetlands within monitored aggregations(S8)
 - Prevent introduction, establishment or spread of exotic plants, in the 200 m buffers of wetlands within monitored aggregations.
 - Safeguard against anthropogenic pesticide inflows into wetlands within monitored aggregations, for example through best management practices targeting pesticides.

Riparian vegetation loss and wetland loss, Connectivity and Marine ecosystems

Refer to actions in the Basin Water Quality Improvement Strategies.

Appendix 2: Diagnostic tool for guiding program delivery

Guidance

This framework supports the design of targeted, evidence-based delivery strategies by identifying the barriers preventing adoption and the enablers that can be built upon. Rather than applying generic approaches, it uses the Behaviour Change Wheel (Michie et al., 2011) to match specific delivery strategies to diagnosed barriers within the target audience.

The COM-B model identifies three components that can enable or be barrier to adoption:

- **Capability** – the physical and psychological ability to perform the behaviour, including having the necessary knowledge, skills, and confidence.
- **Opportunity** – the physical and social environment that enables the behaviour, including access to resources, infrastructure, time, and supportive social norms.
- **Motivation** – the reflective and automatic mechanisms that activate or inhibit behaviour, including beliefs about consequences, intentions, goals, habits, and emotional responses.

For a land manager to adopt a management response, all three components must be sufficiently present. Understanding which component(s) represent the primary barrier to adoption enables program designers to select the most appropriate delivery strategies.

Note: This framework provides general guidance and should be used in conjunction with local knowledge and direct engagement with target land managers wherever possible. Where direct engagement is not feasible, program designers can draw on existing research and monitoring to inform their understanding of land manager capability, opportunity, and motivation. Key sources for the agricultural sector can be sourced from the Social Monitoring program (as part of the Paddock to Reef program and the Office of the Great Barrier Reef and World Heritage), for example: **The Perceptions of Practices survey (Paddock to Reef program)** – measures capacity, opportunity, and motivations of landholders engaged in water quality programs to adopt targeted practices as described in the Water Quality Risk Frameworks.

Social Monitoring Benchmarking survey (Office of the Great Barrier Reef, DETSI) – a biennial survey that benchmarks the broader regional agricultural community, including both program participants and non-participants, using constructs aligned with the Perceptions of Practices survey.

For the urban sector, very little is known about the factors influencing adoption of improved practices (Murray-Prior et al., 2024). Direct engagement with urban land managers and stakeholders will be essential to inform program design in this context.

Diagnostic tool for guiding program delivery

STEP 1	STEP 2	STEP 3	STEP 4
Define the Target Behaviour	Determine the Response Category	Conduct COM-B Diagnostic	Select & Scale Strategies

Step 1: Define the Target Behaviour

Clearly define the specific behaviour or management response you want land managers to adopt:

- **WHO** needs to do the behaviour? (Target audience – agricultural landholders, urban land managers, councils, etc.)
- **WHAT** specifically do they need to do? (The specific management response from the Water Quality Risk Frameworks)
- **WHERE** will this occur? (Basin-specific context and priority areas)

Step 2: Determine the Management Response Category

Based on the pollutant exposure likelihood for the basin (as determined in the Regional Water Quality Targets), identify the appropriate Management Response Category. This determines the intensity and scale of your program:

Category	Exposure	Scale	Strategy Mix & Intensity
Foundational	Minimal	Region-wide, baseline/minimum standard	1–2 strategies, lower intensity
Proactive	Low	Local-scale, preventative actions	2–3 strategies, low-medium intensity
Accelerated	Moderate	Sub-catchment targeted to impact	3–5 integrated strategies, medium intensity
Intensive	High	Comprehensive, large scale, across multiple land uses	All strategies, maximum intensity

Use the following checklist to identify the primary barriers preventing adoption of the target behaviour. This diagnosis will guide your selection of delivery strategies in Step 4.

a) CAPABILITY Assessment

- ☐ Do they have the necessary knowledge about water quality and impacts?
- ☐ Do they have the skills to perform the management response?
- ☐ Do they have confidence in their ability?

b) OPPORTUNITY Assessment – Physical

- ☐ Is the necessary infrastructure available?
- ☐ Are resources (time, money) accessible?
- ☐ Is appropriate technology available?

c) OPPORTUNITY Assessment – Social

- ☐ Do they see others performing the behaviour?
- ☐ Is there community/peer support?
- ☐ Do they trust the science and delivery organisations?
- ☐ Are there positive social norms around the practice?
- ☐ Do local leaders model the behaviour?

d) MOTIVATION Assessment – Reflective

- ☐ Do they believe the action is important?
- ☐ Is it aligned with their identity/values?
- ☐ Do they see economic benefit?

e) MOTIVATION Assessment – Automatic

- ☐ Are existing management practices (i.e., habits) aligned or conflicting?
- ☐ Is there fear or anxiety about change?

Step 4: Delivery Strategy Matching Matrix

Based on your diagnostic assessment, match barriers to appropriate delivery strategies. The *number* of strategies and *intensity* of investment should be scaled according to the Management Response Category determined in Step 2.

COM-B Component	Primary Barriers	Recommended Strategies
CAPABILITY BARRIERS		
Lack of knowledge	Don't understand impacts	Knowledge & awareness
	Unaware of options	Knowledge & awareness + Decision support
Lack of skills	Can't perform practice	Capacity
	Can't use tools/technology	Technology & equipment + Capacity
PHYSICAL OPPORTUNITY BARRIERS		
Resource constraints	Can't afford change	Incentives & markets
	Lack time	Technology + Decision support
No/expensive infrastructure	Missing equipment	Technology & equipment
	No market access	Incentives & markets
SOCIAL OPPORTUNITY BARRIERS		
Negative norms	"No one else doing it"	Social norms & Trust
Lack of trust	Distrust science/orgs	Social norms + Knowledge & Awareness
REFLECTIVE MOTIVATION BARRIERS		
Low importance	"Not my problem"	Knowledge & Awareness + Social norms
Low confidence	"Too complex"	Capacity + Decision support
Economic concerns	"Not profitable"	Incentives & Markets + Decision support
AUTOMATIC MOTIVATION BARRIERS		
Established habits	Long-standing practices that don't align	Social norms + Technology
Risk aversion	Fear of change	Social norms + Incentives

Example 1: Sugarcane – Switching to Lower Risk Products for Pesticides - as part of an Accelerated Response for pesticides

Target Management: Transition from higher-risk pesticides to lower-risk alternative products

COM-B Diagnosis:

- Capability: Limited knowledge of alternative products and their efficacy
- Opportunity: Some alternative products may be more expensive; need access to application guidance
- Motivation: Concerns about pest control effectiveness; uncertainty about impacts on yield

Matched Strategy Package:

1. Knowledge and awareness: Local trials and demonstrations to improve advisor and grower confidence in efficacy of alternative products.
2. Capacity building: Offer advisors training in the assessment of aquatic risk associated with different chemistry and the importance of timing.
3. Decision support: Product selection guidance; Pesticide Decision Support tool (Pesticide Projector)
4. Social norms: Grower networks sharing experiences with alternative products

Example 2: Streambank – Revegetation in the Riparian Zone as part of a Proactive Response for response for sediment

Target Management: Establish and maintain native vegetation in riparian zones to stabilise streambanks

COM-B Diagnosis:

- Capability: May lack knowledge of appropriate species selection and planting techniques
- Opportunity: Time and labour requirements; fencing costs to exclude stock
- Motivation: Concerns about loss of productive land; long timeframes before visible results

Matched Strategy Package:

1. Knowledge & awareness: Information on benefits of riparian vegetation for bank stability and water quality
2. Capacity building: Training on species selection, site preparation, and ongoing maintenance
3. Incentives: Access to small grants for fencing and planting materials

Example 3: Stormwater Treatment Interventions in Urban Areas – as part of an Accelerated Response for DIN management

Target Management: Install and maintain stormwater treatment systems (e.g. biofilters, vegetated swales)

COM-B Diagnosis:

- Capability: Limited technical expertise in design, installation, and maintenance of treatment systems
- Opportunity: High capital costs; competing budget priorities; land availability constraints; unclear responsibilities between councils and developers
- Motivation: Uncertain about long-term effectiveness and maintenance burden; water quality may not be seen as core business

Matched Strategy Package:

1. Knowledge & awareness: Technical guidelines and case studies demonstrating water quality outcomes

2. Capacity building: Training for council staff, developers, and maintenance teams in design and upkeep
3. Decision support: Design tools, maintenance scheduling resources
4. Incentives: Co-funding for demonstration projects; developer incentives for incorporating treatment systems

Example 4: Grazing – Improving herd efficiency as part of an Intensive Response for sediment management

Target Management: Improving herd efficiency to enable land condition improvement.

COM-B Diagnosis:

- Capability: Varying levels of knowledge and skills
- Opportunity: Ecosystem markets
- Motivation: Small profit advantage; perception of small environmental advantage

Matched Strategy Package:

1. Knowledge & awareness: On farm trials, field days, demonstration sites, one-on-one engagement.
2. Capacity building: Computer literacy training, focused extension strategy to promote herd efficiency outcomes.
3. Decision support: Extension support for property level economic analysis
4. Incentives
5. Social norms: Champion farmer network; grower-to-grower learning networks



Get involved

To find out more about the Mackay Whitsunday Regional Water Quality Strategy, or to connect with delivery programs in your area, contact Reef Catchments.

Phone: (07) 4968 4200

Website: reefcatchments.com.au



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Prepared by Rachael Smith, Jane Waterhouse, and Katie Sambrook (C2O Consulting, [coasts|climate|oceans](#)) and Tracy Schultz (University of Queensland), in collaboration with Reef Catchments Mackay Whitsunday Isaac.

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