Queensland
REEF WATER
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Program

Queensland Reef Water Quality Program

Annual Investment Report 2019–2020

Queensland
Government

#32193

Contents

Introduction

The Queensland Reef Water Quality Program (QRWQP) is the Queensland Government's key response to addressing water quality impacts affecting the Great Barrier Reef. It delivers activities as part of implementing the Reef 2050 Water Quality Improvement Plan 2017–2022 (Reef 2050 WQIP) which supports the water quality theme of the Reef 2050 Long-Term Sustainability Plan (Reef 2050 Plan).

In 2017–2018, a new five-year Investment Plan 2017–2018 to 2021–2022 was developed outlining the delivery of the Queensland Reef Water Quality Program (available online at www.qld.gov.au/environment/coasts-waterways/reef/reef-program).

This annual report covers activities and investments for the 2019–2020 year of the five-year investment plan.

The Office of the Great Barrier Reef (OGBR) in the Department of Environment and Science (DES) is responsible for overseeing the Queensland Reef Water Quality Program, working with the other DES divisions, the Department of Resources (DoR) and the Department of Agriculture and Fisheries (DAF).

Program investment

The five-year Investment Plan 2017–2018 to 2021–2022 detailed $78.22 million to deliver projects and activities in 2019–2020. During the 2019–2020 year, $58,213,851 was expended across the program.

Planned investment against actual expenditure is shown in the following investment table.

The total in the table that follows differs from the amount shown above because of additional co-contributions provided by partner agencies.

The QRWQP Investment Plan for 2020–2021 will detail the planned investment for the coming financial year.

Measuring success

The program was delivered through two work areas, aligning to the structure of the Reef 2050 WQIP: Responding to the challenge, and Enabling delivery (see Figure 1). The following investment tables, report activity progress against these areas.

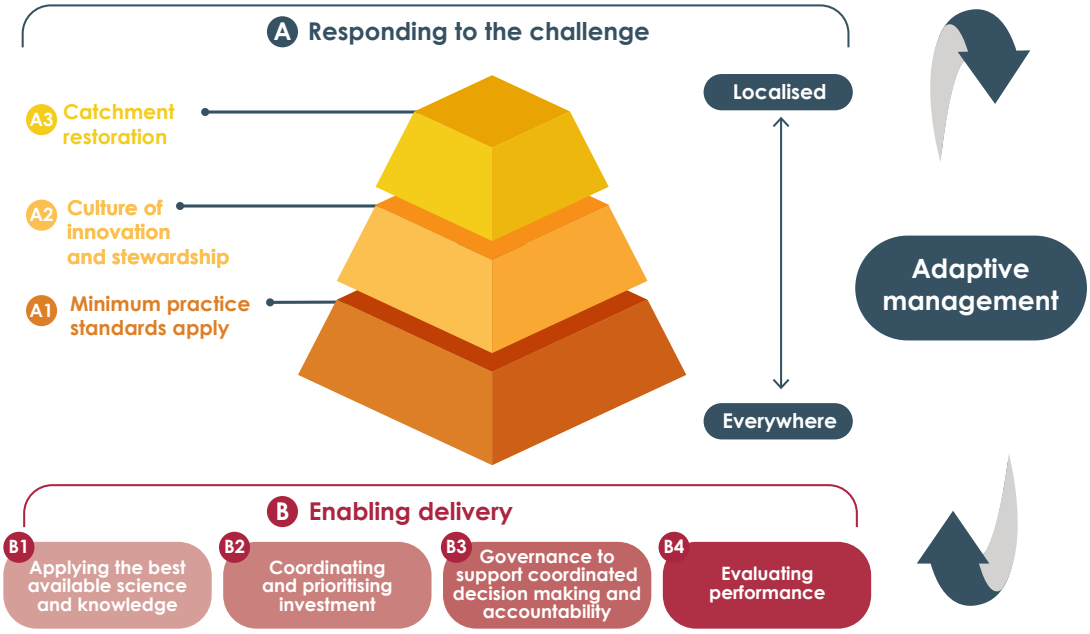

Figure 1: Implementing Reef 2050 WQIP

(Reference: 2018, State of Queensland, Reef 2050 Water Quality Improvement Plan 2017–2022 www.reefplan.qld.gov.au/about/)

Funding categories

Annual: Queensland Government annual funding

Additional: Additional funding over five years, supporting the Great Barrier Reef Water Science Taskforce recommendations

Co-contributions: Includes funding from:

- an existing departmental program that supports Reef water quality work
- as part of a broader state program where funding can be clearly separated into Reef regions
- as part of a state program where an approximate funding allocation is made for Reef regions achieving Reef 2050 WQIP targets.

Investment table

Acronyms

DAF: Queensland Department of Agriculture and Fisheries; DES: Queensland Department of Environment and Science; DNRME: Queensland Department of Natural Resources, Mines and Energy; GBR: Great Barrier Reef; OGBR: Office of the Great Barrier Reef; QRWQP: Queensland Reef Water Quality Program

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
Responding to the challenge: actions to progress towards targets							
Minimum practice standards							
1.1 Implement minimum practice standards for agricultural industries, which can be met either voluntarily, e.g. through industry-led best management practice (BMP) programs or as a result of regulation.	Support to voluntary industry-led BMP programs in sugarcane, grazing, grains, and banana industries, including continual improvement of BMP modules, benchmarking of producer's operations and accreditation to industry standard.	$8,291,720	$7,258,598	Annual	DES	This program includes banana, cane, horticulture, and grazing industries and pesticide monitoring and risk management. Banana – this project includes benchmarking of new growers against the Banana BMP, re-benchmarking existing participating growers and developing an Accreditation Scheme to enable recognition under the Environmental Protection Act. Sugarcane - phase 3 of the Smartcane BMP project. Emphasis is placed on practice change, providing data to Paddock to Reef, benchmarking growers' practices and achieving accreditation, with a strong focus on progressing growers that have completed benchmarking, to achieve accreditation. Grazing - support the transition of graziers and cane and banana growers to improve practices through access to professional advice. Validating the economics of management practices that improve water quality and providing this information to landholders in decision support tools and as part of the extension program. A new program Grazing Resilience and Sustainable Solutions (GRASS) began in late 2019. Hort360 - sets out to promote and deliver horticulture best management practices across GBR catchments, to deliver environmental sustainability and Reef water quality outcomes relating to the reduction in sediment, pesticides and nutrient loads from horticultural lands. Managing pesticide risk in priority Great Barrier Reef catchment areas - provides education, extension and compliance activities to support growers to adopt best	Banana • Land managed under the Banana BMP increased during the reporting period. At the end of June 2020, the area of land benchmarked in Reef catchments under Banana BMP is approximately 86.8% (9,631 ha). • New grower BMP targets were not met however, grower re-benchmarking exceeded the target by over 200%. Future targets will focus on larger properties previously engaged. • The development of an Accreditation Scheme is progressing. • The nutrient trials project steering committee (PSC) formed in April 2020, which includes local banana growers. First year plant data has been collated and presented to the PSC. The final two commercial farm trial sites have been installed - one in Tully and one in Upper Darragee. • The first wet season of pesticide monitoring priority basins in the Wet Tropics has shown high concentrations of pesticides in waterways. Data is being finalised for communication to stakeholders. Sugarcane • Phase 3 of the project has seen a sharp increase in growers achieving accreditation. As at July 2020, 16% of cane businesses (29% of cane land in reef catchments) are accredited as at or above best practice. Paddock to Reef reporting commenced in 2019 with a small number of growers consenting to provide data, with this number gradually increasing. Grazing • GRASS NQ Dry Tropics (NQDT). 20 producers have completed GRASS Action Plans for Land Management (APLM) in North Queensland dry tropics, and 21 incentive projects (combined NQDT and DAF) are contracted. A further 15 producers have signed up to DES's acknowledgement framework, formally confirming landholder participation in the project. • GRASS DAF. 53 plans were completed across Fitzroy, Burdekin and Burnett Mary catchments. Land Management Plans are being developed with incentive applications being assessed by Natural Resource Management (NRM) groups.

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						practice chemical use practices and comply with the Chemical Usage legislation.	• GRASS Fitzroy Basin Association (FBA). FBA Land Management Officers have engaged 50 property owners and developed 24 APLMs. 14 on-ground incentive projects are contracted. Hort360 • A new project supporting horticultural producers in Reef catchments was launched in partnership with industry. Land managed under the new Hort360 BMP GBR project was increased and a certification pathway for growers to demonstrate best practice in horticultural production commenced. Managing pesticide risk in priority GBR catchment areas • The project focus is on high priority reef catchments including Plane Creek (very high) and Haughton River (high) catchments located in the Burdekin. Approximately 80 growers identified several areas for improvement specific to the use of agricultural chemicals, including adoption of mandatory record keeping requirements and adhering to product label instructions. Discussions between DAF and CANEGROWERS have also led to agreement for a collaborative review of the industry best management practice program (Smartcane), to ensure better alignment with regulatory requirements.
	Proposed changes to the Reef regulations of the *Environmental Protection Act 1994*. Reef regulation implementation.	$1,846,503	$2,051,630	Additional	DES	*Reef regulations implementation* The package of regulatory reforms includes setting pollution load limits for each Reef catchment to target water quality responses, setting minimum practice standards for key industries such as sugarcane, beef cattle grazing and banana production, setting standards for the provision of professional advice to regulated producers, establishing a framework to recognise industry best management practice programs and accredited producers and countering residual pollution from new cropping and industrial development through requirements to have an environmental authority. *Erosion and sediment control capacity building* The project seeks to deliver a range of activities to build the capacity of those in local councils and the building and land development sectors to implement best practice erosion and sediment control and urban stormwater management. *Improved nutrient offsetting by comparing nutrient characteristics* Nutrients enter waterways via stormwater, industrial and agricultural run-off, soil erosion, and treated effluent released from wastewater treatment plants. This project is to develop a nutrient equivalency indicator to compare	*Reef regulations implementation* Amendments to the Environmental Protection Act 1994 were passed by Parliament on 19 September 2019 to renew the Reef water quality regulatory protection measures. The Environmental Protection Regulation was also subsequently amended and new regulated minimum practice standards were set for sugarcane, grazing and bananas. Amendments were also made to regulate new cropping and horticulture activities. The amendments commenced on 1 December 2019, with minimum practice standards for sugarcane and basic record keeping taking effect immediately. Minimum practice standards for bananas and grazing and other measures will roll out progressively over three years based on priorities for water quality improvement. Information sessions about the Reef protection regulations were held in late 2019 and in 2020. *Erosion and sediment control capacity building* With the support of DES, Healthy Land and Water (HLW) delivered two community of practice events that brought together key stakeholders from across the Reef catchment; worked in-depth with three local governments to improve their stormwater and erosion policies and practices; hosted two field days to improve erosion and sediment control compliance; developed an online training portal with six digital training sessions held; developed five educational videos; delivered two co-design training workshops; supported the update of two Development Manuals; and provided ongoing expert support to local governments.

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
						nutrient characteristics of these different nitrogen sources. *Water quality credit trading* This research project considers whether trading in water quality related emissions can cost-effectively offset emission increases from new development and develops a potential framework for nutrient and sediment emission trading. It was part funded by the Australian Government through the National Environmental Science Program.	*Improved nutrient offsetting by comparing nutrient characteristics* • Produced a discussion paper to identify nutrient offset science and policy gaps entitled 'Scientific knowledge and decision support gaps relating to the Point Source Water Quality Offsets Policy and draft Guideline'. • Produced a technical report that summarises bioassay methodology improvements and preliminary findings on explanatory metrics for nitrogen equivalency, 'Improved nutrient offsetting by comparing nutrient characteristics'. *Water quality credit trading* Final report submitted, 'Exploring trading in water quality credits as a cost-effective approach for managing water quality in the Great Barrier Reef'.
	Build compliance capacity for erosion and sediment control during urban, industrial and infrastructure construction and maintenance.	$0. Completed.		Additional	DES		
	Data and project management system for Reef projects.		Part of Reef regulation implementation	Additional	DES	Development and implementation of the CORAL Data System to improve project management and data accessibility.	• Performed a Security Assessment of the System operating in the QCIF hosted environment, provided a report with the findings, and recommended actions for identified risks and issues from the security review. • Customisation and enhancement of the CORAL application based on defined packages of functionality selected from the High Level Requirements document. • Completed development, testing and implementation of nine defined packages of work, with no significant defects and operational issues. Functional capabilities implemented include: - The capture and viewing of profile, descriptive and activity data about each project. - The capture and access to agreed data sets relating to project activities. - Analysis, understanding, assessment and evaluation of project activities, outputs and outcomes. - The capture and access to project background documents and supporting material in a data repository. - The capture and management of project plan information, including delivery approach, key evaluation questions, milestone and payment data and risks and issues. - Project monitoring and reporting by project managers; and - Program (portfolio) management operations and reporting of the QRWQP programs and projects.
	Enhance integration of data and use the Water Tracking and Electronic Reporting System (WaTERS) to capture point source	$0.	$71,215	Additional	DES	This investment aims to enhance the accuracy of predicting the nutrient loads from point source activities, and which GBR catchments are most likely affected. This	A draft final project report was provided for consultation to local governments, industry associations and key stakeholders in November 2019. Consultation feedback has been incorporated into the draft

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	release monitoring and tracking data online for Environmentally Relevant Activities (ERAs).					information can be used to fine tune and inform alternative management/treatment strategies for nutrient-related point source activities, resulting in reduced nutrient loads to the Reef.	report and the final report will be peer reviewed and made publicly available during 2020-21. The draft report and findings will inform development of a Stage 3 proposal for priority point source activities, particularly aquaculture.
	Targeted compliance program under the *Environmental Protection Act 1994*.	$2,082,001 $100,000	$1,489,791	Annual Additional	DES	Delivery of this program is an identified action under the Reef 2050 Water Quality Improvement Plan. It aims to drive increased uptake of minimum practice standards by sugarcane growers through compliance with Reef protection measures under the *Environmental Protection Act 1994*. The compliance program also provides an incentive for growers to increase participation in voluntary best management practice (BMP) and practice change programs. Inspection results continue to show a positive trend of increased compliance rates with regulations after compliance visits and increased uptake of voluntary practice change programs.	The program delivered 66% (218) of the target compliance activities for the year: 78 in the Wet Tropics catchment, 58 in the Burdekin catchment, and 85 in the Mackay Whitsunday catchment. Remaining activities scheduled for March to June 2020 were postponed due to COVID-19 response measures, resulting in a lower number of activities this financial year. The program also prepared for and commenced compliance activities against amended Reef protection measures that came into effect on 1 December 2019. Approximately 12% of growers contacted were compliant with the regulations at initial engagement across the three catchments; with a further 14% involved in a practice change program and 14% BMP accredited. At follow-up engagement, compliant growers had increased to 28%, and those involved in a practice change program increased to 21% and BMP accredited growers increased to 17%.
	Transition program to support the sugarcane, grazing and banana industries in Reef catchments to transition to new minimum standards.	$10,147,019	$317,157	Annual	DES	The Farming in Reef Catchments Rebate Scheme administered by the Queensland Rural and Industry Development Authority (QRIDA) provides eligible graziers and sugarcane and banana growers with a $1000 rebate for expert agronomic advice to support transition to new regulated, commodity specific minimum practice standards.	There are 66 Accredited Agricultural Advisers registered with QRIDA for the provision of agronomic advice. As the Reef regulations recently came into effect on 1 December 2019 and roll out over three years, access to the scheme is expected to increase with the new requirements for bananas in the Wet Tropics and grazing in the Burdekin region commencing on 1 December 2020. The majority of funding was deferred to 2020-21 due to the timing of the commencement of the legislation.
	Banana Nutrient Rate Trials (RP191)	$493,000	$414,000	Annual		The Banana nutrient rate trials aim to provide a robust scientific basis on which to judge how the proposed regulated minimum standards will affect current banana production from a research perspective and within a commercial setting. They are assessing if optimum banana bunch size and economic return are possible using the minimum standard nutrient rates within commercial production systems, consistent with normal production timeframes, and based on conventional crop management production practices. Replicated banana field nutrient trials will assess the agronomic performance of specific nutrient management treatments primarily focused on nitrogen with a secondary focus on phosphorus. Soil and water nutrient levels in conjunction with leaf nutrient testing results will be used to underpin crop growth, marketable yield, and economic performance analysis in both the initial plant and two subsequent ratoon crops.	During 2019-2020 collection of intensive on-station trial data has occurred on banana plant crop and ratoon crop performance under a range of nitrogen (N) application rates. In addition to the work at the South Johnstone Research Facility, three collaborating banana producers are now conducting nitrogen rate comparisons at on-farm trial sites. Regular monitoring that is comparing agronomic differences of nitrogen rates against normal farm operations is underway. Project stakeholders including Australian Banana Growers Council and industry reference growers meet regularly to ensure key aspects of the trial such as fertiliser application, crop productivity measures and water quality monitoring is meeting industry guidelines and needs. The trials are currently due to conclude June 2022, though the potential to extend this until December 2022 is being explored. This will allow additional ratoon crop data to be developed and provide industry with greater confidence.

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Culture of innovation and stewardship							
2.1 Support land managers and industries to adopt improved management practices, e.g. through coordinated extension, education and awareness programs.	Extension and education						
	Boost extension resources, providing greater access for farmers to extension services to enable greater practice change in Great Barrier Reef farming communities and building long-term capacity in the advisory services.	$2,000,000	$4,192,000	Additional	DAF	This program includes • Grains Extension Support, including management practice program improvement. • Grazing Extension Support across GBR catchments with the support of government extension and technical advisers directly supporting Queensland Government-funded program delivery. • Sugarcane Extension Support. Realigned extension support program to focus on the whole-of-farming system approach. • Extension support to vegetable and other small cropping industries in Reef catchments (e.g. Bowen vegetable industry). • DAF Reef Water Quality program oversight and support, and BMP communications contracts.	Grains Extension Support • 186 grain growers (farming 304,902 hectares of land) and 72 other interested parties were engaged in 13 project activities during 2019-2020, with the average area of grain production managed by producers at each event being 37,705 hectares. • Activities focused on the importance of stubble management, paddock layout and design and soil conservation processes to limit sediment movement from paddocks into waterways. • 73% of attendees indicated increased confidence in making management decisions following their attendance. • 85% of attendees stated that participation in the events encouraged them to think about making a change on their property and 53% were planning changes in the next 12 months. • 38 enterprises (49,913 hectares) across the Fitzroy, Burnett and southern Burdekin catchments recorded practice benchmarks, with practice change reported for 14 enterprises. Grazing Extension Support • The project has influenced management decisions on approximately six million hectares of extensive grazing land during the 2019-2020 financial year in the Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary catchments. • 671 businesses were engaged in project activities, and 414 beef properties were mapped for input into the Paddock to Reef monitoring framework. • 94% of producers engaged in DAF activities reported an improvement in knowledge and skills. 53% indicated they were highly to very highly likely to make a management practice change within 12 months. • 30 graziers from a previously commissioned practice change survey participated in an independent longitudinal survey. 97% attributed their current skills and knowledge, at least in part, to DAF activities. 93% of the graziers surveyed had continued to use the management changes made in their businesses. Sugarcane extension support • 1,149 sugarcane producers were engaged in DAF extension activities, exceeding the target of 500. This interaction resulted in a 94% improvement in producer KASA (Knowledge, Aspirations, Skills, Attitude). 93 growers, managing 7100 hectares, made practice change because of DAF's engagement. • DAF's promotion of crop diversification and introducing legumes into the cane farming system for productivity and sustainability benefits has seen strong growth in mung bean and soybean
	Including extension and education activities targeted at adoption of voluntary industry-led BMP programs.	$3,130,000		Annual	DAF		

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							production in sugarcane growing areas. Peanuts were also successfully cultivated in the Burdekin - not a traditional crop for this region. • The project is utilising Unmanned Aerial Vehicle (UAV/drone) capability to support industry capacity building programs including the Wet Tropics Major Integrated Project and the Wet Tropics Sugar Industry Partnership. • DAF is leading the drive to improve industry understanding of pesticide modes of action, and application technology through a series of workshops and extension activities. Independent assessment indicates an 82% impact on producers improving their pesticide management practices. Extension support to vegetable and other small cropping industries • The first major data sets on potential nitrogen losses via deep drainage leaching in avocado production systems of Burnett Mary catchment and the use of cover crops during the wet season to increase groundcover, reduce nutrient losses, and enhance soil organic matter in Qld Dry Tropics horticulture systems were produced. Data will be developed and analysed to provide industry with verified best management practice options for reduced off-farm water quality impacts. • Replicated trials for small vegetable production systems showed reductions in conventional rates of pre-plant nitrogen fertiliser improves marketable yield and reduces nitrogen losses to deep drainage, a win for both the producer and water quality. • Grower-led trials in the pineapple industry showed no difference between high, medium and zero pre-plant fertiliser rates on crop establishment, yield and fruit quality when soil tests show adequate nutrient availability. The implications are that decision-making based on soil test results and foliar fertiliser programs avoids the need for soil applied fertilisers and reduces nutrient losses to surrounding water bodies. • A trial of an edge-of-field bioreactor in pineapples (Burnett Mary) installed by landowners showed that it was cost effective for removing nitrate from groundwater moving from the farm into adjacent freshwater environments. • Grower-led trials of macadamia nut diversion netting enhanced yield and harvest efficiency while reducing soil disturbance and the potential for water quality impacts. • Tree cropping industries (macadamia and avocado) have approached DAF to commence work to prepare them for emerging regulations/minimum standards - this has been developed into a internal proposal for consideration.

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							Program oversight and support • A collaboration with regional NRMs in 2019-2020 identified local extension provider communication and engagement training needs. Six training workshops across the Reef regions attended by 115 extension professionals. Training topics included developing trust, dealing with negative stakeholders, photography, understanding social and emotional cues, public speaking, active listening, and engagement that is more effective. • An independent review of the monitoring and evaluation of DAF Reef extension was undertaken. It established new performance indicators, aligned to six new contribution categories for measuring and reporting the impact of Reef extension activities. Seven case study extension projects highlighted the diversity and reach of extension. Monitoring and reporting of Reef extension activities will improve by articulating the different extension contribution categories and how these contribute to enabling practice change and water quality improvement. • A new Customer Relationship Management system was developed and trialled to improve recording and monitoring of interactions with clients and their pathways to practice change. • An external review of DAF's Reef Program governance arrangements was undertaken and the implementation of the new framework to improve program governance is in progress.
	Enhanced education and extension coordination to support large scale land management practice change through: • stakeholder engagement to achieve practice change • a review of current extension and education approaches • development of a three-year program plan and implementation strategy • developing a framework for education and extension. Pilot an agriculture capacity building program focusing on extension training networks and interns.	$3,671,000	$2,999,000	Additional	DAF	Enhanced Extension Coordination in GBR This project is delivering a training program to address the high priority extension and technical skill areas identified from the training needs analysis and regional extension plans.	• The Enhanced Extension Coordination in GBR project is the first time extension networks have been specifically coordinated across the entire GBR catchment and formally integrated into implementation planning. The project has extended the previous approach to extension coordination and substantially enhanced the collaborative arrangements between extension providers, establishing a cohesive and better informed regional and cross-regional extension network. • The project has operated across all 35 GBR catchments. Seven Regional Extension Coordinators (RECs) were appointed across the six NRM regions, five hosted in NRM organisations and two in DAF. The RECs have coordinated extension delivery and enhanced communications and information sharing through facilitating 11 industry-focused regional extension working groups, made up of active representatives from over 58 extension service provider organisations. Coordinators have co-developed seven Regional Extension Plans (REPs). • The project has been highly successful in identifying the key players in the fragmented Reef extension system, comprising over 100 different organisations, and has established strong links with industry and other government programs. It has provided a new framework to implement effective collaboration, which the RECs

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							proactively use to facilitate collaborative approaches to address priority water quality issues in the regions. The RECS increased formal linkages and support cross-regional and cross-industry links and coordination in extension programs. • The seven REPs provide a detailed review of regional water quality projects across the GBR catchments. A situation and gap analysis identifies regional priorities, gaps and barriers that may impede the on-ground roll out of Reef projects and opportunities to address these gaps through a more collaborative approach and through strategic investment. • The project has empowered local decision-making, established local ownership of REPs and developed transparent and collaborative systems and processes to prioritise project activity. The need to prioritise projects provided a strong purpose for regional stakeholders to meet, consider local needs and be in a position to address those needs. The input of local knowledge has resulted in projects that better meet producer needs and make greater use of innovative extension approaches to help achieve GBR water quality targets. • More than 100 projects addressing priorities identified in the REPs were supported and funded. They included 26 small 'Flexible' projects addressing local priorities and five larger co-designed collaborative projects, and 23 producer peer-to-peer learning groups to undertake 22 projects. As well as direct benefits, e.g. facilitating greater adoption of cover crops, more efficient irrigation practices or improved pasture management, these projects engage local producers and are primers for involvement in other Reef programs. The ability for the RECs to be able to provide funding to add value to regional activities and fill gaps has proven to be critical to the effectiveness of their role in providing extension coordination and collaboration across projects and stakeholders. • 47% of 120 extension staff interviewed as part of the project evaluation had been involved in a regionally funded activity – reporting significant impacts on collaboration, delivery efficiency and reach to include producers not covered through other project funding. Almost 80% said that it enabled a needed activity that would not otherwise have been possible.

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	Capacity building of Reef extension practitioners Key objectives: • Improve the professional capacity of the extension network through undertaking a training needs analysis, identifying professional capacity challenges, and working collaboratively to address them • develop a training framework and develop and source training material for core Reef extension skills • develop a mentoring framework for early career extension officers • establish a formalised network of Reef extension deliverers, and support opportunities for career development of extension officers.	$599,000	$525,000	Additional	DAF	This project is delivering a training program to address the high priority extension and technical skill areas identified from the training needs analysis and regional extension plans.	This capacity building project has been highly successful at building the capacity and skills of 335 extension practitioners from 80 different organisations. A training needs analysis was conducted with over 160 respondents identifying their high priority skill requirements. Based on those results, 11 training programs were delivered during the last 12 months. In total 44 workshops were delivered in regional locations, attracting over 400 enrolments. A preliminary external evaluation conducted in December 2019 determined that the project's approach has been professional and systematic and has already proven its worth in building extension capacity. Key elements that were identified to have contributed to the success included: • Providing a foundation by collecting contact details and establishing a database for the 300 to 500 staff in the Reef extension area across all sectors – gaining a much more informed picture of who is based where, with which organisations and projects. • Undertaking a comprehensive Training Needs Analysis (160 respondents) and using that as basis and framework for developing training opportunities. • Commencing a training program across technical (e.g. soil health) and extension (e.g. behavioural science; facilitation) skills. • Providing training opportunities through a range of delivery formats including large central meetings (Reef Think Tank in Townsville, 100+ people); distance education/online (two University of Melbourne modules on extension practice); and small regional workshops (e.g. soils; facilitation) – as well as supporting staff to participate in the Australasia Pacific Extension Network (APEN) conference and attend specialist workshops. • Courses were evaluated to capture impact on understanding, skills and effectiveness in relation to the ability to improve water quality outcomes. A survey of participants in December 2019 showed that on average, they highly rated their learning and gains in confidence and ability to perform their role. • Creation of a Reef Extension Online Discussion group that currently has almost 100 members.

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	Increased use and improved function of grazing extension tools for extension service providers to support the capacity of graziers to make climate responsive management decisions using decision support tools such as Forage and VegMachine.	$561,000	$570,000	Annual	DES	The joint DES and DAF project leverages funding through the Drought and Climate Adaptation Program to provide the tools graziers need to maintain land condition in Queensland's drought-prone climate, which will ultimately reduce sediment loads to the Reef.	This investment contributed to improved tools, information and data to inform land managers including: • Released a new FORAGE report - Pasture Growth Alert combining ground cover, pasture growth in the previous 12 months and forecast growth for six months, for a property, as a guide to the pasture resilience risk. • Delivered improvements to the GRASP pasture model that underpins the FORAGE and AussieGRASS tools, including improving the representation of evapotranspiration from soils, trees and grasses, and nitrogen use. • Collected important data through an extensive field sampling campaign across eastern and northern Queensland. This data will support modelling and test the use of unmanned aerial vehicle technology to more efficiently capture pasture growth data. • Promoted the use of FORAGE and other tools available on the Long Paddock website through regular field days, seminars and webinars. • Launched the Drought Map Sequence Viewer which shows drought maps together with rainfall and pasture conditions for the period leading into the drought. The Drought Map Sequence Viewer has been expanded back to 1964. • Relaunched SILO historical model-ready data. • Updated the Qld Future Climate dashboard with the addition of RCP4.5 data (moderate emissions scenario) to the existing RCP8.5 (high emissions scenario) data.
	Project Cane Changer – a large scale social change program in the Wet Tropics, to better understand motivations and associated benefits of behaviour change to encourage sugarcane farmers to adopt actions that will improve water quality outcomes.	$11,800	$9,114	Additional	DES	Project completion costs. Project Cane Changer website www.canechanger.com	
	Wetlands demonstration on-ground case studies, wetlands extension with clients, management of local wetlands committees, development and delivery of wetlands information and tools for landholders.	$100,000	$100,000	Annual	DAF	The project supports treatment system trials, capacity-building events and develops decision support tools to increase awareness, knowledge and implementation of treatment systems and wetland management on farms. The project maintains regional stakeholder networks in the Wet Tropics, Burdekin and Mackay Whitsunday regions to share information and assist in the coordination of activities to improve water quality and wetlands in agricultural environs in the GBR catchment.	• 50 people attended the first International Bioreactor Forum held in March 2020. 76% indicated that networking with others working on bioreactor trials in Australia and overseas as a highlight of the event. On average people met 12 new acquaintances at the forum, highlighting the networking benefit of the event. 80% of participants said as result of the forum they would follow up with people they met, seek more information or apply the information learnt to delivering on-ground works projects. • Results from three bioreactor bed trials in the lower Burdekin have been collated detailing treatment performance, costs,

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							limitations and recommendations for the use of bioreactor beds to improve water quality. This information significantly increases knowledge of bioreactor treatment technology for pollutant mitigation and will be used to develop Queensland Bioreactor Guidelines and to update the Queensland Government's online water treatment system toolbox. • The creation of a Bioreactor Network has connected organisations from across Queensland to increase the level of interaction between people involved in treatment system trials. Members stated that they could deliver their projects more effectively through the network.
	Targeted extension approach to accelerate adoption of improved grazing management practices in priority areas in the Burnett Mary region.	$219,300	$193,800	Additional	DES	The Burnett Mary Regional Group (BMRG) has successfully delivered the Better Beef for the Reef project. Since commencing the project in July 2017, 45 grazing businesses are engaged, fully reaching the landholder engagement target.	Approximately 883 hours of dedicated landholder one-on-one extension (to 30 May 2020) were delivered. This includes property visits, one-on-one consultations, involvement of technical expertise as well as phone and email correspondence with Better Beef for the Reef landholders. Five demonstration sites were developed and completed. • 18 grazing businesses have made practice change improvements. Paddock to Reef practice change surveys are yet to be finalised. o 16 received Erosion Rehabilitation Guides and follow-up soil conservation extension support. o 13 developed property maps that have been used as basic property management tools. o 5 graziers have now transitioned to the GRASS program.
	Implementation of two major integrated Projects (MIPs) in the Wet Tropics and Burdekin regions to pilot a range of activities with producers and the community to reduce nutrient, pesticide and sediment loads into local waterways and ultimately the Great Barrier Reef.	$10,644,266 $439,234	$8,063,543	Additional Annual	DES	This year involved an acceleration of on-ground activity, as the teams used experience gained to move smoothly through project selection and planning to on-ground implementation. The team continued to build expertise in monitoring and evaluation, with results from 2019-2020 activities due to the department in September 2020.	The following key activities have been delivered: Wet Tropics Enhanced Catchment Modelling support. • Built sugarcane and banana models for demonstration sites • Worked with Griffith University to collate wetland efficacy numbers for MIPs. • Developed simple Source Wetland model in collaboration with MIPs team. • Fine scale water quality model built and calibrated for Johnstone and Tully incorporating latest MIPs and GBR Catchment monitoring data sets. Bowen Broken Bogie Enhanced Catchment Modelling support. • Rebuilt finer resolution model for the Bowen Broken Bogie catchments updating sediment budget based on MIPs data. • Assessed scenario requirements for OGBR reporting. Enhancing Management Practice Adoption monitoring and reporting. • Conducted project specific analyses of Landholders Driving Change (LDC) project sites to evaluate management practice adoption (additional to the Reef Report Card process). • Delivered land condition training at LDC Mt Pleasant field day.

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
							• Delivered training in the use of the Land Condition Assessment Tool (LCAT) app to LDC landholders and staff. • Provided access and support to the Paddock to Reef Projector for GreenCollar projects, as an initiative of the Wet Tropics MIP. Included additional fields to Paddock to Reef Projector to export files to enable the calculation of dissolved inorganic nitrogen reduction ratio, as required by the Reef Credit methodology. Wet Tropics MIP. • Constructed 14 treatment systems to reduce pollutant loads from farms to waterways. Systems include bioreactors, constructed and natural wetlands, high efficiency sediment basin, riparian revegetation site, vegetated drains and a study assessing effectiveness of vegetated drains for removing dissolved inorganic nitrogen. • Established 37 farm demonstration sites to highlight improved farm practices and nitrogen loss pathways. • Developed a grower requested water quality monitoring program. Over 30 monitoring sites are operating at a range of scales and land uses, including grab sampling sites, in-situ sites and intensively monitored paddocks, and supported by stream flow measurements taken during large weather events. • Engagement of 304 landholders through industry workshops, shed meetings, training events, field visits, one-on-extension, and a Leadership Program. This represents greater than 80% and 75% of the sugarcane and banana production area in the Johnstone and Tully catchments respectively. • Held 30 shed meetings to share results of the water quality-monitoring program with participating landholders. 85% of growers rated their increase in knowledge of local water quality issues at 8/10 or above. • Analysis of water quality benefits of treatment systems and improved farm practices, as well as economic benefits of improved fallow management, with interim results due in August/September 2020. • Leveraged over $4 million of co-funding/in-kind support/resources from partners, landholders and stakeholders. • Contributed $3.19 million to regional economies through working with locally based businesses. The project has engaged 40 local contractors and employed nine staff based in Tully and Johnstone, including five Indigenous water quality monitoring officers. • Supported development of the Reef Credit scheme, with 22 growers signed up to participate in the Reef Credit pilot to reduce nutrient run-off from their farms, while generating income from providing this environmental service. The scheme is finalising

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							governance arrangements, with trading to commence in the second half of 2020. The Burdekin MIP. • Engaged 58 properties, including 42 large and 16 smaller grazing properties, in on-ground management practice change projects. • Established seven cluster groups with each consisting of a group of properties working together to deliver on-ground practice change projects. • Established two collaborative Meat and Livestock Australia (MLA) cluster projects, comprising four regenerative agriculture properties over five years; and six integrated weed management properties over three years. • Held extension and training events with 134 landholders attending between September 2019 and March 2020. • Remediated seven large scale gully sites, with two completed and five being implemented. • Completed 12 small-scale gullies, with an additional six underway. • Completed a Gully Rehabilitation Prioritisation Report for the Bowen and Bogie catchments, providing detailed gully mapping and classification to identify gullies that can be most cost-effectively targeted to achieve catchment water quality targets. • Established a Landholder driven community learning hub and grazing property demonstration. Principles of regenerative agriculture used to restore landscape function, with findings to be shared with the local community and science partners through a range of learning platforms. • Approved nine new incentives project grants to landholders to implement innovative techniques for building business reliance and improving water quality. • Progressed a collaborative policy engagement project between OGBR, DNRME, NQ Dry Tropics and a Burdekin grazier. This will test the interaction between different legislation and water quality outcomes on this property and potentially lead to a trial or case study. • Continued to monitor water quality benefits of large scale gully remediation and roll-out a local water quality monitoring program. Results are due in September 2020. The MIPs Steering Committee supports the collaborative, ground-up design, delivery and transferability of the MIPs. The committee participated in a field trip to Wet Tropics MIP sites to see first-hand the range of activities underway. The committee has also formally met twice during this time to learn about progress and results of MIPs, provide advice on technical matters, suggest focus areas, and identify opportunities for potential integration with other programs.

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							The committee provides practical advice to the department on how best to evaluate and communicate the achievements of these projects.
	DES's scientific information, technical expertise and advice supports research agendas underpinning the Reef 2050 Plan and the Queensland Government.	$140,000	$131,000	Annual	DES	This investment supports DES Science's technical expertise, analysis, advice and science and research programs underpinning the Reef 2050 Water Quality Improvement Plan and the Queensland Reef Water Quality Program. Program support includes facilitation and participation in governance arrangements, committees and technical working groups.	Provided scientific and technical advice and information to inform and value add to the development of Reef policies and programs. Participated in Reef governance and collaborated across Reef stakeholders to support integrated delivery of policy, science, monitoring, modelling and evaluation.
	Economic validation of practices						
	Validating the economics of management practices that improve water quality and providing this information to landholders in decision support tools and as part of the extension program.	$1,300,000	$1,530,000	Annual	DAF	The Reef Water Quality Economic Evaluation Project addresses gaps in economic knowledge of best management practices and communicates findings to improve profitability and sustainability. Information developed from this project informs the profitability, cost effectiveness and prioritisation of investment. The project has four major components: 1. Validation of Management Practices 2. Decision Support Tool Development and Support 3. Economics Extension and Education 4. Economic Modelling. DAF's agricultural economists engage directly with growers and industry stakeholders, including in collaboration with industry organisations, government departments and Natural Resource Management groups. Key commodities of focus include sugarcane, grazing, bananas and grains.	Validation of management practices • DAF economists analysed 30 gully rehabilitation projects involving a range of treatments including: installation of whoa-boys (water diversion banks on roads), sediment banks, water distribution points, paddock subdivision, and riparian fencing activities. These analyses showed significant variation in cost effectiveness depending on scale and the type of activity undertaken. • The relative profitability of applying urea at SIX EASY STEPS recommendations with different types and blends of enhanced efficiency fertilisers was published. The report presents findings from 60 replicated trials on commercial sugarcane farms through the Enhanced Efficiency Fertiliser (EEF60) project. Preliminary results reveal that some EEF types and blends (e.g. nitrification inhibitor, or 80% urea and 20% controlled release fertiliser blends) applied at nitrogen rates 20% below industry guidelines have performed as well as urea at industry guidelines. Decision support tools •The Farm Economic Analysis Tool (FEAT) and Breedcow Dynama have undergone a major development update and are now interactive web applications, hosted online at https://featonline.com.au/ and https://breedcowdynama.com.au/. This represents a major improvement in the usability and accessibility of these tools and a new way for sugarcane farmers and graziers and to engage with economics and understand the economic costs and benefits of adopting recommended practices There have been 150 registrations as at June 2020 for FEAT online.

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							Extension Support • In 2019-20 grazing economists engaged with 177 producers and advisers, managing 65 properties covering approximately 1.02 million hectares. They assisted producers with advice including on land rehabilitation and pasture improvements, destocking and restocking opportunities, and supplementary feeding. • Sugarcane economists engaged with 142 growers in the 2019-2020 year across the Burnett Mary, Mackay Whitsunday, Burdekin and North Queensland growing regions. This work directly assisted industry with understanding the benefits/costs of best practice nutrient management, legume rotations, harvesting and irrigation practices. Economic modelling (Paddock to Reef Program) • DAF economists continue to lead the Reef Economics Co-ordination Group to ensure economists working across the Queensland Government, universities and private enterprises within the Queensland Reef Water Quality program have access to the latest information and on-going project data to ensure the best quality economic outcome. The collective expertise has assisted to identify gaps in economic knowledge relevant to Reef prioritisation projects and outlined opportunities to improve the accuracy, consistency and transparency of information to fill those gaps. • A cost-benefit analysis of the Paddock to Reef management practice water quality risk frameworks in sugarcane and grazing is continuing in order to understand the economic outcomes of adopting recommended practices at farm level. This data analysis is being undertaken across the entire Great Barrier Reef catchment area and will account for key attributes that drive enterprise variation including different land types, soil types, rainfall zones, management practices and land condition combinations. The next phase of the project will involve the interpretation of results and completion of reporting.
2.4 Identify and address barriers to change and practice improvement uptake through programs and policy.	Innovation						
	Great Barrier Reef Innovation Fund addressing agricultural management practices, water treatment systems and water and support to the Coral Abundance Innovation Challenge.	$914,777	$950,974	Additional	DES	The GBR Innovation Fund comprises projects: 1. Bentonite and limestone use in sugarcane for improved soil and water quality in the Mackay Whitsunday. 2. Water treatment systems - project management. 3. Determining the role of a constructed treatment wetland system in improving water quality in the Barratta Catchment.	1. Informing the potential benefits of bentonite application as a means of improving water quality and soil condition in the sugarcane industry. Project will conclude in September 2020 with outcomes reported next financial year. 2. Expert knowledge and understanding of the management of treatment system trial projects funded through the Innovation Fund. A final report will be delivered early 2020-2021. 3. Key learnings on the effects of constructed wetlands in reducing nitrogen run-off and will help to inform the design and location of future investments.

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						4. Validation of water quality improvement from constructed wetland treatment trains in Mackay Region. 5. Bioreactors for GBR. 6. Denitrification bioreactor trial in the Russell catchment of the Wet Tropics 7. TF6.6.4 Maximising the efficacy of variable rate technology to reduce nutrient use and sediment transport in vegetable and melon production (Burdekin and Wet Tropics) 8. SyncFert (Synchronised controlled release fertiliser) investigating efficacy of a biodegradable coated fertiliser (as opposed to polymer coated) to allow commercial scale manufacturing in collaboration with Haifa – the world's largest manufacturer of controlled release fertilisers. 9. Innovative Gully Remediation Phase 3. Co-contribution to Great Barrier Reef Fund (GBRF) funded gully remediation at Strathalbyn southern gullies 10. Radishes for water quality trialled the use of deep-rooted daikon radishes to improve water infiltration and decrease run-off from citrus crops in the Wet Tropics.	4. Key learnings on the effects of constructed wetlands in reducing nitrogen run-off will help to inform the design and location of future investments, including the monitoring regime required. 5 & 6. Construction and monitoring of bioreactors informing effectiveness in different conditions to determine the design and location of future bioreactor investments. Informing and driving the development of bioreactor state guidelines. 7. Proved preliminary understanding of using spatial data sets for improving agronomic effectiveness. 8. Investigating the field efficacy of a CSIRO developed fertiliser coating that is biodegradable to avoid micro plastic contamination issues while synchronising N supply with crop N demand over the growing season. 9. Trialling and implementing innovative approaches to gully remediation at a range of scales and in partnership with on-ground organisations. 10. Demonstrated that tillage radish is a viable cover crop that can deliver outcomes in water quality and water use efficiency on a citrus farm in the Barron catchment and there are valuable learnings that are able to be shared as a result of the multiple radish planting trials over three years.
2.6 Trial and implement innovation in technologies for on-ground management, water treatment and monitoring.	Implement projects to build on successful trials of on-ground management practices. DAF's agricultural research and development projects in relation to grazing, sugarcane, grains, bananas and horticulture with partner organisations, including industry and universities that provide significant Reef water quality benefits through exploring new technology and practices, improved pesticide and fertiliser management, economic evaluation and incorporating improved management into farming systems.	$1,290,000	$2,077,581	Annual—co-contribution	DAF	DAF's agricultural research and development projects are trialling innovative practices, technologies and products in the sugarcane, grazing, grains and horticulture sectors.	Drought and Climate Adaption Program • Research to improve the climate forecast model output for northern Australia will provide agriculture in northern Australia has focused on developing and improving a new Northern Rainfall Onset forecast product and improving understanding of the passage of the Madden-Julian Oscillation (MJO) across the tropics. On-ground extension activities have been boosted by a doubling of 'Climate Mates' across Queensland and northern Australia, whose role is to support extension of climate forecast information and understanding into existing and new industry engagement activities across the grazing industry. Further refinement of forecast models continues and should provide better and more skilful forecasting across northern Australia. • Feedback from key sugar industry stakeholders on prototype extreme climate event forecasts has indicated the new forecasts for shorter-term, multi-week out to monthly and seasonal forecasts, three months ahead, may be very useful for industry decision-making across the sugar industry value chain. The farmer reference group guiding the project has been expanded to include cane farmers across the growing regions from Cairns to northern NSW. A project narrative has been published which demonstrates the way in which forecast products can be used to better manage farm

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							management decisions. The formats in which products are presented to users have been modified using stakeholder feedback to ensure the final products are user-friendly to improve land management decision-making. Forecast products continue to be refined in preparation for official release at the end of the project. Project Catalyst The profitability outcomes of practice change for 10 Project Catalyst trials were determined. The trials examined the impact of varied nitrogen rates, subsurface application of soil ameliorants and Bio Dunder, and reduced irrigation. These are practices with the potential to improve water quality through reduced nutrient run-off. Preliminary results show that there is no economic benefit to applying nitrogen above SIX EASY STEPS rates. Soil health Six demonstration sites were analysed and first year results presented on the economics of incorporating legume crops into sugarcane farming systems. This collaborative project aims to improve soil health and supplement the income received from sugarcane. An economic extension tool is being developed and training and support in using Farm Economic Analysis Tool (FEAT) has also been provided to growers. Practices that aim to improve soil health may improve profitability and sustainability, depending on region, farming system, and whether the legume was a cash crop. This project continues for another two years. Gully system redemption • The Gully System Redemption project is aiming to monitor and better understand gully redemption techniques in key priority Reef sub-catchments at sites near Collinsville, Queensland. DAF is monitoring the land condition response subjected to Ultra High Density (UHD) gully rehabilitation on two major soil types and contributing to training and extension events. • The UHD gully rehabilitation approach implemented in this project has not contributed to improved land condition. However, there has been an overriding influence of good seasonal conditions improving pasture yield and ground cover while pasture composition has not changed. • The lack of change is likely from the lack of a viable seed bank and/or the competitive advantage of the dominant Indian Couch. It shows that long timeframes (~10 years) will be needed to achieve significant change in the landscape. The monitoring also provides a useful benchmark and change data in couch dominated, poor condition landscapes.

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							• DAF staff have designed and implemented effective diversion and spreader banks on two of the sites adjacent to the UHD plots giving an excellent demonstration of effective earthworks for gully redemption. Legume BMP • This project commenced in 2017 to facilitate widespread and successful (high productivity and persistence) adoption of pasture legumes in the Brigalow Belt region within the broader GBR catchment. • Industry engagement through workshops and field days is progressing ahead of schedule with 26 events delivered as at June 2020. On-farm demonstration is also ahead of schedule with 105 trial sites initiated with producer co-operators, including 11 detailed trial sites. Yet, due to severe drought from 2017-2019 progress in terms of establishing new sowings or measuring results on existing pastures at these trial sites has been limited. • Work has also started on two fact sheets (stylo identification and Leucaena) and five case studies are planned—these will be published on the FutureBeef website. Eight conference papers have also been presented. CQ Grower Solutions • This project delivers extension activities on themes identified from Central Queensland (CQ) grower consultation processes. DAF collaborated with the Australian Herbicide Resistance Initiative in Western Australia to deliver for the first time in Queensland, Weedsmart week. This week-long event included a series of forums and field days promoting integrated weed management and improved herbicide application approaches with more than 100 growers and advisers attending. Participant survey results indicated 58% would adopt new weed control strategies.
	Science in the Paddock						
	Targeted projects of direct action to address water quality pollutants across all agricultural industries based on priorities through Science in the Paddock program.	$6,600,925 $491,299	$4,587,721	Annual & Additional	DES	The Science in the Paddock program is delivered by a suite of projects across all Reef catchments. New projects beginning in the reporting period include • Fine-scale water quality monitoring in high risk catchments, addressing an identified need for greater water quality monitoring, commenced in June 2020. • Cairns and Babinda Nutrient Management planning project with Sugar Research Australia (SRA). The aim of the project is to engage 50 sugarcane farms in the Russell Mulgrave and Babinda regions of the Wet Tropics and help adjust fertiliser rates in line with SIX EASY STEPS, as required for their crop.	Science in the Paddock program 29 projects were underway in 2019–2020 across areas including: • Improved knowledge of nutrient and sediment processes in agricultural systems. • Pesticide monitoring and progress towards guidelines. • On-ground demonstration of improved practice. New projects. The Cairns and Babinda Nutrient Management planning project with SRA commenced in early 2020 and has engaged 50 growers providing benchmarking with work commenced on tailored nutrient management plans.

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						• Cairns and Babinda Nutrient Management planning project with Farmacist. The aim of the project is to engage 50 (+50 under Reef Trust funding) sugarcane farms in the Russell Mulgrave and Babinda regions of the Wet Tropics and help adjust fertiliser rates in line with SIX EASY STEPS, as required for their crop. These projects will contribute to Reef 2050 WQIP objectives of achieving 60% reduction of nitrogen in anthropogenic end-of-catchment dissolved inorganic nitrogen loads from this catchment. • Managing the trash blanket as an asset project aims to enhance understanding of the quantity of cane trash required to minimise off-plot sediment movement by maintaining 'adequate surface cover'.	The Nutrient Management planning project with Farmacist commenced in early 2020. Over 40 growers have been engaged providing benchmarking and commencing work on tailored nutrient management plans. Managing the trash blanket as an asset project site trials were successful. Data generated informs appropriate volumes of trash retention for soil health and conservation purposes. Findings will provide guidance in development of policy initiatives around best practice for trash management for water quality benefits. Data will inform paddock and catchment scale modelling and management practice adoption component for Paddock to Reef.
	Demonstration projects to encourage improved practice uptake at a local scale.	$220,000	$220,000	Annual	DES	The aim of the Sandy Creek on-farm change for water quality project is to build on the success of previous Sandy Creek projects to improve pesticide management practices and water quality outcomes. Griffith University was engaged to identify and assist with addressing barriers to engagement and chemical management practice change in the Sandy Creek catchment.	The Sandy Creek on-farm change for water quality project is providing targeted extension activities, agronomic support, trials and demonstrations, communication products and water quality monitoring to increase the adoption of improved chemical practices in the Sandy Creek area. The project has successfully engaged growers in the Brightly sub-catchment, all having received a chemical management plan and undertaken spray rig audits with upgrades made possible through a small grant. Early indications from monitoring indicate that a water quality improvement at the end of this branch of Sandy Creek may be attributable to these growers' on-farm changes. There are a further 22 growers across the broader catchment also engaged in practice change with many implementing spray rig upgrades (replacing nozzles etc.) with the available funding. Learnings from the Griffith University research are available to inform the current Sandy Creek project.
	Burdekin sugarcane farmer engagement: complete nutrient management planning for cane farming.	$476,000	$1,229,840	Annual	DES	The Complete Nutrient Planning for Cane Farming project aims to engage 230 sugarcane farms in the Burdekin area and help adjust fertiliser rates in line with SIX EASY STEPS, as required for their crop. This will contribute to the Reef 2050 WQIP objectives of achieving 60% reduction of nitrogen in anthropogenic end-of-catchment dissolved inorganic nitrogen loads. The aim of the Tailored nutrient and farm management solutions for the Herbert Catchment area project is to engage 50 (+50 under Reef Trust funding) sugarcane farms in the Herbert region of the Wet Tropics and help adjust fertiliser rates in line with SIX EASY STEPS, as required for their crop. This will contribute to Reef 2050 WQIP objectives of achieving 70% reduction of nitrogen in	The project engaged a further 54 farms in 2019–2020 delivering the full program including personalised nutrient management plans, calibrations, baseline and post practice surveys while providing on-farm and over the telephone support to the growers for a full year. Google Earth and SIX EASY STEPS training was offered to all growers. The project achieved an over 89 tonne reduction in nitrogen application across engaged farms. The Tailored nutrient and farm management solutions for the Herbert Catchment area project has achieved practice change across 51 sugarcane farms in its first year, reducing nitrogen applications by 66 tonnes. The project team has provided tailored nutrient management plans to all growers in the project, worked on their calibrations and provided support with optimising nitrogen management practices on farm.

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						anthropogenic end-of-catchment dissolved inorganic nitrogen loads from the Herbert catchment.	
	Research, development and innovation projects filling human dimensions gaps.	$500,001	$49,999	Additional	DES	This new program began in May 2020 with building a comprehensive literature analysis. 1. Addresses an identified knowledge need from the Reef 2050 Research Development and Innovation Strategy – "How can we use existing knowledge about human dimensions of practice change to overcome barriers to adoption, increase practice uptake, identify and fill key knowledge needs in priority sectors?". 2. Review traditional, social and community media narratives that drive behaviour supporting natural resource management and Reef water quality outcomes. 3. QUT is leading a project team that will bring together experts from different research fields (law, planning and governance, behavioural sciences and economics) to articulate how different policy instruments are likely to influence farmer behaviour, and how those instruments are expected to interact. By building a model to integrate this knowledge, we can assess the impact of multiple policy instruments on the adoption of management practices and design better evaluation systems. 4. Reducing the impact of diffuse water quality outcomes from farming lands needs different groups like governments, communities, researchers and farmer groups to work together effectively to solve problems. Partnerships are a common way these groups formally collaborate to address this challenge in Reef regions. This project will investigate how partnerships contribute to water quality outcomes. Investigate whether mechanisms to register the environmental interests of consumers (e.g., eco-labelling, environmental standards) would be underpinned by support and price premiums from consumers, and that there are potential systems to transmit different price signals through the agricultural value chains.	As the projects only commenced in May 2020, there are no outcomes reported in this reporting period.
Catchment restoration							
3.2 Use guidelines, Traditional knowledge, and other decision support tools to design and inform interventions.	Queensland Wetlands Program. Provision of wetlands tools and WetlandInfo website.	$200,000	$123,919	Annual	DES	Qld Wetlands Program continues to provide policy, governance, tools, information and stakeholder relationships in order to ensure the effective delivery of the Wetlands in the GBR catchments Management Strategy 2016-21	• Delivered 'Walking the Landscape' and management intervention workshops and built capacity in regional NRM groups to facilitate their own workshops. Workshops held 2019-2020: - Great Sandy Strait

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	Delivery of Walking the Landscape whole-of-catchment management understanding.					Despite Covid-19 and impacts on spending, the program continues to provide excellent value for money with significant progress made towards achieving the Strategy's goals and objectives.	- Murray River - Shoalwater and Water Park - Annan/Endeavour and Jeannie - Lower Herbert River • Delivered training workshops to NRM groups to apply the Walking the Landscape Methodology to produce their own catchment stories. • Four additional Catchment stories released on WetlandInfo • Burnett (with QRA) • Plane • Great Sandy Strait and surrounding catchments • Water Park • Ensured good governance via the Qld Wetlands Program Governance Group. • Maintained and updated the WetlandInfo website. • Maintained and provided secretariat support for the GBR Wetland Network, quarterly teleconferences and the GBR Wetland Network Annual Forum (Rockhampton) • Commenced a program for strategic prioritisation of wetland rehabilitation and restoration, including fish passage, with DAF. • An additional 16 projects added to the Wetland Projects Search Tool (an interactive online spatial tool that features on-ground wetland-related projects across all of Queensland, with a focus on the catchments of the GBR – hosted on WetlandInfo). • Funded catchment scale wetland Nitrogen research by Griffith University resulting in a ground-breaking finding that wetlands denitrify floodwaters. • Supporting Dr Fernanda Adame's Advance Queensland project 'Wetlands for improving water quality of the Great Barrier Reef' investigating nitrogen processing by wetlands in the Moresby catchment, which commenced in May 2020. • Commenced a project to update wetland mapping attributes in collaboration with the Queensland Herbarium. • Funded GBR research on birds by James Cook University. • Signed a data sharing agreement with Qld Wader Study Group to share shorebird data. • Contribute to and support applied scientific research into priority knowledge gaps: • Adame MF, Roberts ME, Hamilton DP, Ndehedehe CE, Reis V, Lu J, Griffiths M, Curwen G and Ronan M (2019) Tropical Coastal Wetlands Ameliorate Nitrogen Export During Floods. Front. Mar. Sci. 6:671. doi: 10.3389/fmars.2019.00671 • M. F. Adame, H. Franklin, N. J. Waltham, S. Rodriguez, E. Kavehei, M. P. Turschwell, S. R. Balcombe, P. Kaniewska, M. A. Burford and M. Ronan (2019) Nitrogen removal by tropical floodplain

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
							wetlands through denitrification. Marine and Freshwater Research https://doi.org/10.1071/MF18490 • M. F. Adame, V. N. L. Wong, S. R. Balcombe, M. P. Turschwell, E. Kavehei, D. C. Rodrı´guez, J. J. Kelleway, P. Masque, and M. Ronan (2019) Carbon and Nitrogen Sequestration of Melaleuca Floodplain Wetlands in Tropical Australia. Ecosystems https://doi.org/10.1007/s10021-019-00414-5
3.3 Trial and implement innovation in catchment repair and restoration projects to reduce sediment and nutrient delivery to the Reef.	Targeted projects of direct action through sustainable landscape management and system repair including riparian revegetation, gully repair, streambank stabilisation and coastal wetlands rehabilitation.	$3,509,000	$3,788,324	Annual	DNRME	Five Natural Resource Investment Program (NRIP) Reef Water Quality projects are funded in high risk priority areas of the Normanby, Burdekin, Pioneer, O'Connell, Burnett and Mary River catchments. NRIP is a four-year program funded until 2022. Overall expenditure across the four years will be within budget.	In a challenging year, the highlights from the second year of the 2018-22 program of activities includes: • commencement of on-ground works including riparian repair and restoration sites, wetland reconstruction and works to restore ecological condition of freshwater streams; and • Regional NRM bodies have implemented the state-wide Indicator monitoring methodologies that are providing consistent measurement indicators of change in the management and condition of natural resources across all projects and regions.
	Streambank and gully remediation projects including innovative gully remediation in partnership with Greening Australia and erosion management plan and operational works on Springvale Station.	$1,064,014	$544,369	Additional	DES	This program included a land survey, LiDAR data capture providing baseline data for gully remediation, and streambank guidelines and classification at Springvale Station to support decision-making.	Trialling and implementing innovative approaches to gully remediation at a range of scales and in partnership with on ground organisations. Captured data has provided best available science to support decision-making on site.
	Reef Islands Project - protecting the Reef's most precious land and seascapes with a focus on islands and their adjacent waters.	$0. One-off investment complete.		Additional	DES		
	Reef water quality projects in the Central Queensland region seeking to reduce nutrient, pesticide and sediment losses to waterways.	$908,803	$973,295	Additional and Annual	DES	This program included the following projects: 1. Pathways to water quality improvements in the Myrtle Creek sub-catchment. Four sugarcane farmer groups within the Myrtle Creek sub-catchment investigate the impacts on water quality of their current farming practices. 2. Grassroots project. 24 grazing business participated in grazing for profit training program. 3. Fitzroy River Catchment Erosion Gully Restoration. 4. Delivering tailored solutions to Mackay Whitsunday growers to improve nutrient management project will engage with 150 farms in the Mackay Whitsunday region. The aim is to improve their confidence and provide the skills required to implement the SIX EASY STEPS program on their farm through tailored agronomic support.	1. Grab sample results collected on Myrtle Creek (December 2019 to March 2020), and case studies of various management practices on four different sugarcane farms, have been developed into communication handouts for sharing, discussing (and peer-to-peer learning) with the broader community in the Myrtle Creek sub-catchment. 2. Final report drafted summarised outcomes for Reef water quality. See case studies at https://reefcatchments.com.au/types/grazing/ 3. Trialling and implementing innovative approaches to gully remediation at a range of scales and in partnership with on-ground organisations. Contractor site access has been limited due to COVD-19 restrictions. 4. 53 farms received personalised nutrient management plans, calibrations, and baseline and post practice surveys while providing on-farm and over the telephone support to the growers. Google Earth and soils training workshops were offered to all growers. The project achieved over 63 tonne reduction in nitrogen applied.
Enabling delivery							

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
Science and knowledge							
4.1 Identify, prioritise and fill knowledge gaps through the Reef 2050 Water Quality Improvement Plan (Reef 2050 WQIP) Research, Development and Innovation Strategy (RD&I).	RD&I strategy development.	No project cost.			DES		
	Address priority gaps in the Reef 2050 WQIP RD&I Strategy through Reef water quality research and development programs.	$0. Completed		Annual	DES		
4.2 Integrate forms of knowledge including science, policy, management, Traditional Owner and community through regular synthesis workshops and theme-specific working groups to support consistent communication messages and guidance for managers.	Annual synthesis workshop and projects across science, policy and management	$733,350	$240,662	Additional	DES	Establishment of a coral and marine water quality program led by Traditional Owners in the southern GBR. Convening of a fourth and final Reef Water Quality Synthesis Workshop.	The project commenced in early 2020 and will commence coral and water quality monitoring in early 2020-2021 to help inform the impacts of neighbouring land-based practices on the southern inshore GBR environment. The fourth and final annual Reef Water Quality Synthesis Workshop was held in Mackay in November 2019. 110 participants from 58 organisations participated in the workshop. The overall purpose of the 2019 Synthesis Workshop was to bring science, policy, and management together to share successes and find new and better ways of delivering the Reef 2050 Water Quality Improvement Plan (Reef 2050 WQIP).
4.3 Deliver decision support tools, communication and education products tailored to specific audiences.	Communication projects.	$0. Completed		Additional	DES		
	Activities to improve communication and information to support large scale change in practice, including communication tools, workshops, communication strategies and implementation plans.	$306,524	$320,043	Additional	DES		Development of the new content management system for the interactive online 2019 Reef Report Card (to be released in early 2021).
Governance							
6.1 Collaborate and coordinate between the Queensland and Australian governments, in line with the Reef 2050 Plan governance structures.	Secretariat support to governance groups.	$734,959	$834,903	Annual	DES	WQIP Action 7.4 Evaluate effectiveness of programs	Reefonomics cloud-based platform developed to couple water quality and economic models to assess natural resource management investment options for the Great Barrier Reef catchment. The tool uses data management functionality to enable revision and updating of the latest available water quality and economic data. - Live version of the tool developed and presented to the Reefonomics Working Group - Updated data incorporated for: land management practice adoption, paddock modelling efficacy data and catchment modelling data.
6.3 Ensure accountability of investment to outcomes in the Reef 2050 WQIP.	Annual Queensland Reef Water Quality Program Investment Report/Plan.	Included in Governance		Annual	DES		
	Program management.	$272,000	$550,437	Additional	DES	The Office of the Great Barrier Reef continues to provide oversight and coordination of the program including investment planning, implementation, monitoring and reporting.	The following documents have been published to the Queensland Government website: 2019-2020 Annual Investment Plan 2018-2019 Annual Investment Report.

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
						Annual Plans and Reports are published for the Queensland Reef Water quality Program	
Evaluating performance							
7.1 Monitor and model management practice and water quality improvements through the Paddock to Reef program.	Implementation of Paddock to Reef program						
	Great Barrier Reef ground cover, riparian vegetation, catchment loads, wetland condition and wetland mapping and extent monitoring programs.	$1,876,500 $240,673	$1,873,000 $241,403	Annual Additional	DES	DES delivers key Paddock to Reef monitoring programs including monitoring sediment, nutrient and pesticides; remote sensing to measure landscape indicators such as ground cover, gullies and riparian vegetation; and assessing wetlands.	Riparian vegetation monitoring • Delivered program enhancements and wider program delivery including adapted riparian data and reporting to inform the 2019 Wet Tropics Regional Report Card. Ground cover monitoring • Delivered ground cover data and information for incorporation into the Reef Water Quality Report Card 2019. • Provided seasonal ground cover data for the water quality models. • Provided a range of data metrics, technical support and advice to the Paddock to Reef Management Practice Adoption Program to assist reporting and data review requirements. • Delivered program enhancements and wider program delivery including: O Developed an API (application programming interface) providing data analysis routines to the Paddock to Reef Grazing Projector. O Migrated fractional cover/ fractional ground cover seasonal and monthly products to new Terrestrial Ecosystem Research Network (TERN) portal, providing public access to ground cover data and servicing of data requirements for VegMachine. O Continued provision of data and information through FORAGE online reports and VegMachine, as well as open data access via TERN. • Provision of support and information to assist implementation of grazing minimum standards for Reef regulations. Catchment loads monitoring • Delivered data and information to inform the Reef Water Quality Report Card 2019. • Monitored water quality at 52 sites in 23 river basins across six natural resource management regions. • 46 sites across six natural resource management regions were monitored for sediments and nutrients and 29 sites across five natural resource management regions were monitored for pesticides. • Provided high quality pollutant loads for sediments and nutrients from priority catchments for validation of the Source Catchments water quality models. • Provided pesticide concentrations data for the pesticide risk metric to report on pesticide condition in the report card. • Delivered program enhancements and wider program delivery including:

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							O Completion of re-build of monitoring site on Bonnie Doon Creek at Strathalbyn following flooding event in early 2019. O Refurbishment of East and West Normanby River sites to improve sediment sampling. During 2019-2020, the department's Chemistry Centre laboratory processed 21,608 water, soil, sediment, and plant samples from Reef catchments as part of its monitoring program and performed more than 65,054 tests on these samples. The data is used to calibrate and validate the water quality models that track progress towards the Reef targets, is used by stakeholder and partner organisations, and supports the regional report cards. Wetland mapping and extent Delivered program enhancements and wider program delivery including: • Progressed development of wetlands mapping version 6.0. • Progressed incorporation of natural wetlands derived from waterbodies data into regional ecosystem mapping with a view to producing a more accurate pre-clearing wetlands map and improving the accuracy of extent change reporting. • Collaborated with the Department of Natural Resources, Mines and Energy (DNRME) to progress automated incorporation of DNRME held waterbody datasets (drainage, waterbody areas and waterbody points) into the next wetland extent map version. Automation completed for a subset of the waterbody data, limited to artificial wetlands and natural riverine waterbodies due to the complexity. Manual incorporation of all other DNRME waterbody data will continue. • Established a collaboration between the Queensland Herbarium's Ecosystems Survey and Mapping unit and Geoscience Australia for the provision hydrological attributes (such as frequency of inundation, residence time, duration and timing) for palustrine and lacustrine wetlands derived from 30-year Landsat satellite imagery analysis. Pilot areas within Queensland including a GBR catchment have shown excellent early results. Wetland condition monitoring • Completed 2019 wetland condition and pressure assessments and data collection. • 58 additional wetlands involving 53 landholders and land managers were incorporated into the program. • Intensified wetland monitoring commenced in the Fitzroy Basin enabling Fitzroy regional wetland condition reporting for the next Reef Water Quality Report Card. • Delivered program enhancements and wider program delivery including:

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							O Published journal article 'Pervasive Pesticide Contamination of Wetlands in the Great Barrier Reef Catchment Area'. O Development, updating and testing of a rapid assessment method for monitoring freshwater wetlands in northern Australia. O Completed database migration to ArcGIS Pro, providing spatial data visualisation to enhance desktop assessment processes.
	Catchment loads modelling, gully mapping, Paddock to Reef support to Regional Natural Resource Management body components.	$1,540,000	$1,347,394	Annual	DNRME	Catchments loads modelling Modelling scenarios for the Reef Water Quality Report Card 2019 run with updated land management practice adoption data and ground cover. Gully mapping Improve the quality of input data layers for the foundational gully erosion data layers for Paddock to Reef paddock and catchment loads models. Produce gully density maps and associated parameters regarding gully geometry and activity rates for GBR catchments Improve gully erosion and other erosion features data layers in priority GBR catchments Produce gully density/surface area maps of gully erosion and distribute to key Reef catchment funding and delivery organisations to inform on-ground investment decisions and funding prioritisation. Paddock to Reef support Project to advance communication of the importance of Reef 2050 Water Quality Improvement Plan targets, highlighting regional activities being undertaken by key stakeholders to achieve these targets. Activities include management and reporting, regional liaison and regional communications and data collection.	Catchments loads modelling Best estimate of target sediment and nutrient loads for the 35 catchments draining to the Great Barrier Reef lagoon using the latest science and input data sets were delivered on-time for the Reef Water Quality Report Card 2019. This assessed progress towards the Reef 2050 Water Quality Improvement Plan water quality targets to track if joint government investment and programs are achieving on-ground outcomes to improve water quality flowing to the Reef. Gully mapping This project has been of significant benefit to the robustness of the outputs of the modelling program and the prioritisation of regional program expenditure for the Australian and Queensland governments. Achievements of this project to-date include: - 94% of high priority GBR catchment mapping is complete (Lower Burdekin, Fitzroy, Herbert, Burnett and parts of the Normanby (improved imagery or additional LiDAR is required to complete the Normanby)). - Overall 70% of all GBR catchments is complete. This represents 318,802km2 of completed mapping of which 299,247km2 has been quality checked. - 20% of mapped areas have had gully geometry and activity rates collected. - The collection of gully growth rates has just started for mapped areas in the Fitzroy Lower Burdekin and Burnett. Paddock to Reef support The achievements of this project in 2019-2020 include: • The delivery of scheduled regional Science Forums were successfully held online. • The production of regional communication products to disseminate Paddock to Reef results with local stakeholders. • Annual provision of management practice adoption data. • Collection of annual fertiliser and pesticide use data for relevant regional industries.
	Management practice adoption reporting.	$630,000	$538,000	Annual	DAF	DAF's management practice adoption project describes and monitors the farm management practices that influence off-farm water quality. All Queensland and	• All elements for management practice adoption required to generate the Reef Water Quality Report Card 2019 were delivered on time, including the GIS layers required to drive the catchment

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						Australian government investments that target farm management practice improvement are required to report their project impacts in a GIS-based system which is developed and maintained as part of this project.	modelling effort, and populating the new content management system for the interactive online Report Card. • The Paddock to Reef Projector decision support tool has undergone a major upgrade during 2019-20. During the last year the Projector tool has become a critical part of program and project design for the Queensland Government and for the Great Barrier Reef Foundation [GBRF], and is now utilised in the project application processes to demonstrate that proponents are targeting resources for maximum impact. Further, the Projector's use as the accounting method for dissolved inorganic nitrogen [DIN] Reef Credits was settled during 2019-20. The full functionality of the Projector will enable estimation of pollutant load reductions for all agriculture sectors. It will also allow users to export collections directly to the DAF Paddock to Reef team, simplifying and streamlining reporting and ensuring that data sets are complete before being provided to DAF. • The Gully Toolbox app was completed during 2019-2020, undergoing two development iterations to improve user experience. The app is now available for proponents to use in the field, and via desktop. The major advantages are a simplification of GIS tasks for proponents, and a major streamlining of the process for DAFs Paddock to Reef team and the Reef Trust technical partners that review each remediation site for design and efficacy, as all elements of the toolbox are managed in one cloud-based geodatabase. The DAF team will finalise dashboard functionality (via web app) in early 2020-2021 so that technical partners, DAF, and program managers have at-a-glance capabilities for tracking progress of individual sites. • The Land Condition Assessment Tool (LCAT) app project was completed during 2019-2020, as a key element of improving the rigour and confidence of Paddock to Reef assessments in grazing lands. The app is available on iOS, android and PC and there are approximately 150 users that access the secure LCAT cloud-based geodatabase. A licencing agreement has been executed with NRM Regions Qld (NRMRQ) which allows NRMRQ to host the app for 12 NRM regional bodies in Queensland. Approximately 120 individual grazing project officers have already completed detailed training in the use of the app and land condition framework and have been provided with supporting resource material. Training will continue during 2020-2021, with more emphasis on field workshops (that were not possible due to COVID19). LCAT assessments are now a mandatory reporting requirement for any site on grazing lands that is being reported for impact under the Reef 2050 Water Quality Improvement Plan (WQIP). Data collected with LCAT will underpin the collaborative efforts of DES Remote Sensing Centre and DAF to develop robust modelling

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							capability for land condition, which has not been possible before now due to lack of validation data. • The DAF team, in collaboration with NRMRQ and DES, has developed, piloted and commenced delivering workshops on using the Paddock to Reef monitoring and reporting systems. Approximately 75 officers completed the training during 2019-2020 with very positive results indicated in evaluations. The project team will continue to make the training available to delivery organisations and program managers as it will improve the quality of, and confidence in, impact reporting for the Reef 2050 WQIP.
	Monitoring, modelling, evaluation and reporting.	$1,855,412	$1,823,402	Additional	DES	This program includes: Catchment modelling as part of the Paddock to Reef program estimates the effectiveness of current and alternative management practices that reduce pollutant loads. Lines of evidence of management practice adoption are reviewed and validated and then provided to the modellers to evaluate progress towards the targets.	Enhanced catchment modelling Continued to refine input data layers for the Reef Water Quality Report Card including: • Wet Tropics and Mackay stream realignment and slope correction. • Gully mapping in Fitzroy and Cape York regions. • Drone LiDAR pilot study on the Mary River to improve stream geometry numbers for modelling. • Continuation of work to refine methodology and calibrate models and report uncertainty in modelled load estimates. • Hydrology calibration method being tested in Burnett Mary region. • Water quality calibration method applied in Wet Tropics. • Stream cross-section and gully volume data from LiDAR across the GBR was collated. • Literature review of reservoir stratification to enhance reservoir models was conducted. Management practice adoption support • Funded a significant proportion of the upgrades to the Paddock to Reef Projector functionality in 2019-2020. • Projector upgrades include capabilities to estimate pollutant load reduction in grains and grazing sectors, and for users to export projects directly to DAF MPA program for analysis, reducing potential for errors and streamlining reporting process. • Independent review process for technical reports commenced.
	Wetland condition monitoring and water quality monitoring and modelling.	$1,190,000	$2,424,000	Annual—co-contribution	DES	This is DES co-investment to deliver key Paddock to Reef monitoring and modelling programs and regional report card support.	DES scientists provided additional support to projects and programs including: - GBR catchment loads monitoring program. - GBR wetland condition monitoring program. - ambient water quality monitoring. - catchment modelling.
	Data management and delivery through Science and Spatial Information Management for Reef (SSIMR).	$180,000	$204,694	Annual	DNRME	Data management and delivery for SSMIR provided through Data Recording Tool for Science (DARTS) and	Ongoing support for the DARTS and SKIP systems was provided. The software upgrade for DARTS was completed and the software upgrade for SKIP is well advanced.

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						Science and Knowledge Information Provision (SKIP) systems	
	Ambient water quality monitoring, high resolution satellite imagery.	$1,500,000	$2,073,582	Annual—co-contribution	DNRME	The surface and groundwater monitoring network delivered by DNRME provides timely and reliable flow and ambient water quality data that underpins modelling tools and loads reporting within the Paddock to Reef program. The network is maintained to an ISO 9001:2015 standard. DNRME collects high resolution satellite imagery within Reef catchments that allows estimation of changes in land cover, land use change and changes in the extent of wetlands.	DNRME continues to invest in high quality, high resolution satellite imagery for the state, which is instrumental in Great Barrier Reef catchment monitoring and disaster mapping. Surface and groundwater data available was provided within agreed timeframes and quality assurance.

	Research and development improvement of water models in the Great Barrier Reef catchments through the Queensland Water Modelling Network (QWMN).	$200,000	$461,000	Annual—co-contribution	DES	The QWMN is a cross-agency initiative to address critical gaps in the state's water modelling capability in hydrology, groundwater and water quality and support greater use of water modelling by policy-makers and program designers.	The QWMN supported Reef related activities in 2019–2020 including:
							• Communication tools to explain Queensland water plan climate risks and the underlying methodology.
							• Responding to the Critical Review of Climate Change in water models in Queensland.
							• Completed five projects that contribute new knowledge and tools towards Reef and landscape restoration. Projects included:
							  ○ Improved modelling of streambank erosion in GBR catchments.
							  ○ Addressing uncertainty in linked catchment and receiving water models using machine learning.
							  ○ Development of a gully erosion framework for Queensland.
							  ○ Visualisation of coupled economic and Queensland water quality models.
							  ○ Development of a data portal to deliver catchment modelling data to end users.
							• QWMN Fellow, Dr Melanie Roberts has completed the second year of research to develop estuarine, gully and streambank erosion modelling capability to influence land use/management, climate change and policy interventions to sustain the GBR.
							• Enhanced Reef and state-wide modelling capabilities through the QWMN External Engagement Program, e.g. community of practice events on technical subjects such as climate change impacts, remote sensing and uncertainty as well as more strategic discussions around multiple plausible futures.
							• Two of the EEP Innovation Associates (industrial PhDs) focusing on research into the use of artificial intelligence to improve water quality forecasting of ungauged catchments that drain to the GBR, and developing an improved biogeochemical model for the GBR

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
							that builds upon the existing eReefs models, but better accounts for processes and responses relevant to climate change scenarios.
	Collection, storage, access and enhancement of information that support catchment restoration and land management as well as monitoring, modelling and reporting of outcomes in Reef catchments.	$820,000	$950,000	Annual—co-contribution	DES	This investment provides a range of foundational landscape monitoring and scientific computing infrastructure and services that underpin and support Reef programs: • State-wide Landcover and Tree Study (SLATS). • Queensland satellite image archive. • Queensland Land Use Mapping Program (QLUMP). • Queensland Crop Monitoring Program. • ground cover monitoring research and development. • soil and nutrient management for productive. • agriculture and ecosystems services in Reef catchments. • decision support and improved management. • practices for informed nitrogen management and nutrient efficiency. • analytical laboratory services.	Investment highlights include: • Continued progress on the Enhanced SLATS program of work including: o Production of high-resolution woody extent mapping for the state. o Transition of the clearing analysis from Landsat to Sentinel-2 satellite imagery for the 2018-2019 analysis for priority areas including Reef catchments. o Development of vegetation age and regrowth monitoring approaches. o Development of a BioCondition modelling and mapping framework. • Continued to maintain comprehensive archive of Landsat and Sentinel-2 satellite imagery for all Reef catchments and Queensland, including maintaining active role on Copernicus Australasia Regional Data Hub for all Sentinel satellite data. • Continued to maintain and develop extensive archives of LiDAR and derived products, other high resolution satellite imagery and aerial photography as well as an extensive range of derived image products. • Reviewed the QLUMP to inform stakeholder and future development requirements for the program. • Processed and delivered summer and winter growing season crop monitoring data, including ongoing production of FORAGE crop monitoring report. • Developed and finalised ground cover metrics and a land condition modelling and mapping approach to better quantify and map land condition and ground cover patchiness to inform Reef programs and reporting. • Developed a new fractional cover algorithm based on a significantly expanded field calibration data set (previously 1500 sites, now over 4000 sites). • DES scientists provided in-kind support to the QRWQP and commissioned projects including: o Processed and published derived data products for the Australian Government-funded GBR airborne LiDAR data collection for Reef catchment areas. o Provided technical support and advice to NESP gully monitoring project in collaboration with CSIRO, including detailed terrestrial laser scanning and analysis at a range of experimental sites. o Contributed to NESP 5.8 project progress report on advances in the understanding of the origin and fate of the

Overarching action in Reef 2050 Water Quality Improvement Plan	Activity within the Queensland Reef Water Quality Program	2019-2020 Planned investment	2019-2020 Expenditure	Funding source	Lead agency	Investment summary	Outcomes achieved
							environmental detrimental sediment to the Reef and associated bioavailable nutrients (led by James Cook University). o Monitored total and bioavailable nutrient export from two control gullies and two rehabilitated gullies at Strathalbyn station during the 2019-2020 wet season. o Advanced the development of a baseline method to quantify bioavailable nutrient export from gully systems. o Advanced the understanding of nutrient equivalencies between wastewater treatment plant effluent, aquaculture effluents and GBR catchment soils. o Advanced the understanding of the effect of trash blanket management on nitrogen mineralisation and the export of bioavailable nutrients from sugarcane systems. o Advanced the understanding of soil condition and environmental accounts for land restoration, working with the Land Restoration Fund to develop an environmental condition accounting method for soil health for third party verification of Environmental co-benefit classes. o Delivered final technical report for *RP166 - Fertiliser Nitrogen Deep Drainage Monitoring to Assess the Environmental Benefits of Enhanced Efficiency Fertilisers.*
7.4 Evaluate the effectiveness of programs, governance mechanisms and adaptations.	Develop an evaluation framework and annually evaluate and report on performance of overall Reef investment program and review governance.	$39,312	$101,857	Annual	DES	The second evaluation of the Queensland Reef Water Quality Program was undertaken in 2019 and presented in December 2019. Actions were taken towards addressing all recommendation. Preparations for a third evaluation were commenced.	
7.5 Report progress towards targets, objectives and outcomes.	Develop and release a Reef Water Quality Report Card.	$475,533	$470,768	Annual	DES	Action 7.5 - Reef Water Quality Report Card (Water Quality Improvement Plan) https://www.reefplan.qld.gov.au/	Reef Water Quality Report Card 2017 and 2018 released in August 2019, and can be found at: https://www.qld.gov.au/environment/coasts-waterways/reef/reef-program/report-cards Reef Water Quality Report Card 2019 developed.
7.6 Communicate regionally relevant information for management decisions and local communities.	Regional report card partnerships membership and support.	$2,293,197	$1,840,169 (including DES Science $555,000 expenditure)	Annual	DES	This program includes support for five regional report card partnerships and an urban water stewardship framework: • Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership. • Gladstone Healthy Harbour Partnership. • Wet Tropics Waterways Partnership. • Fitzroy Partnership for River Health. • Dry Tropics Partnership for Healthy Waters. • Urban Water Management Practice and Stewardship Framework for Report Cards evaluated the Urban Water Stewardship Framework pilot assessment method and workshop delivery process to identify	Report cards for regional partnerships can be found at: https://www.qld.gov.au/environment/coasts-waterways/reef/reef-program/report-cards Urban Water Management Practice and Stewardship Independent evaluation report outlined recommended areas for improvement, which are currently being actioned. DES Science Division Reef monitoring and report cards and enhanced systems • Completed monthly water quality monitoring in 20 estuaries and 8 freshwater streams up to March 2020. The data informs the 2019 Wet Tropics, Dry Tropics and Mackay Whitsunday regional report

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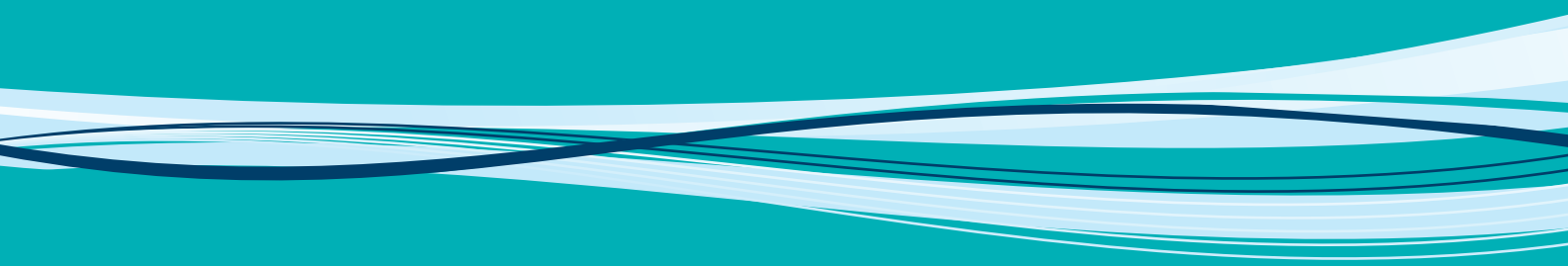
						how these could be improved prior to report card application. DES Science Division Reef monitoring and report cards and enhanced systems • This investment supports DES's ambient monitoring program which assesses condition and long-term trends in water quality and ecosystem health and provides estuarine and freshwater fish data to support the development of regional report cards.	cards. • Provided data on the extent and any changes to wetland and riparian habitat for report card estuaries. • Modelled freshwater fish species for the Wet Tropics, Dry Tropics and Mackay Whitsunday 2019 regional report cards. • Completed sampling of fish communities at 119 sites distributed across nine of eleven basins reported in the Wet Tropics and Dry Tropics report cards. Results were used as the basis for ecological assessment of the condition of freshwater fish communities in those areas.
7.7 Make data and information publicly available through a range of communication products.	eReefs	$250,000	$250,000	Annual	DES	This investment aims to enhance the scientific basis and integration of GBR terrestrial and marine water quality modelling within the current eReefs framework and build on innovation, enhanced data wrangling and other emulation projects. The enhanced catchment scenario and operational modelling aims to develop a suite of tools and systems to enable eReefs self-management of updates and automate supply of model outputs to eReefs, Paddock to Reef and other stakeholders. Representativeness of pollutants and associated generation/transformation to be considered as well as other emerging parameters, such as bioavailable nutrients, wetlands and estuarine modelling.	• Delivered an evaluation of Queensland Government core catchment load information and services to eReefs to inform eReefs strategy development. • Developed linear regression generation model alternative for water quality for 35 catchments. • Transferred scenarios to eReefs partners (CSIRO) for marine models to inform the Reef Water Quality Report Card 2019. • Commenced development of non-proprietary tools and alternative modelling environments to facilitate robust and efficient water quality models suitable for cross-agency deployment and advanced statistical analysis.



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