

**STAGE 1 REPORT: OUTCOME
EVALUATION OF THE LONG TERM
INTERVENTION MONITORING (LTIM)
AND ENVIRONMENTAL WATER
KNOWLEDGE AND RESEARCH
(EWKR) PROJECTS FOR THE
COMMONWEALTH ENVIRONMENTAL
WATER OFFICE**

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Contents

Executive Summary	iv
Background.....	iv
Findingsiv	
Recommendations for the CEWO’s future monitoring, evaluation and research program	vii
Improvements to the CEWO’s future monitoring, evaluation and research program	viii
Further considerations in designing the CEWO’s future monitoring, evaluation and research program	xi
Methodology	xii
Evaluation strategy	xii
Key evaluation questions (KEQs)	xiii
Evaluation criteria.....	xiii
Lines of evidence	xiii
Evaluators	xiii
1 This report	1
2 Findings in relation to merit, worth, and significance	1
2.1 Focal areas (Appendix D and F).....	1
2.2 High-level KEQs (Appendix D and F).....	2
2.3 Stakeholder Sentiment Analysis Findings (Appendix C and E)	3
2.4 Summary statement on LTIM evaluation.....	3
2.5 Summary statement on EWKR evaluation	4
3 Opportunities for moving forward	5
3.1 Sumative evaluation recommendations	5
3.1.1 Purpose of future MER	9
3.1.2 Improving governance and program management.....	9
3.1.3 Improving design, modelling and data management.....	10
3.1.4 Improving objectives	10
3.1.5 Improving communication.....	11
3.1.6 Improving integration	11
3.1.7 Improving adaptive management.....	12
3.1.8 Additions/refinements.....	13
3.2 Formative evaluation recommendations.....	13
3.2.1 Interview responses to options for moving forward	13
3.2.2 Evaluator synthesis workshop - Recommendations	15
3.3 Stage 2 of the CEWO’s review project	17
4 Methodology	18
Evaluation strategy	18
Lines of evidence	18
Evaluators	19

5	References cited	19
6	Glossary	20
	Appendix A: Evaluation Strategy	23
	Appendix B: KEQs, survey and interview questions	23
	Appendix C: EWKR stakeholder engagement report.....	23
	Appendix D: EWKR independent evaluators’ report - Boulton and Davies (2020).....	23
	Appendix E: LTIM stakeholder engagement report.....	23
	Appendix F: LTIM independent evaluators’ report - Hart, Ladson and Robinson (2020).....	23
	Appendix G: Independent Peer Review of Stage 1 outputs – Likens (2020)	23
	Appendix H: Summary of Stage 1 Outputs	23
	Appendix I: Re-cap of project context and approach	25
	Context 25	
	Evaluation purpose.....	25
	Evaluation design.....	25
	Modifications to the evaluation design	26
	Appendix J: Formative evaluation - analysis of interview responses on options for moving forward	28

Acronyms

BEWS	Basin-wide Environmental Watering Strategy
EWP	Environmental Water Plan
EWKR	Environmental Water Knowledge and Research
CEW	Commonwealth Environmental Water
CEWO	Commonwealth Environmental Water Office
KEQ	Key Evaluation Question
LTIM	Long Term Intervention Monitoring
MDBA	Murray-Darling Basin Authority
MEP	Monitoring and Evaluation Plan
MER	Monitoring, Evaluation and Research
MERI	Monitoring, Evaluation, Reporting, Improvement

EXECUTIVE SUMMARY

This document provides a summary of the independent evaluation of the Long-Term Intervention Monitoring (LTIM) and Environmental Water Knowledge Research (EWKR) projects undertaken by Water's Edge Consulting and associates for the Commonwealth Environmental Water Office (CEWO).

The LTIM evaluation was undertaken by Prof. Barry Hart, Assoc. Prof. Anthony Ladson and Dr Wayne Robinson¹. The EWKR evaluation was undertaken by Prof. Andrew Boulton and Prof. Peter Davies². Each evaluator made their initial assessment independently, followed by discussions to reach a consensus rating.

BACKGROUND

The LTIM project commenced in July 2014 with the aim of monitoring and evaluating the ecological and water quality response to Commonwealth environmental water (CEW) in the Murray-Darling Basin. The EWKR project commenced in June 2014 with the aim of improving knowledge about the ecological responses to environmental water to better inform the adaptive management of CEW. Both projects ended in June 2019³.

The CEWO is undertaking a *Review of the LTIM and EWKR projects* comprising three stages:

- Stage 1: Independent evaluation of the LTIM and EWKR projects (undertaken by Water's Edge Consulting and associates)
- Stage 2: Consultation with Murray-Darling Basin stakeholders (led by the CEWO, with support from the consulting team)
- Stage 3: Design of the CEWO's future monitoring, evaluation, and research activities (led by the CEWO).

The purpose of this Stage 1 project was to evaluate the merit, worth and significance of each project across five focal areas:

1. The extent to which the projects' objectives were achieved
2. The extent to which the projects supported the CEWO's legislative reporting requirements
3. How well the environmental outcomes were either demonstrated (LTIM) or supported the achievement of environmental outcomes (EWKR)
4. How well the findings were communicated to all stakeholders
5. The extent to which the projects were fit for purpose.

The CEWO also required the evaluation team to identify opportunities for improvement to be incorporated within the CEWO's future monitoring, evaluation, and research (MER) activities. These are summarised below under Recommendations for the future MER program.

FINDINGS

It is important to note that both the LTIM and EWKR projects were highly ambitious and included many aspirational objectives. The LTIM evaluators commented that:

*'The LTIM project is world-leading in its scope, both spatially (the entire Murray-Darling Basin) and temporally (5 years), objectives and budget (over \$32 million over 5 years). It sought to achieve an outcome – assessment of the effectiveness of Commonwealth environmental water (CEW) delivery in achieving local and Basin scale ecological outcomes – that has never been attempted before anywhere in the world. It was a highly ambitious project.'*⁴

¹ Hart, B.T, Ladson, T. and Robinson, W. (2020). Independent Expert Evaluators' Assessment of the Outputs and Outcomes of the Long-Term Intervention Monitoring (LTIM) Project, Stage 1 Report, Appendix F.

² Boulton, A.J and Davies, P.E.D. (2020). Independent expert evaluators' assessment of the outputs and outcomes of the Environmental Water Knowledge and Research (EWKR) Project, Stage 1 Report, Appendix D.

³ The CEWO has extended the activities of the LTIM and EWKR projects through an integrated Monitoring, Evaluation and Research (Flow-MER) program until June 2022 to: complete the LTIM Basin Evaluation (June 2020), and to review the success of the LTIM and EWKR projects to inform the design of the CEWO's future monitoring, evaluation, and research activities.

⁴ See Hart et al. (2020), p 7.

The specific findings of the evaluation of each project across the five focal areas is provided in Figure E 1, with further detail provided below.



Figure E 1. Overall evaluative judgement of value across focal areas for each project. The numbers relate to the five focal areas. The graphic is a 'traffic light' with the rating being moderate (yellow) for all focal areas. High (green) and low (red) ratings were not found for the focal areas.

THE EXTENT TO WHICH THE PROJECT OBJECTIVES WERE ACHIEVED

Overall, the LTIM project was assessed as being '*moderately effective*' in achieving its objectives, including aspects such as the contribution of CEW to Basin Plan objectives and at Selected Areas. The evaluators noted that there was scope to build on the relatively good quantitative assessments at Selected Areas, for example by increasing the use of statistical models to better demonstrate the contribution of CEW and other environmental water sources to ecological outcomes⁵.

The EWKR project was assessed as '*moderately effective*' in bringing researchers and managers together to discuss and share scientific information, by improving the understanding of the way environmental flow management influences ecosystem function and thereby sustains biodiversity, and by making this scientific information more available to support environmental water management by the CEWO and others, given the available time, funding and researchers' capabilities⁶.

THE EXTENT TO WHICH THE PROJECTS SUPPORTED THE CEWO'S LEGISLATIVE REQUIREMENTS

Overall, the LTIM project was assessed as being '*moderately appropriate*' in supporting the CEWO's legislative requirements. Some, but not all, of the legislative reporting requirements specified in the *Water Act 2007* and the Basin Plan (S12) were met. The required reporting scale is at the Basin-scale, and the annual Basin-scale evaluation reports provide information on the contribution of CEW to protection of biodiversity, ecosystem function and resilience of the water-dependent ecosystems of the Murray-Darling Basin. Although valuable, for most Basin Matters, these reports are focused on information collected at the seven Selected Areas with little information on other Basin areas. There were challenges in obtaining a Basin-scale synthesis for matters such as vegetation and fish because of a lack of data⁷.

⁵ See Hart et al. (2020) p 3-7.

⁶ See Boulton and Davies (2020) p 2-3.

⁷ See Hart et al. (2020) p 7.

Overall, the evaluators judged the information produced by the EWKR project to be *'moderately appropriate'* in supporting the CEWO in meeting their legislative requirements. However, it was acknowledged that the EWKR research was not specifically designed with this intent but was more focused on addressing knowledge gaps to improve environmental water management⁸.

HOW WELL THE ENVIRONMENTAL OUTCOMES WERE EITHER DEMONSTRATED (LTIM) OR SUPPORTED THE ACHIEVEMENT OF ENVIRONMENTAL OUTCOMES (EWKR)

Overall, the LTIM project was assessed as being *'moderately effective'* in demonstrating environmental outcomes, including aspects such as the contribution of CEW to Basin Plan objectives and at Selected Areas⁹. In terms of the Basin Matters, there is tension between the design of the project around Selected Areas and the need to report at the Basin-scale. This created a mismatch of scales for monitoring and reporting that particularly applies to vegetation, fish, biodiversity, and stream metabolism and water quality. This is less of an issue for hydrology and ecosystem diversity as these are based on Basin-scale evaluations. Quantitative demonstration of ecological outcomes at the Basin-scale was challenged by the lack of a method to infer outcomes to areas not monitored. Qualitative descriptions of outcomes are provided in the annual synthesis reports¹⁰.

Overall, the EWKR project was assessed as *'moderately effective'* in improving the understanding of how environmental flow management influences the achievement of environmental outcomes over time, and in developing predictive tools, conceptual models and frameworks to inform environmental watering regimes¹¹. It was acknowledged that improvement in understanding is still taking place, which will happen via ongoing communication between scientists and managers¹².

HOW WELL THE FINDINGS WERE COMMUNICATED TO ALL STAKEHOLDERS

Overall, the LTIM project was rated *'moderately effective'* in communicating key findings to stakeholders. The evaluators identified the lack of a communications strategy from the commencement of the LTIM project as a deficiency at the whole-of-project level. At the Selected Area scale, some local communication plans were established; however, the effectiveness of these plans varied¹³. In general, there was a lack of reporting on what communication activities were undertaken by Selected Area and Basin Matter teams and other project members. Consistent feedback from the interviews was that neither the Selected Area nor the Basin Matter reports were particularly effective in targeting key stakeholders¹⁴.

Overall, the EWKR project was evaluated as *'moderately effective'* in communicating findings to stakeholders. The reports and scientific papers produced were effective, but other media more routinely accessed by key stakeholders such as water managers was less effective. The EWKR 'Story Space', instigated half-way during the project, was acknowledged as being effective in communicating findings to a wider audience¹⁵.

THE EXTENT TO WHICH THE PROJECTS WERE FIT FOR PURPOSE

The evaluators assessed the LTIM project design was *'moderately appropriate'* with respect to being fit for purpose in meeting the CEWO's strategic requirements. The LTIM Basin-scale Evaluation Plan was considered fit for purpose in most areas. The project design made appropriate use of existing scientific and complementary knowledge and cause-and-effect diagrams in developing appropriate standard methods. In addition, best available scientific and much local knowledge was appropriately used to develop the Selected Area Monitoring and Evaluation Plans, which were the basis for monitoring and evaluating the contribution of CEW to ecological outcomes at the Selected Areas. There was, however, no consistent consideration of cultural knowledge¹⁶.

⁸ See Boulton and Davies (2020) pp 3-4.

⁹ See Hart et al. (2020) pp 7-8.

¹⁰ See Hart et al. (2020) pp 118-138.

¹¹ See Boulton and Davies (2020) p 3.

¹² See Boulton and Davies (2020) p 60.

¹³ See Hart et al. (2020) pp. 107-109.

¹⁴ See Hart et al. (2020) p 8.

¹⁵ See Boulton and Davies (2020) p 3.

¹⁶ See Hart et al. (2020) pp 8-9.

The EWKR project was rated as ‘*moderately appropriate*’ with respect to being fit for purpose. The alignment with Basin Plan objectives during planning, the relevance of the priority research questions to the three overall Environmental Watering Plan objectives, and the research and evaluation plans for each research theme, were all rated ‘*appropriate*’, and the design of the overall project as ‘*moderately appropriate*’¹⁷. However, the project was assessed as ‘*inappropriate*’ in two aspects. The first was in improving the understanding of how the major drivers of system condition (e.g., environmental flow, land use, invasive species etc.) interact to affect biodiversity, ecosystem function, resilience and water quality. Research addressed water and flow drivers but other non-flow drivers and threats was patchy. The second was in the extent to which environmental water effectiveness was improved through the application of science, this suffered from the lack of targeted research into these operations¹⁸.

RECOMMENDATIONS FOR THE CEWO’S FUTURE MONITORING, EVALUATION AND RESEARCH PROGRAM

*‘A fundamental component to the success of this CEWO project in the future is integration of the pieces of the project, integration of the questions driving the research and monitoring, integration of the data collected, integration of the diverse findings at the system level, and integration of the reporting of findings’*¹⁹

The evaluators of both LTIM²⁰ and EWKR²¹ provided separate recommendations relating to possible improvements to the CEWO’s future monitoring, evaluation and research activities. These recommendations were considered at the December synthesis workshop in consultation with the CEWO and grouped into two categories: improvements and further considerations in designing and developing the CEWO’s future monitoring, evaluation and research program. Interview responses from stakeholders were also taken into consideration to arrive at the recommendations presented below. Figure E 2 provides a schematic summary of key points raised in the synthesis workshop which informed the final set of recommendations.

¹⁷ See Boulton and Davies (2020) p 88.

¹⁸ See Boulton and Davies (2020) p 4.

¹⁹ Likens, G.L. (2020) Review of Evaluative Process and Outputs from the Program Evaluation of the Long-term Intervention Monitoring (LTIM) and Environmental Water Knowledge and Research (EWKR) Projects for the Commonwealth Environmental Water Office (CEWO), p 4.

²⁰ See Hart et al. (2020) pp 11-20.

²¹ See Boulton and Davies (2020) pp 6-11.

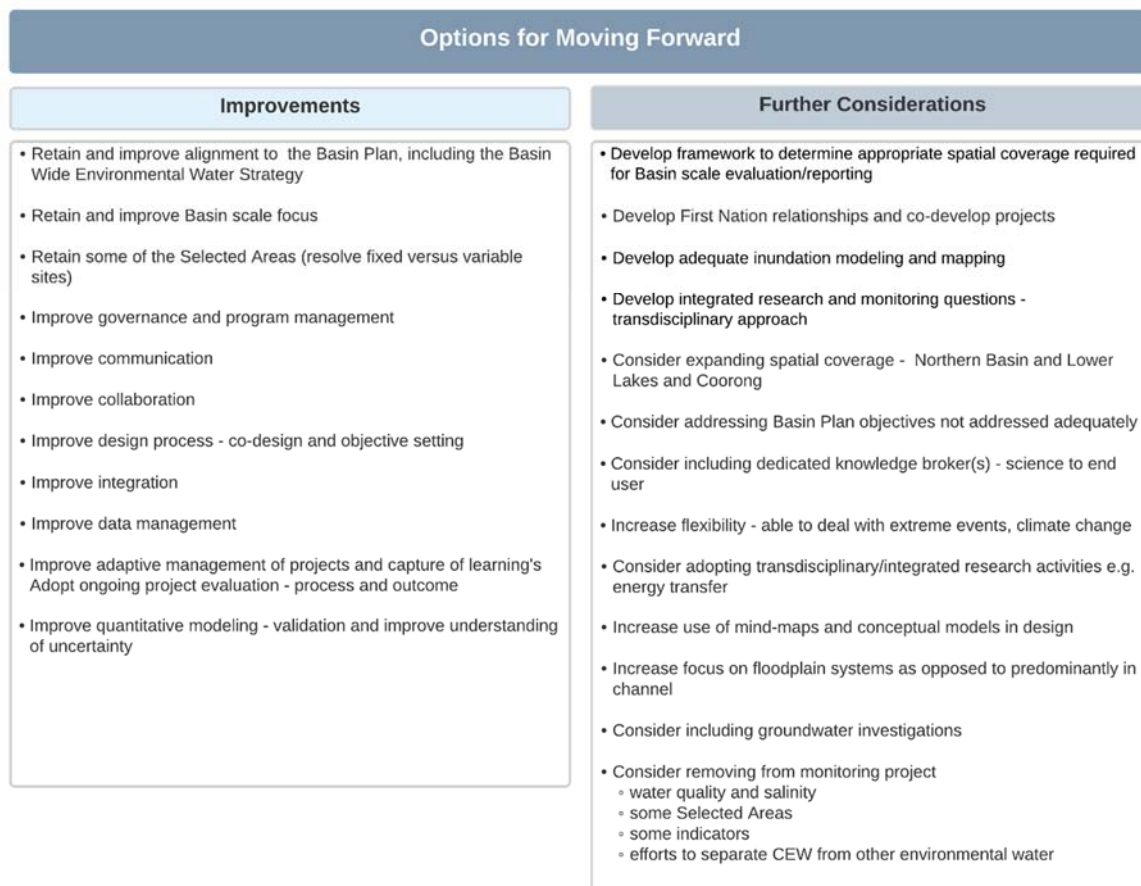


Figure E 2. Schematic summary of the key points considered in making the final recommendations for designing and developing the CEWO’s future, monitoring, evaluation and research program.

IMPROVEMENTS TO THE CEWO’S FUTURE MONITORING, EVALUATION AND RESEARCH PROGRAM

Recommendation 1 - Purpose and objectives

The purpose of the CEWO’s future monitoring, evaluation and research program will be to contribute to the CEWO’s legislative requirement to evaluate the ecological outcomes of CEW at the Basin-scale. The initial design of the LTIM objectives was focused on an interpretation of the relevant objectives of the Basin Plan²², which are very high level and proved difficult to translate into achievable monitoring objectives. However, since then the MDBA has produced a more detailed Basin-wide Environmental Watering Strategy (BEWS) that has better defined and environmental outcomes.

The BEWS defined four broad categories of expected environmental outcomes from implementation of the Basin Plan - river flows and connectivity, native vegetation, water birds and native fish. Also, in the recent 2020 Evaluation of the Basin Plan²³, the MDBA has evaluated the hydrological, environmental and water quality outcomes at the Basin-scale in five categories – restoring southern Basin rivers, restoring northern Basin rivers, improving the Murray-Darling end of system outcomes, watering the floodplains and wetlands of the Basin, and improving water quality and salinity.

²² These relate to Chapter 8 (Environmental watering plan) and Chapter 9 (Water quality and salinity management plan) and Chapter 13 (Program for monitoring and evaluating the effectiveness of the Basin Plan).

²³ MDBA (2020). The 2020 Basin Plan Evaluation, Murray-Darling Basin Authority, Canberra, 168 pp.

It is recommended that the CEWO's future monitoring, evaluation and research program objectives:

- *be based on the BEWS*
- *address Basin Plan objectives not adequately addressed to date²⁴*
- *are SMART²⁵*
- *focus on evaluating the ecological effects of all environmental water (that is both 'held' and 'planned' water) and not just CEW²⁶*
- *include First Nations cultural water needs*
- *shift emphasis from channel to floodplain investigations.*

Recommendation 2 – Basin-scale evaluation

The evaluators supported the use of data from Selected Areas to inform Basin-scale evaluations but raised the issue of the most appropriate sampling design, e.g., multiple fixed Selected Areas, multiple variable Selected Areas or a mix of fixed and variable Selected Areas²⁷.

It is recommended that:

- *the CEWO determine whether a Basin-scale evaluation is best supported by fixed Selected Areas, variable Selected Areas or a mix of the two before designing an appropriate monitoring, evaluation and research approach*
- *a robust method(s) for integrating this local data to the Basin-scale be developed (see also Recommendation 4).*

Recommendation 3 – Co-development

Neither the LTIM nor the EWKR²⁸ projects were cooperatively developed (co-developed) with all relevant stakeholders. This resulted in significant disruption in the initial implementation of both projects that could have been avoided. To improve the logic of planning, communication and management of future monitoring, evaluation and research activities mind-mapping should be incorporated into the co-development process.

It is recommended that:

- *the CEWO's future monitoring, evaluation and research program is co-developed with relevant stakeholders*
- *any targeted research components are well linked and integrated with the monitoring and evaluation components from the start²⁹*
- *and captured using mind-mapping as appropriate.³⁰*

Recommendation 4 - Quantitative modelling

It was recognised during the development of LTIM that quantitative hydro-ecological models relating environmental water to ecological outcomes would be essential to evaluate the environmental benefits of CEW at both the local- and Basin-scale, and for inferring ecological outcomes at non-monitored areas. However, few such models were developed during the LTIM project. Two areas need to be targeted: hydro-ecological outcome models; and floodplain inundation models³¹.

It is recommended that:

- *a model development plan be established from the commencement of the CEWO's future monitoring, evaluation and research program, this plan should:*
 - *focus on the development of quantitative flow-ecology and floodplain inundations models*
 - *be implemented by an adequately resourced hydro-ecological modelling team.*

²⁴ See Hart et al. (2020) pp 12-13.

²⁵ Specific, Measurable, Achievable, Relevant and Time bound. See Boulton and Davies (2020) p 6.

²⁶ See Hart et al. (2020) p 15.

²⁷ See Hart et al. (2020) pp 13-14.

²⁸ See Boulton and Davies (2020) p 6.

²⁹ See Boulton and Davies (2020) p 7.

³⁰ See Boulton and Davies (2020) p 8.

³¹ See Hart et al. (2020) pp 15-17.

Recommendation 5 - Data management

Data management was raised as a key issue for both the LTIM and EWKR projects^{32 33}.

It is recommended that the CEWO's future, monitoring, evaluation and research program has:

- *a data management system that is robust, with strong data governance and a dedicated data manager to ensure compliance, and is protected against fire, vandalism and theft*
- *a database that is accessible, meet the needs of the research program as well as client and stakeholder groups*
- *data protocols that comply with industry standards and are embedded within each individual research and monitoring activity*
- *meta-data with clear, consistent rules for data access and recognition of intellectual property*
- *a data management system that is properly resourced.*

Recommendation 6 - Governance and program management

The LTIM and EWKR projects had strengths and weaknesses in differing aspects of governance and project management. Both evaluator teams concluded that that CEWO needs to establish more robust governance and project management arrangements for the new program^{34 35}.

It is recommended that the CEWO's future, monitoring, evaluation and research program include:

- *an overall program manager*
- *a program steering committee to assist the program manager and assist with collaboration*
- *the establishment of an independent science review committee to ensure the quality of the science being undertaken.*

Recommendation 7 - Collaboration and communication

The evaluators identified a number of areas where effective collaboration occurred in the LTIM³⁶ project (e.g., between the Selected Area scientists and the CEWO Delivery Teams), but overall there was a lack of effective collaboration. Equally, while some communication products were produced there was a lack of a strategic approach. Collaboration within the EWKR project was aided greatly by the consultative nature of within-theme (and occasionally between-theme) development of research questions and conceptual models; however project outputs could have been generated more efficiently if the research activities had commenced sooner and there had been more effective collaboration and communication with managers and other end-users³⁷.

It is recommended that:

- *a project collaboration, communication and reporting plan be established at the start of the CEWO's future, monitoring, evaluation and research program*
- *appropriately skilled staff be engaged to produce a range of communication products³⁸*
- *examples of collaboration and communication be collected, documented and reported annually.*

Recommendation 8 - Integration of monitoring, evaluation and research

The evaluators recognise the desirability of a targeted research program to support the CEWO's future, monitoring, evaluation and research program. It will be important that this research is focused on stakeholder needs, can deliver fit-for-purpose products within the contract period and is well integrated with the monitoring and evaluation project³⁹. This was not the case with the LTIM and EWKR projects, which at the time were designed separately. Acknowledging the need for monitoring and research to be integrated, the CEWO designed the Flow-MER project to integrate the LTIM and EWKR projects into one program. However, further integration is required

³² See Hart et al. (2020) p 17.

³³ See Boulton and Davies (2020) pp 9-10.

³⁴ See Hart et al. (2020) p 18.

³⁵ See Boulton and Davies (2020) pp 5-6, 8-9

³⁶ See Hart et al. (2020) pp 17-18.

³⁷ See Boulton and Davies (2020) p 5.

³⁸ See Boulton and Davies (2020) pp 8, 10.

³⁹ See Boulton and Davies (2020) p 7.

at multiple levels, including at the program design phase, between service provider teams and in the development of multidisciplinary research to support meeting the CEWO's legislative requirements^{40 41}.

It is recommended that CEWO's future, monitoring, evaluation and research program:

- *is co-designed with relevant stakeholders*
- *has better alignment of research with the monitoring from the start*
- *supports transdisciplinary research that brings together researchers from multiple disciplines*
- *ensures managers work together during all the phases of planning, data collection and interpretation, and communication of findings.*

Recommendation 9 - Adaptive management

The evaluators identified that effective adaptive management did occur between the seven Selected Area teams and the three CEWO Water Delivery Teams (and other environmental water managers), but that adaptive management of environmental water at the Basin-scale was demonstrated to a lesser extent. In addition, despite being a fundamental objective of the EWKR project, there was limited evidence of adaptive management outcomes demonstrated within the timeframe of the project and the evaluation⁴². Neither project had a system for collecting, synthesising and reporting the adaptive management learnings⁴³.

It is recommended that a comprehensive knowledge management strategy:

- *be developed for the CEWO's future, monitoring, evaluation and research program to support the adaptive management of CEW*
- *includes the appointment of knowledge brokers to assist with the capture, collation and dissemination of the lessons from management of CEW.*

FURTHER CONSIDERATIONS IN DESIGNING THE CEWO'S FUTURE MONITORING, EVALUATION AND RESEARCH PROGRAM

Recommendation 10 - Flexibility

The evaluators questioned the design of LTIM fixed Selected Areas sampled each year and EWKR priority research sites, and identified the need for greater flexibility in the future MER program and more 'real time' field research. This need was captured in Recommendation 2 above.

Climatic change predictions are that the Murray-Darling Basin will experience a greater frequency of extreme events, particularly droughts. This will make more challenging meeting the Basin Plan objective related to increasing the resilience of water-dependent populations of native flora and fauna. Additionally, it is likely that other 'surprises' will occur during the lifetime of the next MER program, making it desirable that the program is as flexible and nimble as possible^{44 45 46}.

It is recommended that the CEWO's future, monitoring, evaluation and research program be sufficiently flexible to be able to inform Basin-scale evaluations, and to respond to extreme events and unexpected future changes.

Recommendation 11 - Social and cultural sciences

This evaluation has identified two areas that need greater consideration in the CEWO's future, monitoring, evaluation and research program. The first is greater involvement of First Nations in environmental watering planning and delivery, and the second is increased focus on the social science of interactions and communications with stakeholders^{47 48}.

It is recommended that the planning, design and implementation of the CEWO's future, monitoring, evaluation and research program have greater involvement of cultural and social sciences.

Recommendation 12 - Groundwater

⁴⁰ See Hart et al. (2020) pp. 6, 19, 73, 35, 184.

⁴¹ See Boulton and Davies (2020) pp. 7, 91, 107, 120, 122, 126, 134-136, 145-146.

⁴² See Boulton and Davies (2020) p 4.

⁴³ See Hart et al. (2020) p 19.

⁴⁴ See Boulton and Davies (2020) pp. 7-8, 120, 145-146.

⁴⁵ See Hart et al. (2020) pp. 34-35, 161.

⁴⁶ See Likens (2020) p 4.

⁴⁷ See Hart et al. (2020) pp. 11, 19.

⁴⁸ See Boulton and Davies pp. 7, 9, 11.

Currently, the focus of the monitoring and research themes on environmental watering is entirely on the surface water component. Groundwater is connected to the surface water in many places in the MDB and environmental water differentially interacts with groundwater via recharge and discharge in different parts of the Basin and at different times. Further, groundwater processes will influence many hydrological, biogeochemical and ecological responses to environmental watering, and would be relevant for some of the themes [vegetation and groundwater-dependent ecosystems (GDEs) spring to mind]. A comprehensive perspective of the MDB ecosystems and environmental watering should explicitly incorporate the groundwater component.

It is recommended that the planning, design and implementation of the CEWO's future, monitoring, evaluation and research program give consideration to including groundwater-surface water interactions affected by environmental watering.

Recommendation 13 - Additional monitoring sites

The evaluators identified a lack of monitoring locations in the northern Basin and suggested this should be reviewed in the CEWO's future, monitoring, evaluation and research program⁴⁹. There are questions about the suitability of the Warrego-Darling Selected Area, particularly its representativeness of the northern Basin, the general lack of CEW in the area, and the difficulties in monitoring this site⁵⁰. Additionally, the evaluators noted that despite being a Ramsar site, and requiring attention by the Basin Plan, the Lower Lakes and Coorong at the end of the River Murray system were not monitored during LTIM.

It is recommended that the CEWO's future, monitoring, evaluation and research program consider additional monitoring sites in the northern Basin and the inclusion of the Lower Lakes and Coorong as a Selected Area.

Recommendation 14 - Water quality and salinity

The CEWO is required under its legislative requirement to report on the effect of CEW on water quality and salinity. However, the evaluators noted that the monitoring of water quality and salinity was infrequent and not well linked with CEW⁵¹.

It is recommended that the CEWO's future, monitoring, evaluation and research program review the water quality and salinity monitoring and either:

- *improve this monitoring so it is better linked with specific flow indicators, or*
- *utilise data from state monitoring programs (these may need some modification to make the data more useful to the CEWO).*

Recommendation 15 - Indicators

The evaluators identified the need to review the relevance to Basin-scale evaluation of certain LTIM Category I and II indicators monitored. Additionally, the potential for omitting or scaling back resource intensive indicators, such as larval fish sampling, was also suggested⁵².

It is recommended that the CEWO's future, monitoring, evaluation and research program review all ecological indicators for their relevance the Basin-scale evaluation and their value for money.

Recommendation 16 - Selected Areas

The evaluators questioned the relevance of two Selected Areas: the Warrego-Darling and the Lower River Murray. The Warrego-Darling is discussed in Recommendation 13. The Lower River Murray site was questioned regarding its representativeness of the River Murray channel (mainly lentic (lake) habitats in this region) and the lack of ability to manipulate CEW in this region since all environmental water is dependent upon upstream actions⁵³.

It is recommended that the CEWO's future, monitoring, evaluation and research program review the appropriateness of continuing with the Warrego-Darling and Lower River Murray as fixed Selected Areas sites.

METHODOLOGY

EVALUATION STRATEGY

⁴⁹ See Hart et al. (2020) p 14.

⁵⁰ See Hart et al. (2020) pp. 99, 92, 85, 86, 79, 82, 96, 126, 205

⁵¹ See Hart et al. (2020) p 13.

⁵² See Hart et al. (2020) pp. 14-15.

⁵³ See Hart et al. (2020) p 68

The evaluation strategy, its design and implementation, is detailed in Butcher and Schreiber (2020)⁵⁴. The design was developed in consultation with the CEWO.

KEY EVALUATION QUESTIONS (KEQS)

These were used to define the information that the evaluation would consider and to provide a focus and a frame for the evaluation to enable robust conclusions to be reached. The KEQs were also designed to address other relevant needs of the CEWO, such as how the two programs contribute to meeting the CEWO's Basin Plan requirements⁵⁵.

The KEQs were nested at three levels (high, mid and micro-levels) and framed by reference to:

- the planning/foundation documents that describe the objectives and intended outcomes for each of the projects
- address the focal areas
- the evaluation criteria (effectiveness, appropriateness, impact and efficiency).

Mid-level KEQs aggregate evidence across themes and/or spatial scales (e.g., Selected Area or Basin scale) to inform the high level KEQs. The micro-level KEQs aggregate evidence to inform the mid-level KEQ and were mostly focused on theme level questions, often relating to specific research or monitoring questions from each project.

EVALUATION CRITERIA

Rubrics containing three levels of performance standards (low, moderate, high) were developed to assess each KEQ related to each criterion - effectiveness, appropriateness, impact and efficiency.

LINES OF EVIDENCE

Three lines of evidence - project reports, surveys and interviews with stakeholders - were used to evaluate just under 150 KEQs for each project. For the EWKR project: an online survey addressing 35 KEQs was sent to 78 stakeholders with 38 (49%) returning responses; 43 stakeholders were interviewed; and 45 documents were evaluated. For the LTIM project: an online survey addressing 36 KEQs was sent to 82 stakeholders with 38 (46%) providing responses; 40 stakeholders (predominantly service providers and the CEWO) were interviewed; and 249 documents were evaluated.

EVALUATORS

Each evaluator made their initial assessment independently, followed by discussions to reach a consensus rating in cases where differences of opinion occurred. Prof. Gene Likens provided a high-level review of both the EWKR and LTIM evaluations⁵⁶. All judgements and consensus reasoning are captured in the evaluator reports. A synthesis workshop was held in December 2020 where recommendations for improvement to the CEWO's future MER program were discussed.

⁵⁴ Butcher, R. and Schreiber, E.S.G. (2020). Evaluation Strategy for the Long-Term Intervention Monitoring and Murray-Darling Basin Environmental Water Knowledge and Research projects. Report by Water's Edge Consulting and Associates to the Commonwealth Environmental Water Office, Canberra.

⁵⁵ See Butcher and Schreiber (2020) p 6-7.

⁵⁶ Likens, G. (2020). Expert peer review of evaluative process and outputs from the Program Evaluation of the Long Term Intervention Monitoring (LTIM) and Environmental Water Knowledge and Research (EWKR) projects. Report to Water's Edge Consulting. 7 pp.

1 THIS REPORT

This document summarises the main outputs from the Stage 1 end-of-program outcome evaluation of the Commonwealth Environmental Water Office's (CEWO) Long Term Intervention Monitoring (LTIM) and Murray-Darling Environmental Water Knowledge and Research (EWKR) projects. It summarises the extent to which the LTIM and EWKR projects effectively achieved their objectives, were appropriately designed and produced impactful outcomes that led to improved management of environmental water. The results reported here are based on what was done in 2014-2019.

The report contains the following sections:

- Findings relating to each project's merit, worth and significance (Section 2)
- Recommendations for moving forward (Section 3)
 - Recommendations based on the summative evaluation (Section 3.1)
 - Recommendations based on the formative evaluation including findings from the interviews for the EWKR and LTIM projects relating to opportunities for moving forward (Executive Summary and Section 3.2).
- Recap on the methodology employed (Section 4).

The following appendices should be read in conjunction with this report (**note:** Appendices A-G are separate documents):

- Appendix A, Butcher and Schreiber (2020), provides the evaluation strategy which outlines the context and approach
- Appendix B, Butcher et al. (2020), provides the key evaluation questions, survey and interview questions for each project
- Appendix C, Butcher and Fenton (2020a), provides the results of the EWKR survey and sentiment analysis of the interviews
- Appendix D, Boulton and Davies (2020), provides the independent evaluators' report for the EWKR project
- Appendix E, Butcher and Fenton (2020b), provides the results of the LTIM survey and sentiment analysis of the interviews
- Appendix F, Hart et al. (2020), provides the independent evaluators' report for the LTIM project
- Appendix G, Likens (2020), provides the expert peer review of Stage 1 outputs
- Appendix H lists the outputs generated in the Stage 1 evaluation
- Appendix I provides a re-cap on the context of the project, the evaluation design and the modifications adopted during the evaluation
- Appendix J provides the coding and examples of interview responses for focal area six – Options for moving forward.

2 FINDINGS IN RELATION TO MERIT, WORTH, AND SIGNIFICANCE

2.1 FOCAL AREAS (APPENDIX D AND F)

The evaluation addresses five focal areas to determine:

1. the extent to which the projects' objectives were achieved
2. the extent to which the projects supported the CEWO's legislative reporting requirements
3. how well the environmental outcomes were either demonstrated (LTIM) or supported the achievement of environmental outcomes (EWKR)
4. how well findings were communicated to all stakeholders
5. the extent to which the projects were fit for purpose

A sixth focal area was to synthesise the findings from the evaluation to identify:

6. what opportunities there are for improvement to support the CEWO's future monitoring, evaluation, and research activities.

The overall evaluative judgement of value (merit and worth) of the projects across the first five focal areas is illustrated in Figure 1. Both projects were rated as 'moderately effective' in achieving their objectives, supporting

CEWO’s legislative requirements, including either supporting the achievement of environmental outcomes (EWKR) or demonstrating outcomes (LTIM).



Figure 1. Overall evaluative judgement of value across focal areas for each project. The numbers relate to the five focal areas. The graphic is a ‘traffic light’ with the rating being moderate (yellow) for all focal areas. High (green) and low (red) ratings were not found for the focal areas.

The worth of the projects was also rated as ‘moderate’, in that both projects had areas in which they were minimally effective in communicating findings to stakeholders. The project design was judged as ‘moderately appropriate’.

The ‘moderate’ rating was reached based on the independent evaluator assessments for each project (see Appendices D and F). In many cases, this reflected the process of aggregating the findings from the micro-level to the mid-level KEQs, then from the mid-level KEQs to the high-level KEQ. If more than a single high-level KEQ contributed to an overall judgement for a focal area (e.g., LTIM had 4 high-level KEQs aggregated to the focal area judgment for achieving objectives), then it is likely that an averaging to a ‘moderate’ rating will occur. Note that this approach was more closely followed in the LTIM evaluation and reflected the more nested nature of the KEQs.

It is important to note that whilst the overall evaluative ratings of merit and worth for both the LTIM and EWKR projects were ‘moderate’, both these projects were highly ambitious and included many aspirational objectives. For example, the LTIM evaluators noted that:

“The LTIM project is world-leading in its scope, both spatially (the entire Murray-Darling Basin) and temporally (5 years), objectives and budget (over \$32 million over 5 years). It sought to achieve an outcome – assessment of the effectiveness of Commonwealth environmental water (CEW) delivery in achieving local and Basin scale ecological outcomes – that has never been attempted before anywhere in the world. It was a highly ambitious project.” Hart et al. (2020), p1.

2.2 HIGH-LEVEL KEQS (APPENDIX D AND F)

For the high-level KEQs⁵⁷, the EWKR project was rated as having been ‘efficient’ at collaboration within the EWKR project, a significant outcome for the project which will form the foundation of future research collaborations across the Basin. The LTIM project was judged as being ‘effective’ at monitoring at the Selected Area scale, with the outcomes at this scale being significant for the overall project. Both projects were judged as having been

⁵⁷ See Appendix B, Butcher et al. (2020) for all Key Evaluation Questions for both projects.

inefficient in data management and sharing. Each project also performed poorly in another of their objectives: for EKWR, it was in supporting adaptive management, and for LTIM it was in inferring outcomes to areas that were not monitored in the Basin (Figure 2).

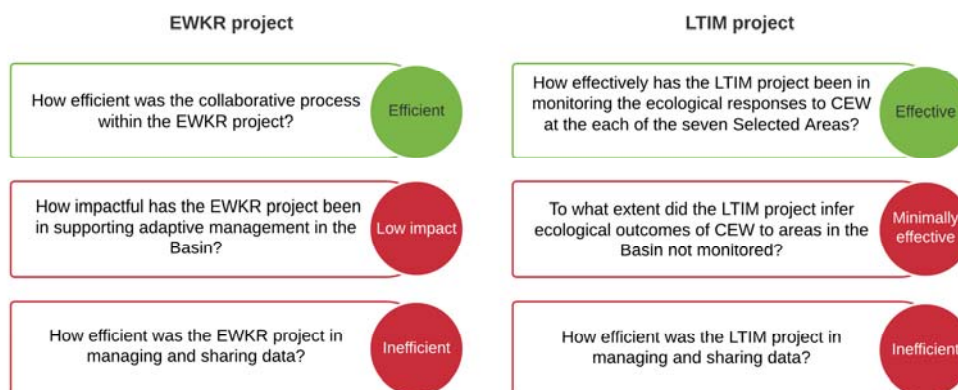


Figure 2. Evaluative judgements of the high-level KEQs for each project that were either rated very high or very low. The remaining high-level KEQs were rated as ‘moderate’.

2.3 STAKEHOLDER SENTIMENT ANALYSIS FINDINGS (APPENDIX C AND E)

Analysis of the sentiment of stakeholders in the interview responses for the EWKR project indicated (Appendix C):

- confidence in the science undertaken
- that the project represented value for money
- that interactions between the stakeholder groups and other agencies have improved across the Basin because of the EWKR project
- positive responses about the adoption and/or use of knowledge, guidance, and tools generated by the EWKR project.

For the LTIM project, interviewed stakeholders indicated positive sentiment relating to (Appendix E):

- the achievement of objectives
- the extent to which the overall LTIM project was aligned to the Basin Plan objectives
- that it was fit-for-purpose to meet the CEWO’s strategic requirements
- that the project had high impacts on the adaptive management of environmental water
- the ecological outcomes of Commonwealth environmental water
- implementation of the Basin Plan.

Overall, both projects were evaluated as significant. Research findings across the four themes of the EWKR project have significantly contributed to our understanding of likely ecological responses of biota and ecosystems across the Murray-Darling Basin to environmental watering, effectively complementing the LTIM project. These findings also support the CEWO’s legislative requirements, and the overall outputs were generally good value for money.

The findings presented above relate to the first five focal areas; the sixth focal area is addressed, in part, by the recommendations listed in Section 3. Additional information obtained during Stage 2 (see Sections **Error! Reference source not found.** and **Error! Reference source not found.**) will capture the full set of recommendations for improvements to the CEWO’s monitoring, evaluation and research program moving forward.

2.4 SUMMARY STATEMENT ON LTIM EVALUATION

Overall, the evaluators identified the key strengths of LTIM as:

- Monitoring of ecological response at the Selected Area scale (KEQ 1A)

- Annual Forums (KEQ 1.2 and KEQ 12.2.2)
- Annual evaluation of hydrology (KEQ 2.4.1) and ecosystem diversity (KEQ 2.4.2)
- Evaluation of ecological outcomes in the Goulburn Selected Area (KEQ 3.5)
- The Basin-scale evaluation plan (KEQ 8.7) and incorporation of best available knowledge into monitoring and evaluation findings (KEQ 8.6)

There were four areas where there were failings:

1. Inference of ecological outcomes of Commonwealth environmental water at the Basin scale.

This included problems inferring outcomes in areas that were not monitored (KEQ 4), in extrapolation of findings from reach to whole of Selected Area (KEQ 4.1) and from Selected Area to the Basin (KEQ 4.2). These issues contributed to poor ratings related to reporting at the Basin scale, annually (KEQ 2.3.2) and cumulatively (KEQ 2.3.3) and via Basin-scale synthesis reports (KEQ 3.8). These and related issues led to low ratings for KEQs 6.3, 6.4, 6.6 and 6.7 and inefficiencies noted in KEQ 11.2.1. One of the main causes of problems with Basin-scale reporting was the lack of progress in predictive modelling (KEQ 8.5.4).
2. Communication and consultation.

Although overall, this was done moderately well (KEQ 5), there were problems consulting with service providers (KEQ 1.4), identifying and making use of existing communication channels and networks (KEQ 5.1.3) and planning communication activities (KEQ 5.1.5).
3. Management of data.

Problems with data management contributed to poor evaluations in a range of KEQs including those related to achieving objectives (KEQ 1.8.2) and efficiency (KEQ 13.1).
4. There were also low ratings related to alignment with Basin Plan objectives resilience (KEQ 2.2.3) and water quality (KEQ 2.2.4) and meeting Basin Plan reporting requirements (KEQ 7.2).

There were also some areas where evaluators were not able to provide a rating because of a lack of evidence. The most significant of these were in the evaluation of efficiency, particularly KEQ 11.1 “How efficiently were the funds and time allocated to address the LTIM project objectives?”. This is certainly an important question and it may be possible for it to be answered, but details of budgets and activities at the Selected Area scale would be required.

2.5 SUMMARY STATEMENT ON EWKR EVALUATION

Overall, the evaluators identified the key strengths of the EWKR project as:

- Presentation of high-quality science in technical reports and scientific papers (KEQ 2) describing the responses of components of vegetation, fish, waterbirds and foodwebs to environmental watering (KEQ 3.2 and sub-questions)
- Reviews of relevant literature and development of conceptual models of likely links among drivers, environmental watering and the four themes which also revealed knowledge gaps and helped focus subsequent work (KEQ 3, KEQ 3.3 and KEQ 5.5)
- Relevance of the research to supporting the CEWO in meeting some of their legislative requirements (KEQ 4)
- Alignment of some of the research themes (notably the fish and foodweb themes, KEQs 5.1b and 5.1d) with relevant policy instruments (e.g., Basin Plan, Basin-wide Environmental Watering Strategy)
- Robustness of the research program logic within several of the themes (notably the vegetation and waterbird ones, KEQs 5.5a and 5.5c)
- Appropriateness of the research and evaluation plans for each research theme (KEQ 5.7)
- Efficient within-project collaboration (KEQ 9) that, for most themes, also extended to external researchers and water managers (KEQs 9.1a-c).
- Efficient use of resources within themes to optimise high-quality outputs (KEQs 10.1a-c)

Four failings of the EWKR project were:

1. Not achieving all of the original objectives specified in the Grant Guidelines.

This was primarily a result of these original objectives being unrealistically ambitious and lacking clarity and research-specificity. As a result, the subsequent process of refining and prioritising the research questions cost the project precious time (KEQ 7) and contributed to poor ratings related to assessing ecological responses to interactions of non-flow drivers with environmental watering (KEQ 3.4 and KEQ 5.4) and to multiple management interventions (KEQ 7.1) and of the links between ecosystem responses to watering regimes and management interventions with incremental changes in ecological condition (KEQ 7.1h and KEQ 7.1i). The delayed start also hampered the timely generation of research outputs (KEQ 10).

2. Ineffective communication of the implications of research findings for enhancing water management.

Communicating to key end users (water managers) about how EWKR's research outcomes might enhance environmental water management was poor (KEQ 2.1b), an effective communication strategy was not in place until half-way through the project (KEQ 2.1) and the information was unable to help build and support collaboration (KEQ 2.2c). These failings seriously limited the impact of the EWKR project in improving environmental watering (KEQ 6), particularly for adaptive management in some themes (KEQs 6.1 a, d and e). It also restricted the extent to which the EWKR project built capacity to report against Basin Plan environmental objectives and targets (KEQ 3.7). With time, it is hoped that there will be more uptake of research information and some demonstrable improvements.

3. Poor integration among the four research themes.

There was little coordinated data collection or collaborative field activities (e.g., concurrently sampling sites) across the four research themes which compromised the integration of the research findings and thus, the appropriateness of the project being fully fit for purpose (KEQ 5). In particular, the 'silo' nature of the research themes arose from a lack of strong science leadership at the theme-level and above which led to inefficiencies in decision-making and inflexibility in allocation of resources among projects (KEQ 10).

4. Data management.

The EWKR project was inefficient in managing and sharing data (KEQ 8), particularly with external collaborators (KEQ 8.1a). Data management protocols were inconsistent and inefficient (KEQ 8.2a) and data access to end users was limited (KEQ 8.2b).

For some areas, evaluators were unable to provide a rating because of a lack of evidence. Two of these were how information produced by each theme of the EWKR project and its synthesis encouraged stakeholders to strive to maintain and improve their contributions to Basin Plan environmental objectives (KEQ 2.2b) and the efficiency of data-sharing with end users such as the MDBA (KEQ 8.1b). The second one is of particular interest, especially given the limitations of data access to end users (see previous paragraph).

3 OPPORTUNITIES FOR MOVING FORWARD

3.1 SUMMATIVE EVALUATION RECOMMENDATIONS

To address the sixth, forward-looking focal area, the evaluators made a series of recommendations to potentially improve the effectiveness, efficiency, impact and appropriateness of future monitoring, evaluation and research (MER) activities to support CEWO's legislative requirements (Table 1; see Appendix D and F). The recommendations were made with respect to the research (EWKR) and monitoring (LTIM) projects separately, however many are equally relevant to both research and monitoring activities.

Table 1. Recommendations for improving the CEWO’s monitoring, evaluation, and research (MER) program.

LTIM evaluator recommendations ⁵⁸	EWKR evaluator recommendations ⁵⁹
<p>LTIM1: The CEWO decide whether the primary objective of future monitoring and evaluation activities is to be focused on Basin-scale reporting or on both Basin-scale and local-scale; map this objective to the BEWS to improve alignment; consider the inclusion of an objective related to Indigenous water needs; and consider additional activities to meet Basin Plan objectives not adequately addressed to date</p>	<p>EWKR1: Use a collaborative project-design process to ensure effective research delivery. This will improve efficiency, cost-effectiveness and relevance by avoiding confusion over the scope and focus of the research activities as well as the key terms, concepts and contexts to be addressed</p>
<p>LTIM2: The CEWO undertakes limited water quality monitoring and obtains any required water quality and salinity information data from the agency responsible for implementing the appropriate water quality management plan</p>	<p>EWKR2: Have realistic ‘SMART’ (Specific, Measurable, Achievable, Relevant, Time-bound) objectives to ensure consistency in research-framing with current policy and management contexts, to improve targeting of research activities, and enable better evaluation of the effectiveness, efficiency, appropriateness and impact of programs</p>
<p>LTIM3: Monitoring of extreme events and responses to these events be included in future monitoring programs</p>	<p>EWKR3: Ensure all stakeholders clearly understand and explicitly adopt an adaptive management focus to research and its application. Ensure all research questions and activities are directly relevant and fit for purpose for the applied and strategic needs of targeted stakeholders (e.g., water managers)</p>
<p>LTIM4: It is determined whether a Basin-scale evaluation of the contribution of CEW to ecological outcomes is best supported by multiple fixed Selected Areas or multiple variable Selected Areas before designing an appropriate monitoring and evaluation approach</p>	<p>EWKR4: Work closely with First Nations to plan, engage and undertake research and communicate its findings. Address the essential need to work with and alongside First Nations in all aspects of the research program design, conduct and communications, to address First Nation objectives and cultural needs, and to appropriately respect country in conducting research</p>
<p>LTIM5: Monitoring and evaluation of the environmental outcomes of CEW is expanded beyond the current two sites in the Northern Basin</p>	<p>EWKR5: Use watering events for ‘real world experiments’ to better inform adaptive water management</p>
<p>LTIM6: Indicators be reviewed based on their performance in during the LTIM project and revised to improve alignment to the BEWS</p>	<p>EWKR6: Integrate research activities effectively and optimally. Integrate monitoring activities (e.g., LTIM) with research activities (e.g., EWKR) wherever possible. Ensure sufficient flexibility in the integration to allow incorporation of opportunistic research (e.g., in response to climatic events or unique collaboration opportunities)</p>
<p>LTIM7: Standard indicators be adopted across sites with the method adopted to inform that indicator being allowed to vary between sites if necessary</p>	<p>EWKR7: Mind-map the planned research, drawing up links between research questions, planned activities, communication strategies and intended outputs and outcomes. Improve the logic of planning, communication and management of research, to identify the implications on outputs and outcomes when planning to amend or remove a given research activity, and to track progress</p>

⁵⁸ See Hart et al. (2020), pp. 11-20.

⁵⁹ See Boulton and Davies (2020), pp. 6-11.

LTIM evaluator recommendations ⁵⁸	EWKR evaluator recommendations ⁵⁹
	as research continues and is modified in response to findings and changing conditions (including access to funding and other resources)
<p>LTIM8: That evaluations should focus on: <u>all</u> environmental water (e.g., ‘held’ water and ‘planned’ or ‘above Cap’ water) and not just on CEW; ‘counterfactual’ assessments, that is evaluations with and without e-water; quantitative assessments, that is greater application of quantitative statistical models, e.g., Bayesian hierarchical modelling</p>	<p>EWKR8: Encourage and plan for opportunism and ensure flexibility to respond to changing needs and circumstances. Keep funds aside for opportunistic work, and encourage this work where it adds value to the overall research objectives. Ensure that funds can be made available rapidly, especially to employ key staff or buy essential equipment. Where possible, plan for opportunities (including such possibilities in the mind-map proposed in Recommendation 7) and ensure flexibility to respond and adapt to evolving or changing needs and circumstances</p>
<p>LTIM9: The CEWO establish and resource a <i>model development plan</i> for any future monitoring and evaluation activities</p>	<p>EWKR9: Do formal risk assessment and develop comprehensive plans to avoid or mitigate risks where possible</p>
<p>LTIM10: A fit-for-purpose inundation modelling (mapping) method is developed to support any future monitoring and evaluation activities</p>	<p>EWKR10: Plan and target communication carefully, being realistic about timelines and expectations. Identify target audiences early, with an emphasis on natural resource managers and other crucial stakeholders and information users. Ensure that enough time and funds are allocated for effective and efficient communication of findings in appropriate media, and to then follow up the effectiveness of that communication</p>
<p>LTIM11: The CEWO ensure that an adequate data management system to capture and process relevant data from future monitoring and evaluation activities is established and properly resourced</p>	<p>EWKR11: Plan for comprehensive program evaluation, including several evaluations during the course of the project as well as on completion. Scope and plan the program evaluation process at the outset. This should include timing, governance, the evaluation methodology and the forms of evaluation outcomes. Ensure that this evaluation process fully satisfies the needs of the key program stakeholders, acknowledging that these needs will change over time and evaluation processes may need to evolve accordingly. As well as several evaluations during the project, include hold-points in program management to address evaluation recommendations. Assign dedicated funding for the evaluation process and responses to the suggestions</p>
<p>LTIM12: A comprehensive communications and reporting strategy be developed for any future monitoring and evaluation activities, and that effective science communicators be engaged to assist the monitoring and evaluation teams to make their various reports more readable, and to assist the CEWO to produce more structured and targeted information products</p>	<p>EWKR12: Ensure active program oversight by consistent and experienced project managers and independent steering committees that are adequately resourced</p>
<p>LTIM13: The CEWO establish robust project management arrangements for any future monitoring and evaluation activities including: an overall project manager; a project steering committee to assist the project manager and assist with collaboration; and the establishment of an independent science review committee to ensure the quality of the science being undertaken</p>	<p>EWKR13: Co-operate closely in data collection, interpretation of findings and communication of outputs</p>

LTIM evaluator recommendations ⁵⁸	EWKR evaluator recommendations ⁵⁹
<p>LTIM14: A <i>project collaboration plan</i> be established at the start of any future monitoring and evaluation activities, that examples of collaboration be collected and documented, and reported on annually</p>	<p>EWKR14: Use robust, consistent, appropriate data management protocols across all research activities in the project, ensuring optimal storage and accessibility of quality-controlled data and metadata. Data management protocols must be embedded within each individual research activity, and there should be strict procedures for submitting data to the central data-base. This data-base is to be maintained by the key program management agency at the end of the program, with suitable accompanying meta-data and clear, consistent rules for data access and recognition of intellectual property. It should also be part of the program evaluation (Recommendation 11)</p>
<p>LTIM15: A comprehensive <i>knowledge management strategy</i> be developed for any future monitoring and evaluation activities to support the adaptive management of CEW, and that knowledge brokers be appointed to assist with the capture and collation of the adaptive management learnings</p>	<p>EWKR15: Explicitly assess and address all sources of uncertainty, ensuring that all stakeholders understand the implications of uncertainty when interpreting and applying the findings. Capture uncertainty and its source(s) within each step of the program logic (see Recommendation 7). Ensure that all sources of uncertainty and their implications (e.g., for predicting ecological responses to environmental water management) are communicated effectively to all stakeholders, and fully understood by communication staff (see Recommendation 10). Explicitly build uncertainty messaging into all communication products</p>
	<p>EWKR16: Use and maintain a comprehensive decision-audit trail</p>
	<p>EWKR17: Implement and manage all communication professionally, consistently, efficiently and effectively</p>
	<p>EWKR18: Be explicit about scales in time and space. In the planning and design of the objectives and research activities of the program and in all communication outputs, be explicit about the spatial and temporal scales of the context, research work and subsequent findings. Use consistent, defined terms around scale, and specify these in appropriate places on the mind-map of the program logic (see Recommendation 7). Ensure that these scales match the scales that are relevant to both the ecological responses and the key and legislative water management and policy contexts. Where results are likely to be scaled from a site to a broader region (maybe even the whole Basin) or extrapolated to longer time periods, clearly explain the caveats on such scaling and what evidence is needed to make the scaling more reliable (e.g., addressing uncertainty, Recommendation 15)</p>

As, at the time of writing, the CEWO had already merged their research and monitoring activities into one program under Flow-MER, the recommendations have been summarised according to program processes, such as program governance, setting program objectives, design considerations (including analysis and management of data), collaborative approaches, communications and annual processes, such as reporting. Whilst governance and project management were not in scope, the evaluators felt that both these are also critical to the success of monitoring, evaluation and research activities in the future.

3.1.1 PURPOSE OF FUTURE MER

It is recommended that the CEWO decide whether the purpose of future MER activities is to be on Basin-scale reporting or on both Basin-scale and local scale. Improved alignment with the BEWS and consideration of inclusion of social and cultural values/water needs are also fundamental decisions in regard to the purpose and direction of MER moving forward (**LTIM Recommendation 1**).

3.1.2 IMPROVING GOVERNANCE AND PROGRAM MANAGEMENT

It is recommended that the CEWO establish robust project management arrangements for any future monitoring and evaluation activities including:

- Robust co-planning is required to lay the foundation for monitoring, evaluation and research to be truly relevant to all stakeholder and end user groups (**EWKR Recommendation 1**)
- Appointing an overall project manager supported by a project steering committee to assist the project manager with collaboration; and the establishment of an independent science review committee to ensure the quality of the science being undertaken. The latter should include social scientists if MER activities are expanded to include social and cultural outcomes. Activities undertaken by the committees should be adequately resourced and supported (**LTIM Recommendation 13, EWKR Recommendation 12; G Likens recommendation**)
- Use and maintenance of a comprehensive decision audit trail including records of relevant one-on-one discussions between researchers and program managers. This information should be searchable and inform updates of program logic (**EWKR Recommendation 16, EWRK Recommendation 7**)
- A project collaboration plan be established at the start of any future monitoring and evaluation activities, and that examples of collaboration be collected and documented, and reported on annually (**LTIM Recommendation 14**)
- A comprehensive communications and reporting strategy should be developed and implemented by science communicator(s) engaged to assist the monitoring and evaluation teams to make their various reports more readable, and to assist the CEWO to produce more structured and targeted information products (**LTIM Recommendation 12, EWKR Recommendation 17, EWKR Recommendation 10**)
- A comprehensive knowledge management strategy is recommended to support the adaptive management of CEW, and that knowledge brokers/science communicators be appointed to assist with the capture and collation of the adaptive management learnings (**LTIM Recommendation 15**)
- Include a risk management plan with a risk assessment framework which adopts standard approaches (e.g., AS/ISO 31000:2018 [<https://www.standards.org.au/>]) and have back-up plans for changes in key staff, altered environmental conditions, altered site access, changed watering objectives etc. Update risk assessment frequently (**EWKR Recommendation 9**)
- Plan for comprehensive program evaluation, including several evaluations during the project, as well as on completion (**EWKR Recommendation 11**)

Monitoring, evaluation, and research around using Commonwealth environmental water to deliver on-ground environmental outcomes is a cross-disciplinary endeavor that requires effective collaboration between managers and scientists. Establish a grant/bid design processes that includes the CEWO, independent water management stakeholder(s) and an independent science review panel to ensure that the granting stakeholder develops the grant/bid guidelines and program objectives in language that is relevant to both stakeholder needs and policy contexts as well as to scientific practice. It should ensure that all terms within the document have clear definitions to avoid ambiguity and improve mutual understanding (see Section 3.1.5). The granting guidelines should have independent stakeholder and scientific input, and the grant stakeholder staff should be literate in both scientific practice and terms and in the stakeholder (target audience) practices, from the outset and by regular engagement.

The evaluators made several recommendations for actions to support effective and efficient planning, including clear and consistent communication at all stages of the program. Tools, such as the use of models to explore and communicate outcomes from environmental watering, and effective risk management of mis-understandings and cross-purpose communication, can assist collaborative planning in this area.

Program evaluation should include both process and outcome evaluations. Evaluation of project governance and management is essential, including consideration of cost effectiveness, these were out of scope of the current evaluation and are recommended for future MER projects.

3.1.3 IMPROVING DESIGN, MODELLING AND DATA MANAGEMENT

It is recommended that the CEWO:

- Initiate, maintain and actively share a mind-map of research questions and sub-questions, together with their links to each other and management questions/Basin objectives, etc. (including to similar current and planned initiatives external to the project). This should occur in the design planning phase, drawing up links between research questions, planned activities, communication strategies and intended outputs and outcomes (**EWKR Recommendation 7**)
- Include capacity to respond to emergent situations, changing needs and circumstances as they arise as part of the initial design phase. (**EWKR Recommendation 8**)
- Develop and implement a MER Modelling Plan should be funded by the CEWO to inform data evaluation at the Basin scale (**LTIM Recommendation 9**).
- Determine whether a Basin-scale evaluation of the contribution of CEW to ecological outcomes is best supported by multiple fixed Selected Areas or multiple variable Selected Areas before designing an appropriate monitoring and evaluation approach (**LTIM Recommendation 4**)
- Develop a fit-for-purpose inundation modelling (mapping) method (**LTIM Recommendation 10**). This is considered an urgent and essential need.
- Ensure robust, consistent, appropriate data management protocols across all activities are established, as well as ensuring optimal storage and accessibility of quality-controlled data and metadata (**LTIM Recommendation 11, EWKR Recommendation 14**).
- Ensure data management is supported by improved co-operation in data collection, interpretation of findings and communication of outputs (**EWKR Recommendation 13**).

The CEWO should both encourage and plan for opportunism and ensure flexibility in future MER activities by allocating a funding line for opportunistic work, especially where it adds value to the overall research objectives. Funds should be available rapidly, especially to employ key staff or buy essential equipment.

Predictive modelling will be an ongoing component of data evaluation at the Basin scale. However, LTIM failed to deliver a clear plan for model development, with validation of the models an essential element of model development. Ensuring the right expertise is engaged to develop and undertake the modelling is also a consideration for future MER activities. Linked to this is the need to determine whether a Basin scale evaluation of the contribution of CEW to ecological outcomes is best supported by multiple fixed Selected Areas or multiple variable Selected Areas before designing an appropriate monitoring and evaluation approach (see also **LTIM Recommendation 1** – overall purpose of MER). The lack of detailed inundation modelling (mapping) has been identified as a major issue in this Evaluation and also previously by Gawne et al (2017), the Joint Steering Committee (JVSC, 2017) and Hart and Butcher (2018).

Data management was problematic at various stages of each project. An adequate data management system able to capture and process relevant data from future MER activities is another foundational requirement. It has to be adequately resourced and retaining a data manager considered essential.

3.1.4 IMPROVING OBJECTIVES

Two specific recommendations were made in regard to improving the objectives:

- Realistic 'SMART' (Specific, Measurable, Achievable, Relevant, Time-bound) objectives are required to ensure consistency in research-framing with the current policy and management contexts, to improve

targeting of research activities, and to enable better evaluation of the effectiveness, efficiency, appropriateness and impact of programs. (**EWKR Recommendation 2**)

- Ensure an adaptive and applied management focus. To make all research questions and activities directly relevant and fit for purpose for the applied and strategic needs of targeted stakeholders (e.g., water managers).and (**EWKR Recommendation 3**)

Improving the process of setting the objectives of the future MER program is essential. For the EKWR project the finding was that the initial set of objectives in the Grant Guidelines were '*broad, unfocused, sometimes ambiguous and often overly ambitious*' (Boulton and Davies 2020, p2.) with many not attempted because of financial and other logistic constraints. A process of refinement was undertaken resulting in a tighter, better-focused subset, but were not fully achieved given the available time, funding and researchers' capabilities. This highlights the importance of getting the objectives right.

3.1.5 IMPROVING COMMUNICATION

Recommendations specific to improving communication include:

- A comprehensive communications strategy be developed and implemented from the outset of any future program, and that effective science communicators (see Section 3.1.7) be engaged to assist the CEWO to produce more structured and targeted information products (**LTIM Recommendation 12**).
- The communications strategy should explicitly include a First Nations inclusion plan (cf. MDBA Native Fish Recovery Strategy) (**EWKR Recommendation 17**).
- The strategy and associated outputs should be frequently reviewed to evaluate their effectiveness and impact (see **EWKR Recommendation 11**), particularly communication methods that match the needs of target audiences such as water managers and policy makers.
- When planning individual research activities within the project, sufficient time and funds should be allocated for effective and efficient communication of findings in appropriate media, and to then follow up the effectiveness of that communication (**EWKR Recommendations 10 and 17**).
- Explicitly assess and address all sources of uncertainty, ensuring that all stakeholders understand the implications of uncertainty when interpreting and applying the findings (**EWKR Recommendation 15**).
- Better targeting of audiences and mechanisms to provide communications that focus on end users (i.e. managers and planners), ensuring there are adequate resources from program inception. This includes provision of resources for experienced communication and engagement officers from the outset of a program, including First Nations peoples (**LTIM Recommendation 7**).

Communication has a social aspect which is based on relationships between communication partners as well as an information aspect, which relates to the type of information that is exchanged. For example, communication between service providers within the LTIM Selected Areas and their CEWO managers was considered highly effective, in that there were strong personal relationships that facilitated transfer of relevant information to inform environmental water delivery at the Selected Area scale. The same was not evident between the Basin Matter team and the CEWO's water delivery teams, with opportunities to create those relationships not available. Improved communication between the service providers, disciplines (e.g., fish, vegetation, cross-cutting themes, etc.) and the governance teams (i.e., of the CEWO) will lead to greater whole-project-team cohesion and collective communication competence. These aspects of collaboration and communication are considered essential to supporting integrated evaluation and research. To improve adaptive management there needs to be mechanisms put in place early to support effective, timely and efficient communication and engagement.

The evaluators noted that collaboration did occur in both the LTIM and EWKR projects but that it could be improved, particularly to overcome any apparent lack of mutual understanding, such as where:

- The Selected Area teams had a limited common understanding of the purpose of the Basin Matter team
- There was limited mutual understanding between the project managers (the CEWO science and delivery teams).

3.1.6 IMPROVING INTEGRATION

It is recommended that CEWO:

- Integrate monitoring activities (e.g., LTIM) with research activities (e.g., EWKR) wherever possible. Ensure sufficient flexibility in the integration to allow incorporation of opportunistic research (e.g., in response to climatic events or unique collaboration opportunities) (**EWKR Recommendation 6**)

There is a strong need for better integration; using concept maps and mind maps to link and integrate ideas, research questions and relevant externalities – and to update these maps frequently – is essential (**G Likens recommendation**). Mind- maps are useful to assess links in collaborative projects to identify benefits and constraints and in identifying where risks may occur (see **EWKR Recommendation 9**).

The LTIM and EWKR projects explicitly separated monitoring and research. More ‘integration’ was called for by the evaluators, some of which was already reflected in the continuation of monitoring, evaluation and research under the Flow-MER program. Two broad approaches to integration were mentioned – integrating research and monitoring under one program, and integrated research and implementation (i.e., transdisciplinary research).

It is desirable to optimise integration of research activities from the outset, preferably funding the process separately with attractive financial incentives for effective and efficient outputs from selected collaborative projects (**EWKR Recommendation 6**, see also **LTIM Recommendation 7**). This includes seeking opportunities where researchers and managers might work together during all the phases of planning, data collection and interpretation, and communication of findings – where this makes the research more efficient and effective. Such transdisciplinary projects involve stakeholders from different sectors (e.g., water managers, water planning and delivery, researchers, First Nations, etc.) in both the research and implementation of outcomes (Bammer et al. 2020) and typically addresses problems that require multiple disciplines to address (Knapp et al. 2019).

3.1.7 IMPROVING ADAPTIVE MANAGEMENT

A fundamental issue for improving adaptive management is communicating the science outputs and outcomes in a format that can be readily applied and used by management. This often referred to in the literature as closing the loop (Fernández-Giménez et al. 2019) in adaptive management. Recommendations arising from the evaluation of each project included:

- Roles and responsibilities of stakeholders/collaborators should be clearly defined at the outset of any project so that expectations can be managed (see **EWKR Recommendation 3**). Underpinning this is a clear understanding of what stakeholders/collaborators are seeking from the project.
- Experienced knowledge brokers (including First Nations peoples) who work closely with the communication officers (see Section 3.1.5) and are also involved directly in the planning processes (see **EWKR Recommendation 13**) are required as essential elements of future programs.
- Knowledge brokers must be ‘briefed’ in the language and context of the monitoring, evaluation and research program and relevant policy and resource management (i.e. be familiar with the Basin Plan) (**EWKR Recommendation 17; LTIM Recommendation 15**).

Issues preventing adaptive management from being successful can include mismatches in spatial and temporal scales in decision-making (e.g., Selected Area vs Basin scale), failure to act and insufficient stakeholder participation (Fernández-Giménez et al. 2019). To make improvements in adaptive management of environmental water, more information is required about the processes and needs of decision-making at all levels.

The evaluators identified the critical need of having everyone agree on what adaptive management means and how to do it. Planning for collaboration and communication is central to achieving adaptive management outcomes (see Section 2.3.7), and it is important to have the managers, researchers and relevant stakeholders in the room together at the outset to achieve an optimal balance between agreeing on what needs to be done and agreeing how it will be achieved. This process should be directed by an experienced leader or steering group. In setting up a steering group, it is important to pay attention to potential power imbalances so that the work remains focused, and the outcomes are achievable and able to be acted upon (i.e. stakeholders have the capacity to enact changes, Porter and Birdi 2018).

For the LTIM project, the evaluators found that while adaptive management was reasonably effective within each Selected Area, learnings were not well captured and transferred between catchments and to areas not monitored. Additionally, the view was expressed that the cumulative effects of adaptive management over the longer term both locally and Basin-wide were not captured.

Knowledge brokers should be appointed to assist researchers and managers wherever possible to optimise the effectiveness of the outputs for different audiences, ensuring that all outputs delivered to water and managers are appropriate, timely and fit for purpose.

3.1.8 ADDITIONS/REFINEMENTS

The final set of recommendations arising from each evaluation relate to options for refinements to the projects such as:

- Improving water quality information to meet reporting requirements by using data collected by other agencies (**LTIM Recommendation 2**),
- Reviewing the current set of indicators and considering new ones to improve alignment to the BEWS (**LTIM Recommendation 6**) and
- Being specific/explicit about scales and time (**EWKR Recommendation 18**) which is important in planning and design of the objectives and research activities and in all communication outputs.

Both evaluations recommended focusing on watering events:

- Use watering events for ‘real world experiments’ to better inform adaptive water management (**EWKR recommendation 5**).
- Focus on all environmental water (e.g., ‘held’ water and ‘planned’ or ‘above Cap’ water) and not just on CEW. Include ‘counterfactual’ assessments and quantitative assessments such as quantitative statistical models, e.g., Bayesian hierarchical modelling (**LTIM Recommendation 8**).

Recommendations for additions to the MER program include:

- Work closely with First Nations (**EWKR Recommendation 4**)
- Monitoring and evaluation of the environmental outcomes of CEW is expanded beyond the current two sites in the Northern Basin (**LTIM Recommendation 5**)
- Monitoring of extreme events and responses to these events be included in future monitoring programs (**LTIM Recommendation 3**).

The recommendations made for each project were considered together in a ‘synthesis’ workshop to produce a final set of recommendations for the future MER activities (see Section 3.3).

3.2 FORMATIVE EVALUATION RECOMMENDATIONS

The evaluators of both LTIM⁶⁰ and EWKR⁶¹ provided separate recommendations relating to possible improvements to the CEWO’s future monitoring, evaluation and research activities based on the summative evaluations undertaken (see Section 3.1, Table 1). These recommendations along with the responses of stakeholders interviewed as part of the summative evaluations (see Section 3.2.1 and Appendix J) were considered at the December synthesis workshop in consultation with the CEWO and grouped into two categories: improvements and further considerations in designing and developing the CEWO’s future monitoring, evaluation and research program.

3.2.1 INTERVIEW RESPONSES TO OPTIONS FOR MOVING FORWARD

All stakeholders interviewed (78) were asked to consider what they would retain, change, or add to future a MER program (see Appendix J). A total of 330 comments received were allocated to 11 broad topics (see Appendix J). The most frequently mentioned areas of improvement for the future MER were related to governance and project management issues. Improving communication was the next most frequently raised issue. Just under 30% of responses related to retaining the status quo under the Flow-MER program.

Whilst governance and project management were out of scope of the evaluation, most stakeholders, (nearly 80%, Figure 3), made suggestions relating to improving governance and project management. Most of the responses focused on improving the planning and design phase (Figure 4)(see Appendix J). Improved

⁶⁰ See Hart et al. (2020) pp 11-20.

⁶¹ See Boulton and Davies (2020) pp 6-11.

communication (Figure 5) was mentioned by over 40% of participants, in particular the communication of outcomes, using knowledge brokers and improved internal communications were all raised as areas requiring improvement.

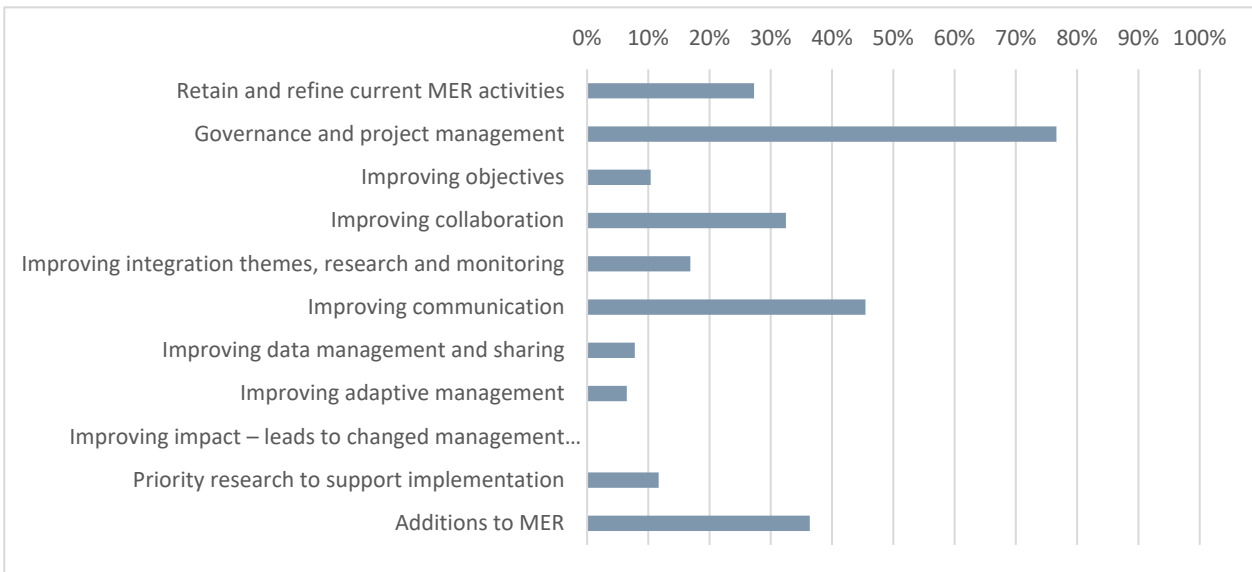


Figure 3. Proportion of participants (78) which provided comments relevant the broad categories/topics.

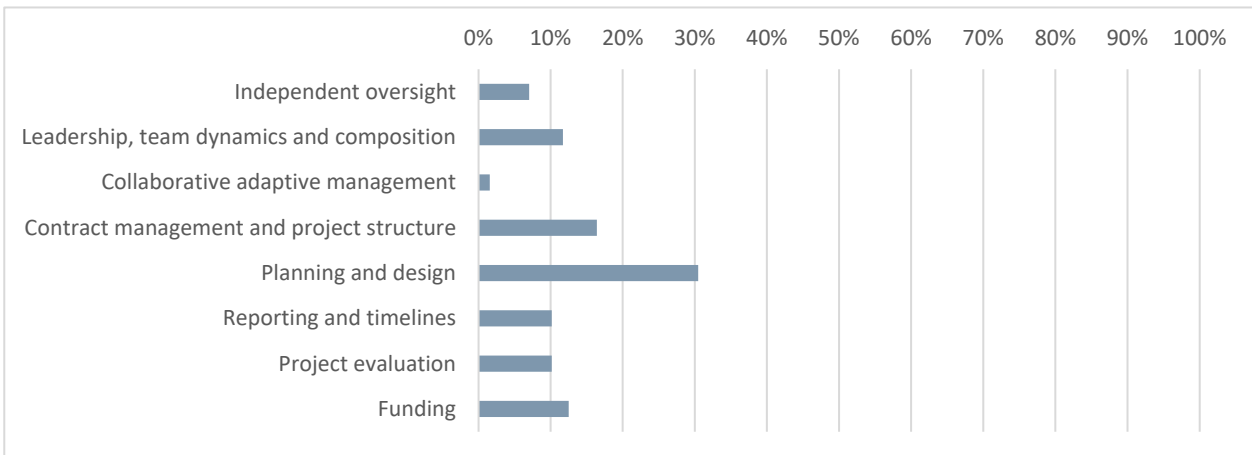


Figure 4. Proportion of the comments relating to 'Governance and project management' broken down by subcategories.

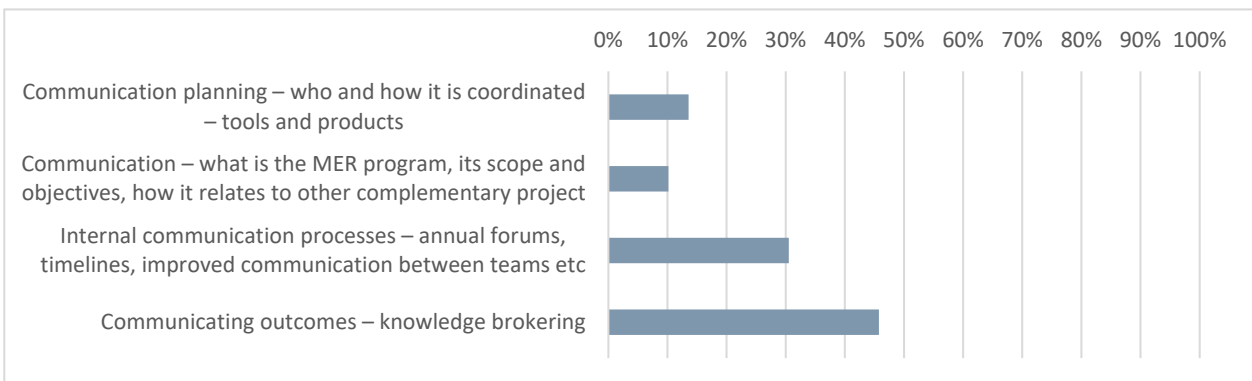


Figure 5. Proportion of the comments relating to 'Improving communications' broken down by subcategories.

3.2.2 EVALUATOR SYNTHESIS WORKSHOP - RECOMMENDATIONS

To synthesise the recommendations arising from the summative evaluation and the suggested improvements made by the stakeholders, the evaluators took part in a final synthesis workshop. The workshop purpose was to identify a subset of priority recommendations the CEWO should consider moving into Stage 3 of their review project for future MER activities. All recommendations from each of the project evaluations will be considered, but a synthesis was required for the future MER program.

Prior to the workshop each evaluator was asked to independently identify the:

- ‘Top 5’ things that needed improvement
- ‘Top 3’ new things that could be added to the future MER program
- What, if anything should be removed/excluded from the future MER program?

Mind mapping using MindMeister software was used to capture the key points and produce a transcript of the workshop discussions (Figure 6 provides a schematic summary of these key points). The final 16 recommendations for the CEWO’s future MER program are listed below and in the Executive summary. The recommendations are presented in two groups, one relating to improvements and the other relating to issues/activities requiring further consideration for inclusion in the future MER program.

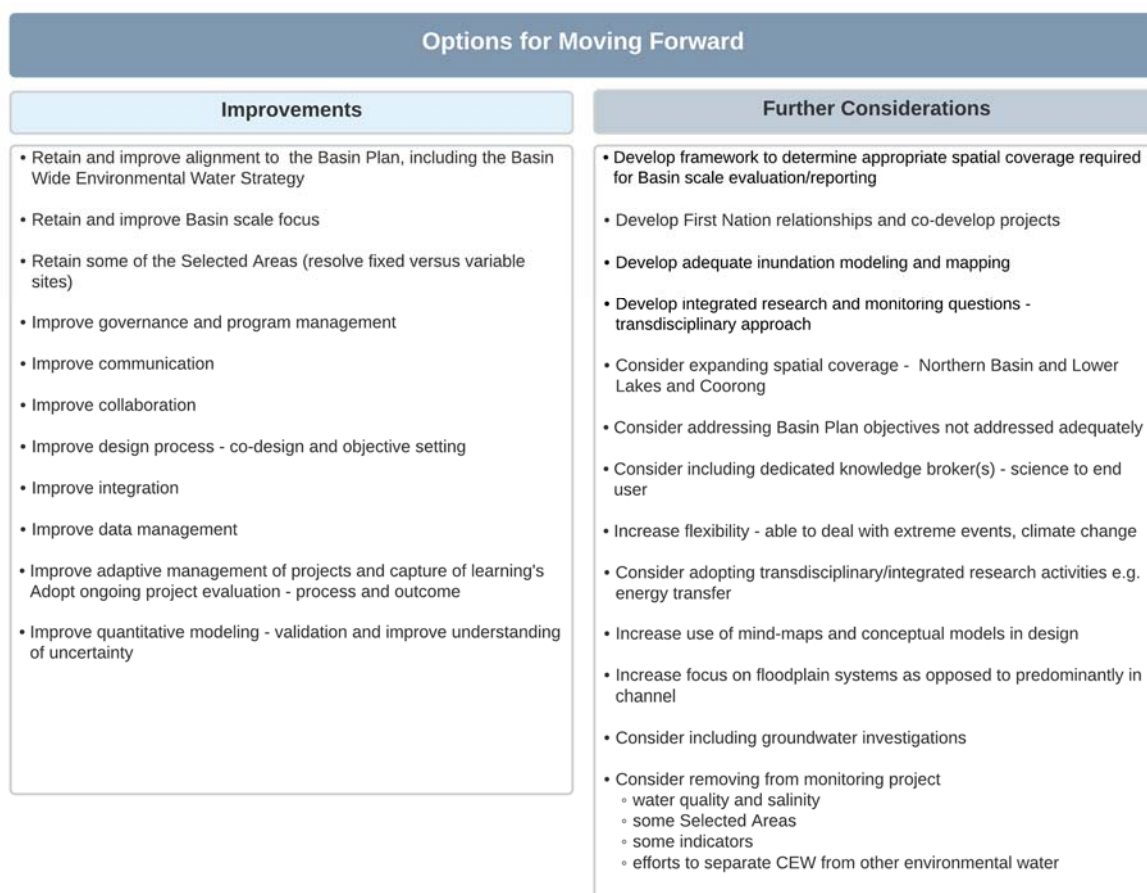


Figure 6. Schematic summary of the key points considered in making the final recommendations for designing and developing the CEWO’s future, monitoring, evaluation and research program.

Recommendation 1: It is recommended that the CEWO's future monitoring, evaluation and research program objectives:

- be based on the BEWS
- address Basin Plan objectives not adequately addressed to date⁶²
- are SMART⁶³
- focus on evaluating the ecological effects of all environmental water (that is both 'held' and 'planned' water) and not just CEW⁶⁴
- include First Nations cultural water needs
- shift emphasis from channel to floodplain investigations.

Recommendation 2: It is recommended that:

- the CEWO determine whether a Basin-scale evaluation is best supported by fixed Selected Areas, variable Selected Areas or a mix of the two before designing an appropriate monitoring, evaluation and research approach
- a robust method(s) for integrating this local data to the Basin-scale be developed (see also Recommendation 4).

Recommendation 3: It is recommended that:

- the CEWO's future monitoring, evaluation and research program is co-developed with relevant stakeholders
- any targeted research components are well linked and integrated with the monitoring and evaluation components from the start⁶⁵
- and captured using mind-mapping as appropriate.⁶⁶

Recommendation 4: It is recommended that:

- a model development plan be established from the commencement of the CEWO's future monitoring, evaluation and research program, this plan should:
 - focus on the development of quantitative flow-ecology and floodplain inundations models
 - be implemented by an adequately resourced hydro-ecological modelling team.

Recommendation 5: It is recommended that the CEWO's future, monitoring, evaluation and research program has:

- a data management system that is robust, with strong data governance and a dedicated data manager to ensure compliance, and is protected against fire, vandalism and theft
- a database that is accessible, meet the needs of the research program as well as client and stakeholder groups
- data protocols that comply with industry standards and are embedded within each individual research and monitoring activity
- meta-data with clear, consistent rules for data access and recognition of intellectual property
- a data management system that is properly resourced.

Recommendation 6: It is recommended that the CEWO's future, monitoring, evaluation and research program include:

- an overall program manager
- a program steering committee to assist the program manager and assist with collaboration

⁶² See Hart et al. (2020) pp 12-13.

⁶³ Specific, Measurable, Achievable, Relevant and Time bound. See Boulton and Davies (2020) p 6.

⁶⁴ See Hart et al. (2020) p 15.

⁶⁵ See Boulton and Davies (2020) p 7.

⁶⁶ See Boulton and Davies (2020) p 8.

- the establishment of an independent science review committee to ensure the quality of the science being undertaken.

Recommendation 7: It is recommended that:

- a project collaboration, communication and reporting plan be established at the start of the CEWO's future, monitoring, evaluation and research program
- appropriately skilled staff be engaged to produce a range of communication products⁶⁷
- examples of collaboration and communication be collected, documented and reported annually.

Recommendation 8: It is recommended that CEWO's future, monitoring, evaluation and research program:

- is co-designed with relevant stakeholders
- has better alignment of research with the monitoring from the start
- supports transdisciplinary research that brings together researchers from multiple disciplines
- ensures managers work together during all the phases of planning, data collection and interpretation, and communication of findings.

Recommendation 9: It is recommended that a comprehensive knowledge management strategy:

- be developed for the CEWO's future, monitoring, evaluation and research program to support the adaptive management of CEW
- includes the appointment of knowledge brokers to assist with the capture, collation and dissemination of the lessons from management of CEW.

Recommendation 10: It is recommended that the CEWO's future, monitoring, evaluation and research program be sufficiently flexible to be able to inform Basin-scale evaluations, and to respond to extreme events and unexpected future changes.

Recommendation 11: It is recommended that the planning, design and implementation of the CEWO's future, monitoring, evaluation and research program have greater involvement of cultural and social sciences.

Recommendation 12: It is recommended that the planning, design and implementation of the CEWO's future, monitoring, evaluation and research program give consideration to including groundwater-surface water interactions affected by environmental watering.

Recommendation 13: It is recommended that the CEWO's future, monitoring, evaluation and research program consider additional monitoring sites in the northern Basin and the inclusion of the Lower Lakes and Coorong as a Selected Area.

Recommendation 14: It is recommended that the CEWO's future, monitoring, evaluation and research program review the water quality and salinity monitoring and either:

- improve this monitoring so it is better linked with specific flow indicators, or
- utilise data from state monitoring programs (these may need some modification to make the data more useful to the CEWO).

Recommendation 15: It is recommended that the CEWO's future, monitoring, evaluation and research program review all ecological indicators for their relevance the Basin-scale evaluation and their value for money.

Recommendation 16: It is recommended that the CEWO's future, monitoring, evaluation and research program review the appropriateness of continuing with the Warrego-Darling and Lower River Murray as fixed Selected Areas sites

3.3 STAGE 2 OF THE CEWO'S REVIEW PROJECT

The outcome-evaluation of the LTIM and EWKR projects completed in Stage 1 included interviews and surveys with stakeholders directly involved in the design and implementation of these projects including representatives of the CEWO, Murray-Darling Basin Authority (MDBA), state government departments, researchers, providers

⁶⁷ See Boulton and Davies (2020) pp 8, 10.

and end users. In Stage 2, CEWO will, with assistance from the evaluation team, undertake broader consultation with groups not yet engaged.

It will be necessary to recognise that different stakeholders will have different, often unique, perspectives on what is needed moving forward, including (modified from Bammer 2020):

- water management's connections with other problems (i.e., land management, climate change),
- different ways the water management can be defined,
- important uncertainties and unknowns,
- some of the real-world constraints on what can be done, and
- what will make a good solution.

Engaging with the broader Basin community, First Nations, NGOs and industry groups will increase the complexity of the 'problem' but is also essential in order to ensure the problem is articulated in a meaningful way and not dictated by any one user group. In developing future collaborative approaches, consideration should be given to power and resource differences among different stakeholder groups, ensuring there is a shared vision, some level of interdependency among stakeholders, awareness of water issues and history of collaboration (Galvez et al. 2019).

4 METHODOLOGY

A recap of the evaluation context, purpose and design is presented in Appendix I. Some minor modifications were made to the evaluation design as Stage 1 progressed, mostly based on lessons learned during the EWKR evaluation. A summary of the outputs generated from the evaluation is presented in Appendix H.

EVALUATION STRATEGY

The evaluation strategy, its design and implementation, is detailed in Appendix A (Butcher and Schreiber 2020). The design was participatory in nature being developed in consultation with the CEWO. The evaluation had two components, a summative evaluation which focused on each project over the period 2014-2019 and a formative evaluation providing guidance on options for future monitoring, evaluation and research activities to meet the CEWO's legislative reporting requirements.

Key Evaluation Questions were used in the summative evaluation providing the framework for the evaluation to enable robust evaluative judgements to be reached. The KEQs were designed to address relevant needs of the CEWO, such as how the two programs contribute to meeting the CEWO's Basin Plan requirements⁶⁸.

The KEQs were nested at three levels (high, mid and micro-levels) and framed by reference to:

- the planning/foundation documents that describe the objectives and intended outcomes for each of the projects
- address the focal areas
- the evaluation criteria (effectiveness, appropriateness, impact and efficiency).

Mid-level KEQs aggregate evidence across themes and/or spatial scales (e.g., Selected Area or Basin scale) to inform the high level KEQs. The micro-level KEQs aggregate evidence to inform the mid-level KEQ and were mostly focused on theme level questions, often relating to specific research or monitoring questions from each project. The full list of KEQs are presented in Appendix B.

Rubrics containing three levels of performance standards (low, moderate, high) were developed to assess each KEQ related to each evaluative criterion - effectiveness, appropriateness, impact and efficiency. This allowed consistency between the evaluators in assigning a rating to KEQ.

LINES OF EVIDENCE

Three lines of evidence - project reports, surveys and interviews with stakeholders - were used to address the KEQs for each project. For the EWKR project: an online survey addressing 35 KEQs was sent to 78 stakeholders

⁶⁸ See Butcher and Schreiber (2020) p 6-7.

with 38 (49%) returning responses; 43 stakeholders were interviewed; and 45 documents were evaluated. For the LTIM project: an online survey addressing 36 KEQs was sent to 82 stakeholders with 38 (46%) providing responses; 40 stakeholders (predominantly service providers and the CEWO) were interviewed; and 249 documents were evaluated. Documents used in the evaluations are captured in the evaluator reports (see Appendix D and F).

EVALUATORS

The LTIM and EWKR projects were evaluated by two different groups of expert evaluators: Prof Andrew Boulton and Prof Peter Davies evaluated the EWKR project while Prof Barry Hart, Dr Tony Ladson and Dr Wayne Robinson evaluated the LTIM project.

The evaluations followed the same sequence of tasks for each project:

- Each expert evaluator first independently addressed each KEQ
- The evaluators (with assistance from the core team) compiled the results and identified where there were differences in judgements (ratings) between evaluators
- Evaluators discussed the reasons for the differences in their judgments to arrive at a consensus judgement for these KEQs. All rationales for the consensus judgement are captured in the evaluator reports
- Different degrees of certainty for reaching evaluative conclusions were further refined by including the additional judgment categories of ‘insufficient evidence’ and ‘not attempted’.

Prof. Gene Likens provided a high-level review of both the EWKR and LTIM evaluations which is presented in Appendix G. All judgements and consensus reasoning are captured in the evaluator reports. Supporting the evaluations are report cards for each KEQ showing the judgement as a ‘traffic light’ graphic and a summary of the evaluator’s judgement. The evaluation rationale and the report cards provide greater insight as to areas in which the projects were successful or need more work.

As discussed in Section 3.2.2 above, a synthesis workshop was held in December 2020 where recommendations for improvement to the CEWO’s future MER program were discussed.

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6 GLOSSARY

Adaptive management comprises (1) problem definition, (2) planning, (3) management, (4) monitoring and evaluation and (5) sharing lessons learnt. Adaptive changes can occur at any stage of this cycle. In particular, adaptive management includes (MDBA 2017):

- a. setting clear objectives
- b. linking knowledge (including local knowledge), management, evaluation and feedback over a period of time
- c. identifying and testing uncertainties
- d. using management as a tool to learn about the relevant system and change its management
- e. improving knowledge
- f. having regard to the social, economic, and technical aspects of management.

As this is an iterative process during the evaluation the specific rules will be documented in the final reports.

Co-design is the process of creating with stakeholders specifically within the design development process to ensure the results meet their needs and are usable. See also transdisciplinary projects.

Collaboration occurs when the activities of individuals are influenced by the activities of others, such that a mutual interdependence of behaviour is established (Crowley and O’Rourke 2021).

Evaluation is the systematic determination of the merit (quality), worth (value), or significance (importance) of something so as to improve performance.

Evaluation criteria the values (i.e., principles, attributes or qualities held to be intrinsically good, desirable, important and of general worth) which will be used in an evaluation to judge the merit of a program (Davidson 2014) and identify areas of improvement. Examples include effectiveness, appropriateness, impact, and efficiency (see CEWO 2013 and Appendix A).

Formative evaluation examines what aspects of a project(s) are appropriate to keep or modify to meet future needs; in this case to meet the legislative requirements of the CEWO.

Key evaluation questions (KEQ) are evaluation questions about overall performance, which the evaluation should aim to answer. KEQs are derived from the purpose of the evaluation (Davidson 2014).

Merit is defined here as the intrinsic quality in the evaluated program.

Mutual understanding is defined as ‘knowledge about each collaborator is held in common by the whole team, but also requires that the collaborators are aware that they share this knowledge in common’ – i.e. it is common knowledge (Crowley and O’Rourke 2021).

Outcomes are variably defined, but typically relate to the expected benefits, changes or results of the project (McDonald 2018) which can relate to either changed management practices or changed environmental/ecological conditions.

Environmental outcomes: The CEWO MERI Framework defines environmental outcomes as the likely or achieved short-term (<1 year) and intermediate-term (1-5 years) effects of a project or policy’s activities and outputs, such as informing annual water use options. Long term outcomes (>10 years) relate to achieving environmental changes. The overall, long term environmental outcome of the Basin Plan is the restoration and protection of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin with strengthened resilience to a changing climate. The outcome in relation to water quality and salinity is that Basin water resources remain fit for purpose. The LTIM project refers to environmental 1 year and 5 year outcomes.

Outcome evaluation⁶⁹ provides information about the short and intermediate changes produced by an intervention. It can be undertaken of a program or a policy, or upstream work – such as capacity building, policy advocacy and support for an enabling environment (OECD 2010 cited in Davidson 2014). It goes beyond looking only at goals and objectives to also examine unintended outcomes, and how the outcomes might lead to improvements in a program and changes in behaviour.

Outputs are defined here as the direct products of project/program implementation. Outputs include tangible artefacts of activities that are in process or complete (e.g., reports, data).

Process evaluation is an evaluation of the internal dynamics (operating procedures) of implementing projects/organisations, their policy instruments, their service delivery mechanisms, their management practices, and the linkages among these (modified from OECD-DAC definition 2010 cited in Davidson 2014).

Program logic is “the rationale behind a program—what are understood to be the cause and-effect relationships between program activities, outputs, intermediate outcomes and longer-term desired outcomes. Program logic shows a series of expected consequences, not just a sequence of events.” (Commonwealth of Australia 2009).

Rubric - commonly defined as denoting “a type of matrix that provides scaled levels or achievement or understanding for a set of criteria or dimensions of quality for a given type of performance” (Allen and Tanner, 2006, p. 197 cited in Dickinson and Adams 2017).

Selected Areas the seven areas within the Murray-Darling Basin in which long-term intensive intervention monitoring were undertaken on behalf of the CEWO.

Significance (of the project) is defined here as the relative importance of the evaluated program/project/object, i.e., the general conclusion on its merit and worth after all relevant considerations have been processed. Merit and worth were captured with evaluation criteria prescribed in the CEWO’s Monitoring, Evaluation, Reporting and Improvement (MERI) Framework (CEWO 2013a) (see also Appendix A). If a program is intended to provide

⁶⁹ Impact evaluation is sometimes confused with outcome evaluation – however impact evaluation focuses on long term changes and tends to be broader in scope.

outcomes for stakeholders and fails to meet their expectations, then overall a value judgement could be that the project had no worth. Similarly, if a program has no merit it could also be considered worthless because it failed to achieve its goals/objectives (Bauer 2019). Judgements of merit and worth can be vastly different depending on who is making the judgement, and there are several ways in which final evaluative judgements can be reached

Stakeholder is considered in the broadest sense, encompassing both project partners and target users (such as MDBA) of project products.

Summative evaluation occurs after a project has been implemented and focuses on the impact of the project. Most often it focuses on the performance of the project, specifically is the objectives have been achieved.

Themes represent specific topics that will be evaluated within each project. EWKR has four themes: fish, food webs, vegetation and waterbirds. LTIM has themes specific to Selected Areas (macroinvertebrate diversity, bank condition etc.), Basin Matters which are assessed in the Selected Areas and basin scale, and also Basin synthesis themes (biodiversity, resilience, and ecosystem function).

Transdisciplinary projects are characterised by participation of all stakeholders (e.g., researchers, managers, planners, policy etc.) in both the research activities (especially in the planning phase) and implementation of solutions. This typically involves multiple disciplines and professions in teams that co-design research, co-produce solution-oriented knowledge, and reintegrate the knowledge into strategies for problem-solving and the development of new scientific insights (see Bammer et al. 2020, Bennich et al. 2020 and references cited therein).

Worth is defined here as the extrinsic quality of the program in relation to the context for which it was proposed and how it meets the real needs of its target audience.

APPENDIX A: EVALUATION STRATEGY

See Butcher and Schreiber (2020)

APPENDIX B: KEQS, SURVEY AND INTERVIEW QUESTIONS

See Butcher et al. (2020)

APPENDIX C: EWKR STAKEHOLDER ENGAGEMENT REPORT

See Butcher and Fenton (2020a)

APPENDIX D: EWKR INDEPENDENT EVALUATORS' REPORT - BOULTON AND DAVIES (2020)

See Boulton and Davies (2020)

APPENDIX E: LTIM STAKEHOLDER ENGAGEMENT REPORT

See Butcher and Fenton (2020b)

APPENDIX F: LTIM INDEPENDENT EVALUATORS' REPORT - HART, LADSON AND ROBINSON (2020)

See Hart et al. (2020)

APPENDIX G: INDEPENDENT PEER REVIEW OF STAGE 1 OUTPUTS – LIKENS (2020)

See Likens (2020)

APPENDIX H: SUMMARY OF STAGE 1 OUTPUTS

The following lists the reports, briefing papers and lines of evidence developed as part of Stage 1 of the CEWO review of the LTIM and EWKR projects.

PLANNING AND DESIGN DOCUMENTS

Butcher, R., and Schreiber, E.S.G. (2020). Evaluation Strategy for the Long Term Intervention Monitoring and Murray-Darling Basin Environmental Water Knowledge and Research projects. Water's Edge Consulting and associates, report to the Commonwealth Environmental Water Office. 50 pp.

Butcher, R., Schreiber, E.S.G., Cottingham, P., and Fenton, A. (2020). Key evaluation questions, survey and interview questions for the end of program outcome evaluation of the LTIM and EWKR projects. Water's Edge Consulting and associates, report to the Commonwealth Environmental Water Office. 27 pp.

Cottingham, P., and Butcher, R. (unpublished). LTIM and EWKR Review Communication Strategy. Water's Edge Consulting and associates, report to the Commonwealth Environmental Water Office.

Butcher, R. (unpublished). Project Plan v06: Evaluation and Review of the Long Term Intervention and Environmental Water Knowledge and Research Projects. Live working document. Water's Edge Consulting and associates.

Butcher, R. (unpublished). Briefing paper: Stage 1 Survey design and interview questions. Water's Edge Consulting and associates.

Fenton, A. (unpublished). Program evaluation using NVivo: Features and tools to be used for the EWKR and LTIM Evaluation. Water's Edge Consulting and associates.

LINES OF EVIDENCE

Butcher, R., and Fenton, A. (2020a). EWKR stakeholder engagement report: Survey results and sentiment analysis of interview responses. Independent evaluation of the Murray-Darling Basin Environmental Water Knowledge and Research (EWKR) project. Water's Edge Consulting and associates, report to the Commonwealth Environmental Water Office. 78 pp.

Butcher, R., and Fenton, A. (2020b). LTIM stakeholder engagement report: Survey results and sentiment analysis of interview responses. Independent evaluation of the Long Term Intervention Monitoring (LTIM) project. Water's Edge Consulting and associates, report to the Commonwealth Environmental Water Office. 102 pp.

Water's Edge Consulting (unpublished data) Redacted interview transcripts for EWKR outcome evaluation.

- Group 1 (client) transcripts – 24 pp.
- Group 2 (service providers) transcripts – 211 pp.
- Group 3 (end users) transcripts – 193 pp.

Water's Edge Consulting (unpublished data) Redacted interview transcripts for LTIM outcome evaluation.

- Group 1 (client) transcripts – 54 pp.
- Group 2 (service providers) transcripts – 196 pp.
- Group 3 (end users) transcripts – 62 pp.

EXPERT EVALUATOR AND PEER REVIEW REPORTS

Boulton, A.J., and Davies, P.E.D. (2020). Independent expert evaluators' assessment of the outputs and outcomes of the Environmental Water Knowledge and Research (EWKR) Project. Report to the Commonwealth Environmental Water Office. 175 pp.

Hart, B.T., Ladson, A., and Robinson, W. (2020). Independent expert evaluators' assessment of the outputs and outcomes of the Long Term Intervention Monitoring (LTIM) project. Report to the Commonwealth Environmental Water Office. 246 pp.

Likens, G. (2020). Expert peer review of evaluative process and outputs from the Program Evaluation of the Long Term Intervention Monitoring (LTIM) and Environmental Water Knowledge and Research (EWKR) projects. Report to Water's Edge Consulting. 7 pp.

STAGE 1 REPORT

Butcher, R., Boulton, A.J., Cottingham, P., Davies, P.E.D., Fenton, A., Hart, B.T., Ladson, A., Robinson, W., and Schreiber, E.S.G. (2020). Stage 1 Report: Outcome evaluation of the Long Term Intervention Monitoring (LTIM) and Environmental Water Knowledge and Research (EWKR) projects for the Commonwealth Environmental Water Office. Water's Edge Consulting and associates, report to the Commonwealth Environmental Water Office. 51 pp. (this document)

APPENDIX I: RE-CAP OF PROJECT CONTEXT AND APPROACH

CONTEXT

The Commonwealth Environmental Water Office (CEWO) required an independent program evaluation of the outcomes of the Long Term Intervention Monitoring (LTIM) and Murray-Darling Environmental Water Knowledge and Research (EWKR) projects. Broadly, the evaluation aimed to assess the achievements of each project and make recommendations for enhancements and inform future program design.

Both LTIM and EWKR were 5-year projects (2014-2019):

- The LTIM Project aimed to monitor and evaluate the use of Commonwealth environmental water and
- the EWKR Project aimed to improve knowledge about ecological responses to environmental water to better inform adaptive management.

Following the completion of LTIM and EWKR in June 2019, the CEWO extended the activities of the LTIM and EWKR projects through an integrated Monitoring, Evaluation and Research (Flow-MER) program until June 2022 to:

- complete the LTIM Basin Evaluation (June 2020) and
- undertake a larger project to inform the design of its future monitoring, evaluation and research activities post June 2022.

EVALUATION PURPOSE

The purpose of the evaluation was to establish the merit, worth and significance of the LTIM and EWKR projects across the following six focal areas:

- the extent to which each project's objectives were achieved
- the extent to which the projects supported the CEWO's legislative requirements
- how well the environmental outcomes were either demonstrated (LTIM) or the research findings supported the achievement of environmental outcomes (EWKR)
- how well findings from both projects were communicated to all stakeholders
- the extent to which the projects were fit for purpose
- opportunities for improvements to incorporate within the CEWO's future monitoring, evaluation, and research activities.

EVALUATION DESIGN

An Evaluation Strategy (Appendix A) was developed to guide the evaluation (Butcher and Schreiber 2020). This included:

- 1. Framing the evaluation**
 - This step included compilation of contextual information about the projects, such as the EWKR and LTIM projects' objectives, program logic, expected outcomes, etc.
- 2. Identifying and engaging with stakeholders**
 - This step included the development of a communication strategy to guide the survey and interview components of the evaluation
- 3. Describing the evaluation types**
 - This step explored the participatory, summative and formative evaluation design in relation to how it influenced the evaluation methods
- 4. Developing key evaluation questions**
 - This step identified over 140 key evaluation questions (KEQs) for each project (see Appendix B). The KEQs were often nested with two or three levels (high-level, mid-level, micro-level) so that evaluative reasoning at higher levels could be explored in more detail at lower levels as required
- 5. Developing simple rubrics**

- This step involved the development of evaluation rubrics based on the evaluative criteria of effectiveness, appropriateness, impact and efficiency. These criteria aligned with the CEWO's Monitoring, Evaluation, Reporting and Improvement (MERI) Framework (CEWO 2013a) and provide the basis of making statements regarding merit, worth and significance. The rubrics allowed the expert evaluators to consistently assess the KEQs into three grades (e.g., efficient, moderately efficient, and inefficient). No weighting was applied to any of the criteria. Rubrics were first developed and applied to the EWKR project, and then the LTIM project. This allowed lessons learnt from rubric application to the EWKR project (e.g., clarification of KEQs, clarification or refinements to rubric performance standards) to be incorporated in the rubrics used for the LTIM project

6. Assessing performance against the key evaluation questions

- This step involved the combination of three main lines of evidence (documents, surveys and interviews – see Appendix B and evaluator reports for documents reviewed) to assess performance against the KEQs. Additional information in the form of sentiment analyses of interview responses, free-form survey comments and additional submissions provided by some stakeholders was also considered. Information relevant to the KEQs was compiled from the three lines of evidence using the software package NVivo. This streamlined the process of aligning information from various outputs, such as project governance, technical and synthesis reports to the KEQs. Similarly, NVivo was used for analysing survey and interview information.

7. Making summative and formative evaluative judgements related to the six focal areas

- The LTIM and EWKR projects were evaluated by two different groups of expert evaluators: Prof Andrew Boulton and Prof Peter Davies evaluated the EWKR project while Prof Barry Hart and Dr Tony Ladson evaluated the LTIM project. Dr Wayne Robinson provided further specific expertise for selected KEQs of the LTIM project as a third evaluator on a subset of the KEQs about fit-for-purpose aspects of project design and the analysis and interpretation of data.
- The evaluations followed the same sequence for each project:
 - Each expert evaluator first independently addressed each KEQ
 - The evaluators (with assistance from the core team) compiled the results and identified where there were differences in judgements (ratings) between evaluators
 - Evaluators corresponded via email and Zoom meetings to discuss the reasons for the differences in their judgments and to arrive at a consensus judgement for these KEQs
 - Different degrees of certainty for reaching evaluative conclusions were further refined by including the additional judgment categories of 'insufficient evidence' and 'not attempted'.

8. Reporting the findings

- The findings of the evaluation are presented in this report. In addition, Prof Gene Likens carried out an independent external review of the evaluation project and its conclusions (Appendix G). All team members contributed to a synthesis workshop in early December 2020 to compile a final collective set of recommendations, explore whether any key points had been missed, and assess relevant input for Stage 2.

MODIFICATIONS TO THE EVALUATION DESIGN

Some minor modifications were made to the evaluation design as Stage 1 progressed, mostly based on lessons learned during the EWKR evaluation. Most notably, there were changes to the wording of some of the performance standards in the rubrics as it became evident that it was almost impossible to attain the highest performance with the original rubrics (see Appendix D for further discussion). Some KEQs were also modified to improve consistency of language and logic. None of these modifications were substantive.

The use of NVivo by the evaluators was successful to varying degrees. The core team and those evaluators who were familiar with the software found the approach of coding evidence relevant to the KEQs a useful process that enabled a streamlined searching of multiple documents for relevant evidence. However, some of the intended use of NVivo was less successful, most notably in transcribing audio interview files to text. As a result,

TRINT, an automated transcription software package was used. TRINT is a speech-to-text platform that allows searching, editing and file sharing.

APPENDIX J: FORMATIVE EVALUATION - ANALYSIS OF INTERVIEW RESPONSES ON OPTIONS FOR MOVING FORWARD

Interview participants were asked to identify ‘*what, if any, improvements could be made to the LTIM/EWKR project moving forward?*’ (see Appendix B). An iterative process of grouping interview responses into broad categories (nodes) was undertaken using NVivo software. This resulted in a final set of broad categories and associated subcategories. For each category, the key points made by the interview participants are presented (see Table J 1).

Table J 1. Summary of key points related to NVivo nodes.

Broad category (Primary node in bold)	Summary of key points
Retain and refine current MER activities	<ul style="list-style-type: none"> • Protect legacy of data history by being cautious of changing anything and potentially missing an opportunity. Make best use of existing data sets. • Maintain a strict requirement for using standard methodology to allow for comparison across sites. “...Because if you lose that, then a lot of the power of the whole design of the program is lost”. • Keep local teams with local knowledge working on the sites to support continuity of understanding of the system. • The same themes (i.e., fish, veg, birds etc) should all still be a priority focus. • Reduce or eliminate category 1 monitoring which is labour intensive and focus on selected area questions. • There needs to be a robust and meaningful process for selecting monitoring sites to answer prescribed questions. “...What are we monitoring and evaluating for? And build it hierarchically and design things from there... At the end of the day, that may be sad because some sites that have being monitored for a long might have to be axed - but I don't think it's good enough anymore just to keep going”. • Formalise a point in the project to re-visit the cause and effect diagrams developed at the start of the project to see what knowledge has been gained from the project as well as contemporary research, and identify the remaining gaps. • Consider a more Basin-scale, broader focus on stream metabolism monitoring rather than just at the selected areas – “...things like using nutrient and data loggers from across the Basin rather than just limited to the selected areas to have a more broader focus and try and pull a modelling dataset.” • Focus research and monitoring on testing the relationships in conceptual models. • Continue research and monitoring on fish, birds, vegetation etc, but improve efforts to synthesize and integrate the findings. Although the food webs research started to gain traction in this domain, develop a less “ad-hoc’ approach to integration. • Improve the incorporation of area scale data and findings in the Basin scale reports – “...the incorporation of some pretty detailed findings of the area scale was often cursory in the Basin scale report.” • Consider expanding selected area monitoring sites into rivers which received commonwealth environmental water but are not monitored. • Review Basin scale evaluation design, giving due consideration to the differences between the Southern and Northern Basin. • Catchment by catchment (i.e. selected area) comparisons of outcomes should be improved in the Basin Matter reports.

Broad category (Primary node in bold)	Summary of key points
	<ul style="list-style-type: none"> • Maintain the robust and transparent process of research site selection, however, consider improving involvement of scientists in this process. • Revisit inclusion of indicators/themes that may not be informing adaptive management of environmental water – focus on practical application. Selection of indicators should demonstrate contribution of CEW, for example demonstrating salt export is good to show value of environmental watering but does not require a lot of monitoring effort as its dependent on amount of water delivered. • Refocus design to be on the contribution of CEW, to focus on watering events. Some indicators (e.g., fish, turtles) are not focused on watering events per se. The focus should be monitoring where CEW is actually delivered. • Consider ways in which data from complementary programs could contribute to the analysis of outcomes – “...In a perfect world, if the SRA data and TLM and so forth, those data sets could be incorporated in ways that support the LTIM outcomes. It's finding useful ways of doing that because I just don't feel that we're answering between the gaps very well at the moment.” • Revisit/further develop counterfactual approach to demonstrating and evaluating the outcomes of Commonwealth Environmental Water. • Whilst long data sets have some rewards, for example the fish theme may provide more patterns over time, other indicators need to be rethought. Metabolism for example may benefit from a different approach. Including data loggers beyond just the Selected Areas would be useful. • Extend the ecosystem diversity theme investigate further patterns of temporal distribution of water annually. • Consider the return on investment of the standard monitoring to support the Basin Matter evaluations and consider the practicality of developing predictive models to infer outcomes across the Basin. Basin scale was a huge investment “and not worth the money”. The need for a Basin scale approach and inferring outcomes has changed. “...the role for the Basin scale team is ...more a summary of outcomes, a more qualitative broad scale look at outcomes across the Basin.”
Governance and project management	
Subcategory: Independent oversight	<ul style="list-style-type: none"> • Establish a ‘chief scientist’ or independent scientific advisory group to advise the CEWO and give the CEWO confidence in their thinking and investments.
Subcategory: Leadership, team dynamics and composition	<ul style="list-style-type: none"> • Project managers should be more analytical with respect to establishing teams. Carefully analyse potential leadership candidates, and select candidates based on a mixture of professional qualities (e.g., seniority, reputation, and authority) and soft skills (e.g., communication, leadership, collaborator). Carefully select subordinates to avoid conflict in authority. • Maximise industry exposure by aiming to include team members from a diversity of organisations • Where possible, build teams with a diversified skillset. • Strengthen internal relationships by investing in annual ‘catch-ups’ for project staff. • Foster an honest, transparent and supportive team environment.

Broad category (Primary node in bold)	Summary of key points
	<ul style="list-style-type: none"> • Improve ability to make inferences using analytic or even using advanced analytical techniques through engaging expertise. “...This is a huge data challenge, incomplete data sets, patchy in space and time, and we want to draw some inferences about how this sort of diffuse intervention has been on those - it’s a computational problem. And I would somehow connect that computational expertise up to the domain knowledge of the ecologists and hydrologists and so that they could really draw on that expertise in both directions”.
<p>Subcategory: Collaborative adaptive management</p>	<ul style="list-style-type: none"> • Increase general awareness of how managers can get involved in the planning phase, and how their insights will be incorporated and communicate the extent to which managers have the potential to influence project development. • Encourage co-authoring and co-publishing of papers with water managers.
<p>Subcategory: Contract management and project structure</p>	<ul style="list-style-type: none"> • Improve transparency around intellectual property (IP) agreements within contracts, particularly in relation to IP arrangements around successive version of the projects wherein there is a change in personnel but continuation of research. • Consider contract procurement and provider selection processes which are less combative (i.e. competitively bidding for contracts). • Consider a less centralised project structure, wherein more autonomy is given to selected areas at the local scale to monitor local values and empower those groups to work locally. • Structure project milestones around your research plan, rather than to justify making payments. This way, staff are not taken off core-responsibilities to author project progress reports. • Improve transparency around allocation of funding within and between teams. • Develop a formalised hand-over process to facilitate a change in personnel. • Improve consistency in project delivery by maintaining the same delivery partners and Selected Areas, rather than re-tendering.
<p>Subcategory: Planning and design</p>	<ul style="list-style-type: none"> • Develop a more robust knowledge-need prioritisation process - like the Basin Science Platform - that focuses more on either key policy questions or key management questions, and then assembling teams that have got the capacity to provide a sensible answer to those questions. This should be an enduring process and would move away from vegetation, birds, fish etc., and be driven by management need rather than the indicators of the management decision. • Embed managers in the planning phase and improve transparency of prioritisation processes. “...I don’t think end users have to dictate the research, but they need to be there embedded in the prioritisation process so they can see why decisions are being made about the direction that's being taken”. • Improve process for establishing priorities and key evaluation questions – find a balance between top down and bottom up. • Engage with end-users and get a clear understanding of the kind of knowledge that is needed, designing the themes around those needs, rather than researchers/consultants pre-empting what they think end-users need. • Provide end-users with an additional opportunity to vet the research questions and outcomes after initial engagement to ensure these meet their knowledge needs.

Broad category (Primary node in bold)	Summary of key points
	<ul style="list-style-type: none"> • Include researchers in the initial engagement of managers and be forth coming with what is achievable. • Embed flexibility into the planning process without the need for undertaking prolonged contract renegotiation. Acknowledge that there are often unanticipated environmental factors (e.g., drought, breeding bird events) which effect the feasibility of a research project after it has begun, and that there is sometimes a need to be 'agile'. • Have to recognize that the greater variability in the sampling regime, the more tailored the monitoring approach has to be tailored to fit those highly variable systems. • Provide opportunities for internal cross-disciplinary collaboration. For example, having fish scientists and productivity scientists formulating research plans at the beginning of the project. Formalise the process and have collaboration embedded within the governance arrangements. • Focus the project on integrating with other water resource management projects in the Basin (e.g TLM, State-based work etc), rather than having a standalone project. Focus on "...connecting the dots" between all monitoring programs, and minimising duplication. • Include projects that have 'runs on the board' within 12 to 18 months, so that progress is evident and able to be communicated early in the funding cycle. • Improve project design to have a greater focus on what is needed to answer the question in terms of Commonwealth Environmental Water – "...if the focus was really on those Commonwealth environmental watering actions and understanding those actions, then the monitoring needs to be where those actions are". • Involve researchers in planning broader scale (e.g., system scale) watering events and then undertaking monitoring to focus on system scale outcomes as opposed to Selected Area/asset scale. • Conceptual models are important for planning, but often underutilised. They need to be co-developed, to "come to an agreed position on how we think a system works".
<p>Subcategory: Reporting and timelines</p>	<ul style="list-style-type: none"> • Reduce administrative reporting requirements of service providers and allocate more time to "...actually doing the work". Consider dropping from quarterly reporting to bi-annually. • Have a more considered approach to setting timelines of deliverables, particularly in relation to disseminating findings and communicating management implications to end-users. Have dedicated time at the end of the project to engage with key stakeholders. • Reduce the reporting burden and allocate funding appropriate to the task of undertaking effective and efficient (timely) basin scale evaluation.
<p>Subcategory: Project evaluation</p>	<ul style="list-style-type: none"> • Conduct interim project evaluations at points in the projects where there is still time to implement change. • Adaptively manage the project itself – "...I think it would be valuable to actually look at the information we got across the range of selected areas, work out do we need to gather exactly the same information?". • Have processes in place to have an independent scientific advisory group review interim and final reports to evaluate if the providers have delivered on what was agreed upon.

Broad category (Primary node in bold)	Summary of key points
Subcategory: Funding	<ul style="list-style-type: none"> • Have flexible funding arrangements in place to be able to monitor outcomes across the Basin on an event basis, and contingency funding to monitor/research the effects of emergent issues (e.g., fish kills, blue-green algae blooms, bushfires). • Have flexible funding arrangements in place to be able to add or drop monitoring indicators depending on conditions. For example, golden perch spawning does not occur under low flows, so only monitoring in events where flows are high and re-allocating funding to recruitment indicating. • Improve transparency in relation to available funding between the themes and funding available to address priority management needs. Improve transparency of the processes for allocating funding to research within and between themes. • Develop a more targeted approach to allocating funding to priority management knowledge needs, rather than ‘spreading’ the funding evenly. • Provide an opportunity (i.e. funding) for providers to do more ‘creative’ data analysis. • Formalise and adequately resource collaboration processes between project team members (scientists, theme leads) and water managers. • Have an adequate and continuous allocation of funding for communications purposes, both internal and external. • Have a full-time communications coordinator and support team embedded within the project. • Invest additional resources towards communicating findings after the project has concluded and results have been published.
Improving objectives	<ul style="list-style-type: none"> • Clearly articulate the objectives of the program and avoid broad objectives. • Consider more closely analysing the ‘line of sight’ between the chosen indicators and the objectives of the program. • The objectives for monitoring need to change and drivers need to be updated. The drivers should be demonstrating outcomes and adaptive management. • Revisit objectives and selection of indicators – ensure alignment to management decision making needs as opposed to building ecological understanding that may or may not influence decision making. • Consider having fewer objectives. Consider prioritisation process to narrow down the scope to what is important and what can be achieved. • In regards to ‘Basin-scale outcomes’, design research to reflect the differences in conditions across spatial boundaries, as outcomes are always contextual and different across the Basin. • Monitoring design and evaluation questions need to have a greater focus on what is needed to answer the question in terms of ‘Commonwealth Environmental Water’.
Improving collaboration	<ul style="list-style-type: none"> • Provide informal, unstructured time prior to formal workshops and forums for project team members and stakeholders to engage in a broader exchange, strengthening professional networks and exposing them to other work within the sector. • Co-develop the objectives of the program with key stakeholders to foster co-ownership of the project and it’s outcomes. • Improve involvement of First Nations people in actual on-ground monitoring.

Broad category (Primary node in bold)	Summary of key points
	<ul style="list-style-type: none"> • Explore opportunities to encourage and incorporate robust citizen science, e.g., members of the community (private landholders etc) taking photo points for monitoring, recording water levels at gauged pools, using basic water quality kits. The citizen science may improve engagement/buy-in whilst providing a useful dataset in an efficient manner. • Maintain relationships and continue to engage with research institutions – “...CEWO would benefit massively from continuing the engagement with people who work in a slightly less applied space”. • Retain and improve collaboration and networks of researchers, scientists, managers – this is a real strength of the projects.
Improving integration themes, research and monitoring	<ul style="list-style-type: none"> • Improve integration of research themes (and teams) from the onset to avoid researchers ‘competing’ for funding with different research proposals. Consider having multi-skilled site-based teams, or question-based teams, that could share resources and develop an integrated science plan and research questions. • Coordinate with MDBA to contribute to the development of an integrated monitoring strategy which integrates condition and intervention monitoring programs. • Improve integration of research themes and approaches to synthesis; recognising that synthesis is not integration. • If the themes are to continue, establish an ‘integration’ team which has a member working within each of the themes. • Before investing funds into integrating themes, consider what kinds of management and policy would benefit from integrated outcomes. • Have multi-disciplinary teams assembled around an integrated research question, rather than looking at things in isolation. For example, ecosystem focused, impacts of floods, drought, infrastructure etc. • Consider ‘place-based’, multi-disciplinary research questions and teams, similar to the ‘Focus Catchment’ model, which formulates research questions around the characteristics of the site. • Integrate the monitoring, evaluation, and research into one complementary program. • Formulate research questions around novel events captured by monitoring and be able to mobilise quickly to undertake studies.
Improving communication	
Subcategory: Communication planning - who and how it is coordinated – tools and products	<ul style="list-style-type: none"> • Leverage increased use and acceptance of videoconferencing as a cost-effective communication tool for internal and external communications. • Retain most elements of the projects but improve interaction and consistent engagement between researchers and managers throughout the life of the project.
Subcategory: Communication - What is the MER program, its scope and objectives, how it relates to other complementary projects	<ul style="list-style-type: none"> • Increase general awareness of projects through general communications, being explicit about the expected outcomes and what the project is trying to achieve. • Communicating explicit links between research and other monitoring and research activities occurring across the Basin. • Communicate the scope of the project effectively, being sure not to foster unrealistic expectations of what the program can deliver in terms of funding and the management recommendations.

Broad category (Primary node in bold)	Summary of key points
<p>Subcategory: Internal communication processes - Annual forums, timelines, improved communication between teams etc.</p>	<ul style="list-style-type: none"> • Improve interaction between all service provider teams and the CEWO water delivery teams to promote greater understanding of water planning needs and annual processes within the CEWO. Particularly relevant to Basin scale evaluation teams as these have not engaged with the water delivery teams yet. • Consider a follow-up water science and water management forum to communicate the outcomes of the projects, which also serves as a mechanism to maintain those relationships. Consider producing booklets etc as a take-home product of the forums. • If monitoring and research are to continue as two separate projects, improve communications around the purpose and division between the programs to manage expectations. • Increase awareness of managers of the projects being undertaken by CEWO and the awareness of researchers of the how outputs are being used in decision making. • Weekly, monthly, and/or quarterly column in local newspapers of communities where environmental water is delivered, or outcomes are expected. • Communicate with managers at the beginning, during, and after implementation. • Improve communication of findings into adaptive management messages. Simple statements that are based on 'what we think' rather than 'what we know'. • "...A workshop may be a more efficient and appropriate method of information uptake than the end of project forums. That's the only way I can think of it. I don't know if there's another way of doing that where you really are unpack the results and linking it to planning documents, mapping research to objectives etc and the expected outcomes. I think that's the sort of advice that needs to be conveyed".
<p>Subcategory: Communicating outcomes - knowledge brokering</p>	<ul style="list-style-type: none"> • Attempt to influence public opinion more broadly than just direct stakeholders, including responding to and navigating misinformation. • Embed a 'knowledge broker' who serves as an intermediary between scientists and managers. Responsible for translating scientific results into management recommendations, raising awareness, and building capacity, and aiding managers to incorporate project findings into planning and decision making. • Improve targeting, delivery mechanism and messaging of communication of outcomes – include a process for knowledge translation from research to practical advice in communication planning. • Increase opportunities (events) for managers to interact with the researchers/scientists to have conversations (not just presentations) allowing managers to ask questions specific to their needs. • Improve timeliness of results and communications to align with when end-users are "ready to use it". • Improve translation of science into knowledge and management recommendations through synthesis of results. • The cause and effect diagrams developed during the planning phase of the LTIM project should be evaluated for adaptive management learnings and used to communicate the change in knowledge and capacity as a result of the LTIM project. • Consider building a "library of knowledge, thematically organised...extending into QLD, the Lower Balonne, the Lower Darling, in collaboration with TLM for the Murray, maybe Macquarie Marshes. That's where the value is."

Broad category (Primary node in bold)	Summary of key points
Improving data management and sharing	<ul style="list-style-type: none"> • Adequately resource data management from the onset of the project with a dedicated data manager. • Maintain funding of a data manager and ensure robust data management as a fundamental aspect of MER. • Improve availability and accessibility of datasets to the public, including the raw data, not just processed data. • Continue to foster two-way sharing of data between LTIM selected area teams and other State-based programs.
Improving adaptive management	<ul style="list-style-type: none"> • Improve adaptive management processes. "...If the measure of success is going to be adaptive management. Then [there needs to be] greater emphasis on unpacking the adaptive management process and where the information needs are and filling those needs". "...The hardest part of my report to write every year was - what are the adaptive management messages?" • One of the things lacking is a knowledge-management framework to capture adaptive management learnings across programs and agencies. • Develop an approach, in consultation with stakeholders (e.g., MDBA), to adaptive management at the Basin scale. • Develop and implement in consultation with the MDBA a knowledge management framework (Basin Science Platform?). • Improve use of conceptual models, including cause effect diagrams, to illustrate adaptive management outcomes and inform management decisions.
Priority research to support implementation	<ul style="list-style-type: none"> • Consider whether 7 monitoring sites is adequate to deal with Basin-scale questions. - "...Is it reasonable to draw Basin-scale inferences from data from seven points and then try to create model"? • Inferring outcomes to areas not monitored needs more attention. In the Northern systems comparisons between valleys is not necessarily appropriate.
Subcategory: Appropriate spatial coverage	<ul style="list-style-type: none"> • Consider using fewer indicators but aim for greater spatial and temporal coverage of the indicators used. • Expansion of the Lower Murray selected area to include the Coorong to get a better understanding of the contribution that environmental water is making to the end of the system – "...I don't think that the work at the basin scale part of the MER or LTIM captures that end of system outcome either. It captures, you know, the salt export outcomes, but that doesn't provide the kinds of information that help to inform better barrage management and configurations of barrages and how the how to best release water to the Coorong." • Consider having Southern Basin monitoring/research questions and Northern Basin monitoring/research, as opposed to the collection of selection areas. • Rather than having prescribed selected areas, focus monitoring efforts on locations where the water is being delivered – "...is Basin scale a reality? And maybe rather than have these defined selected areas, you actually focus on where the water is delivered. And have, I guess, a more nimble approach where you could still have teams that are based in certain localities, but where they're monitoring probably could be more fluid". • Increase spatial coverage of systems in the Northern Basin, Darling system to improve Basin scale outcomes.

Broad category (Primary node in bold)	Summary of key points
<p>Subcategory: Inundation modelling and mapping</p>	<ul style="list-style-type: none"> • Improve understanding of hydrology through adequate inundation modelling and mapping. The CEWOs levers are around hydrology, so focus on improving understanding of how the portfolio can be optimised. i.e. improving understanding of where water can be delivered to, and what that water contributed to the system. • Improve inundation modelling to be able to adequately link environmental outcomes to environmental water deliveries. • Develop a common data set on wetland inundation, able to be used for evaluation across the Basin. Link to vegetation data where possible.
<p>Subcategory: Outcomes framework update, improved line of sight to Basin Plan/BWS</p>	<ul style="list-style-type: none"> • Review the outcomes framework and update it to align better with the MDBA Basin-wide Watering Strategy in collaboration with the MDBA. • Maintain and where possible improve alignment with Basin Plan: retaining themes of waterbirds, fish, vegetation, and food webs/stream metabolism.
<p>Additions to MER</p>	<ul style="list-style-type: none"> • Consider monitoring tree-stand condition at the Basin scale using satellite data. • Energy transfer in systems should be considered moving forward. • Invest in looking at carbon movement on the floodplain and productivity changes in the river as a result of that movement. “...if we wanted to flush carbon out of a floodplain or we wanted to flush carbon into a river, or we wanted to maintain refuge habitats, that we would invest the money in those specific areas rather than just kind of routine (monitoring)”. • Increase investigations of floodplain responses to watering and improve consistency between assets (e.g., indicators, methods, data). - “...The real question is, can the objectives of the Basin plan be achieved with that same strategy of committing the most environmental flows to in-channel and then only small amounts out to a very small number of floodplain wetland assets?” • Consider genetic investigations to look at how populations are changing in response to watering, is environmental water influencing movements of individuals between populations. Give consideration to landscape scale objectives and outcomes – which biota respond at a landscape scale. <ul style="list-style-type: none"> • Consider integration between aquatic and terrestrial systems at the landscape scale. • Scope the use of remote sensing to monitor vegetation outcomes. • Add additional monitoring sites in each valley (including the Macquarie Marshes, the Lower Balonne, Narran, Barwon-Darling, Namoi, Border Rivers, The Coorong, to improve power of Basin-scale evaluation. • Consider developing quantitative models to test watering scenarios. • Consider taking a “..bigger picture view” on research; how much value does just a pure ecological research program offer to water delivery and management compared with a program which is which focuses on constraints or other things that really are influencing the kinds of outcomes that can be achieved. • Climate change – “...I think that in terms of looking forward, I think that the biggest blind spot that I can see for us, and we don't do a lot of blind spot analysis really, things like climate change, that they're just not talked about within the office.” • How environmental water influences productivity, and how that productivity influences native fish breeding and recruitment.

Broad category (Primary node in bold)	Summary of key points
	<ul style="list-style-type: none"> • Investigate the extent to which floodplain inundation and connection drives aquatic food webs. • Geomorph/physical aspects of floodplain dynamics, sediment shifts, loads, sources, erosion. • Consider focusing on priority threats (e.g., speed boats, carp, stable water levels etc) that the community can recognise, understand, and get behind. • The matter transport and salt export type work is very useful for reporting back and demonstrating the positive benefits of environmental water. • Consider a process for assessing trade-offs for intervalley transfers of environmental water, and linking upstream outcomes with downstream outcomes – are there negative consequences upstream and positive consequences downstream etc. • Consider scaling-down the use of Cat I activities at the Selected Areas and focus on the watering objectives of the region.
Subcategory: First Nations	<ul style="list-style-type: none"> • Increase involvement of First Peoples in research and start taking a more “...holistic view of the systems”. • Increase engagement with First Nations and community groups, with dedicated funding to employ groups and build capacity at local scales. • Cultural science capabilities - “...There aren't a lot of examples, I don't believe, where Aboriginal people have actually taken the opportunity that's given them and done something. And that's a capacity issue, but no one ever talks about that. So there's a real lack of capacity in a lot of the Aboriginal people to move from advocate to implementer.”
Subcategory: Social science capabilities	<ul style="list-style-type: none"> • Include consideration of social-ecological systems and cultural systems. • Consider including social sciences expertise within MER moving forward. It's important to recognise the specific skill set required to do social science and the value of insights to water management that can be gained by including social science as a theme separately funded. • Social and cultural considerations were non-existent in LTIM and this needs to be addressed moving forward.
Subcategory: New sites in Northern Basin	<ul style="list-style-type: none"> • Improve representation of the Northern Basin by consideration of additional monitoring sites – “...north being slightly under-represented in terms of the sites. Systems in the north are quite variable, and I guess that some of the Ramsar sites are not represented and some of the selected areas are not necessarily related to where Commonwealth has its environmental water holdings either”. • Increase the number of sites in the Northern Basin to increase statistical power for evaluation purposes.
Subcategory: Ramsar	<ul style="list-style-type: none"> • Consider the inclusion of Ramsar sites in monitoring.
Subcategory: Threatened species	<ul style="list-style-type: none"> • Approach threatened species in a Basin-scale significance context. E.g., some species are located all over the Basin, whereas others are only in one site. If you lose species from that site, you lose them from the Basin.