

Ripples in the stream (Part 2): What might the next 30 years of waterway management look like?

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Key points

- Drawing on lessons from the case study of 30 years of urban and rural waterway management in Greater Melbourne (Coleman et al. 2026 in this proceedings), we identify future challenges and opportunities for waterway management in Australia. Future waterway management must address the barriers and enablers that govern progress.
- We consider how 'known unknowns' — e.g. droughts, floods, urbanisation, climate change, and economic downturns — whilst unknown in magnitude, must shape our strategies, rather than our reactions.
- Emerging priorities such as legal personhood for rivers, First Nations self-determination, room for the river, nature-based solutions, and smart technologies, are all going to require courage to challenge current practices, and will be enabled by 'safe to fail' cultures, impactful demonstration cases, and the willingness to convert long-held ideas into action when opportunities arise.
- Transformative change requires clear and compelling narratives, plus organisational and individual leadership and courage. Waterway champions — individuals and collectives — remain our most critical and yet overlooked, asset. As agentic AI absorbs routine tasks, our deep domain knowledge and leadership capability will become fundamental for industry progress. Investing in the next generation of waterway champions, building communities of practice, and institutionalising leadership are necessary ingredients to streamline and strengthen our waterway management future.

Abstract

The 12th Australian Stream Management (ASM) Conference marks 30 years since inception, providing the opportunity to reflect on the evolution of waterway management. Under the conference theme '*Living and evolving with change*', this paper builds on a companion Part 1 '*Reflections in the stream*' — from a waterway management authority, academic and consultant perspective. While reflections are valuable, its utility is the insights into our sector adapting to future challenges.

This paper considers the ripples we initiate, looking forward nominally 10-30 years. We explore how waterway management may evolve across key themes including: shifting philosophies and narratives, emerging threats, strategic planning, works programs, monitoring and assessment, stakeholder engagement, and economic climate and risk appetite. From reflections to ripples we suggest approaches that are likely to guide future practice, including the importance of clear, forward-looking narratives coupled with a focus on a 'safe to fail' culture, and readiness to seize opportunities. We acknowledge that transformative change often reflects long-term effort and strategic thinking, and is best aligned with external context or events that whilst beyond our control, should not be a continuing surprise (our 'known unknowns').

We recognise the critical role of individuals, or collectives, in driving progress and cultivating and supporting future 'waterway champions'. Emerging enablers—such as recognition of rivers as living entities, First Nations self-determination, headwater protection, 'room for the river', nature-based

solutions, new technologies and demonstration cases —are identified as central to future practice. We hope to facilitate forward-thinking discussion that inspires leadership, supports decision-making across the industry and builds the ripple-effect evolving our waterway management future.

Keywords

Future of waterway management, evolving management, living rivers, room for the river.

Introduction

The 12th Australian Stream Management (12ASM) conference marks the 30th Anniversary of the series. Given 12ASM's theme — *Living and evolving with change* — we saw value in reflecting on 30 years of waterway management with a case study of the waterway management for the Greater Melbourne region (see Coleman et al. 2026: '*Reflections in the stream (Part 1) What can we learn from 30 years of urban and rural waterway management*'). We approached this as a collective perspective from a waterway manager, an academic and a consultant. We see this as the 'living' perspective, because we as professionals have directly viewed these changes over the 30 years, and we hope played a small role in influencing them, in both rural and urban catchments. We also recognise the lived experiences of the ASM community, many of whom we hope connect with these experiences. By collectively reflecting and uncovering what we have learnt, we can better move forward as a waterway management industry. We draw upon the lessons from the Part 1 '*reflections*' paper, and in this Part 2, we contemplate how these lessons might guide the challenges and opportunities or '*ripples*' that may emerge for our industry. We see this as the 'evolving' element of our considerations. Whilst the case study in Part 1 was focused on the urban and rural waterways of the Greater Melbourne region, we feel many of these lessons are relevant for Australian stream management more broadly.

As an eminent geologist once said: "*In examining things present, we have data from which to reason with regard to what has been; and, from what has actually been, we have data for concluding with regard to that which is to happen hereafter*" (Hutton, 1788). This has coined the phrase '*the past is the key to the future*'. Although, we know this to not universally be true. There is a non-linearity element (e.g. climate change) and disruptors are often unpredictable (e.g. a pandemic). There are, however, 'known unknowns' — we know we will see more floods, but we don't know their timing, extent or magnitude. It is how we respond to these known unknowns, and particularly our preparedness, that is important for future strategies.

As with ripples in a slow-moving stream, their influence depends on the displacer (or disruptor), whether the ripples are moving with or against the flow (comparable to the social and economic climate), and what features accentuate or mute the ripples (e.g. policy constraints or industry acceptance). Predicting ripple amplitude is uncertain, but we can be better prepared for a range of possibilities by understanding the context.

How may issues, priorities and approaches evolve?

In the Part 1 '*reflections*' paper, we identified 5 themes: 1) shifting narratives for waterway management priorities, 2) focus threats and responses, 3) how strategic planning drives priorities, 4) evolution of waterway management actions, 5) waterway monitoring and assessment improvements and 6) increasing community and cultural connection to waterways. Drawing upon the findings for these themes over the past 30 years, we propose possible trajectories over the next 30 years, Table 1.

Table 1 Examples of the evolution of waterway management in Greater Melbourne over the past 30 years (Coleman et al. 2026) and possible trajectories over the next 30 years

Theme	What we have seen 30 years to now	What could this mean for the next 10-30 years?
1. Shifting narratives of waterway management priorities	• Management has progressively broadened from narrow considerations (e.g. flooding, water quality) to holistic ecosystem, social and cultural values. • Recognition of waterways as ecological and 'living' systems has grown steadily, culminating in, for example, legal recognition of the Birrarung/Yarra River as a living entity. • Integration with urban water management (IWM) has raised the profile of waterways as central to city resilience and liveability.	• Narratives will increasingly centre around climate adaptation and increasing resilience of stream ecosystems and waterways will be recognised as urban and rural refuges for flora, fauna and social activities. • The role of rivers in community wellbeing & their cultural and spiritual values, will become primary drivers of policy alongside ecological considerations, to reconnect rivers laterally and longitudinally. • Traditional Owner-led management of waterways is expected to expand, with more rivers receiving legal personhood or living entity recognition, reshaping governance and moving management to guardianship.
2. Focus threats and responses	• Threats have evolved from localised, visible pollutants (nutrients, sediment, litter) to diffuse, systemic stressors (flow regime alteration, climate change). • Climate change has moved from a 'future likelihood' to a core present-day driver, compounding all other threats simultaneously. • New threat categories have continuously emerged — from emerging contaminants to pest animals — reflecting the increasing complexity of urban & rural catchments.	• Climate change will dominate most threat categories — intensifying droughts, floods, fire-related runoff & species pressures in ways that overwhelm single-issue responses. • Emerging contaminants and novel pest species will require continuous horizon scanning as a core management function. • Compound and cascading threats — where climate, land use change and biodiversity loss interact — will demand holistic, adaptive responses rather than issue-by-issue management.
3. How strategic planning drives priorities	• Strategic planning has evolved from internal and largely local planning to a goal of multi-partner regional strategies, spanning multiple water mgt domains. • Quantitative, systematic frameworks and tools replaced intuitive prioritisation, enabling evidence-based decisions at regional scale. • The 2020s brought explicit integration of development planning, water security and waterway health — and a growing imperative to express outcomes in economic terms.	• Catchment-scale, systems-based planning will be a focus, and must better address conflicts with local interests, before it is truly integrated into waterway mgt, as it considers realms such as water supply, flood mgt, ecological outcomes & social elements. • Monetisation of environmental and social benefits will be essential to securing investment — natural capital accounting and ecosystem service valuation will underpin business cases. • Adaptive management plans with regular feedback loops (e.g. 1-2) will complement longer-term strategies (e.g. 5–10y), as an uncertain climate future is realised.
4. Evolution of waterway management actions	• Actions have shifted from hard engineering (concrete, rock stabilisation) toward nature-based solutions (water sensitive urban design, revegetation, daylighting, large wood, floodplain reconnection). • The scope of intervention has expanded dramatically — from localised works to landscape-scale programs integrating water quality, flow, habitat and community outcomes. • Real-time control and smart infrastructure are beginning to transform waterway management from fixed works to adaptive, responsive systems.	• Nature-based solutions will become the default approach, and naturalization or daylighting of concrete drains and pipes expanding. With a focus on revegetation, and hard-engineered infrastructure reserved for exceptions, not as a default. • 'Room for the river' and floodplain reconnection will expand, requiring renegotiation of land use in riparian corridors — a major planning and community challenge. • Geographic broadening of approaches will increase, such as regional stormwater harvesting schemes, water transfers across catchment boundaries with surplus (e.g. urban) and shortfalls (e.g. irrigation). This includes blurring boundaries the water cycle actions, e.g. water supply, flood and ecological management. • Smart, and real-time managed infrastructure can improve opportunities in urban and rural settings. Urban includes rainwater tanks, wetlands, detention systems whilst rural applications could include adaptive management of diversions and real-time monitoring modifying actions.

Theme	What we have seen 30 years to now	What could this mean for the next 10-30 years?
5. Waterway monitoring and assessment improvements	- Monitoring has broadened from chemical indicators to biological, ecological, and social indicators, providing far richer assessments of waterway health. - Technology has progressively transformed monitoring — from manual sampling to remote sensing, eDNA, acoustic tracking and AI-driven analysis. - The establishment of formal MERI frameworks represents a shift from single-issue data collection to systematic, strategy-linked evidence generation.	- Continuous, real-time ecological monitoring at catchment scale will become standard — driven by sensor networks, environmental DNA and satellite remote sensing, replacing periodic snapshots. - AI and machine learning will transform data into actionable management intelligence, greatly reducing human analysis, and enabling early detection of threats and near-real-time adaptive responses. - Monitoring will increasingly integrate social, cultural and wellbeing indicators alongside ecological ones, reflecting the broader values that communities place on waterways, whilst being more targeted to the key indicators for each.
6. Increasing community and cultural connections to waterways	- Community relationships with waterways have deepened from passive observers to active co-managers, co-designer, advocates. - Traditional Owner partnerships have evolved from peripheral consultation to genuine co-mgt and self-determined strategies — a fundamental shift. - Legal recognition of Birrarung as a living entity signals a transformation in how society and governance systems value and relate to rivers.	- First Nations self-determination will be strengthened — with Traditional Owners holding increased management authority, not just advisory roles, across significant parts of the landscape. - Community stewardship will become a core delivery mechanism — through citizen science, smart home infrastructure, digital engagement and local advocacy — crossing the boundary between manager and customer

Discussion: How to make ripples

Building on the themes and ‘reflective lessons’ captured on evolving issues, priorities, management approaches and catalysts over the past 30 years (Coleman et al. 2026), here we combine these with ‘ripple effects’ that might guide approaches to waterway management over the next 30 years. By considering the Part 1 *ebbs* — hindering progress for waterway management — we now consider the *flows* that support and enable progress.

Industry capacity and capability

Ripple effect: *Accelerated investment in retention and development of domain-knowledge leaders, capacity and capability-building, and increasing realm knowledge.*

Industry capacity may be less critical in the future. We are at a juncture of great uncertainty, akin to the start of the internet as disruptor to business-as-usual. The rapid development of AI, particularly agentic AI, aims to achieve specific goals with minimal human supervision. It is thus likely that industry *capability* — the ‘know how’ — rather than *capacity* will limit our industry. A lack of technical realm knowledge can be linked to industry ebbs. Examples within Greater Melbourne where initiatives required technical realm knowledge at organizational leadership levels to ensure uptake, and where they require this knowledge to evolve, include:

- Water sensitive urban design (WSUD) advancements were well described to the industry, which broadly embraced the concept. Implementation of assets was common, yet, some examples of poor design could be linked to inappropriate consideration of construction and maintenance operations, and this led to underperformance of WSUD assets. Going forward, increased capacity and capabilities within organisations will ensure appropriate, place-based designs, that are maintenance sympathetic, to increase performance and improve perceptions of these solutions.
- Those designing concrete-lined channels in the 1990s would not have expected concrete removal less than 30 years later. Now, we tend toward rock-lined, trapezoidal channels of a capacity for the 1 in 20 yr Annual Recurrence Interval. Similarly, to our move from concrete, we expect we will be looking for opportunities to remove rock from waterways within the next 30 years, so that hard engineering is a last resort. This shift from business-as-usual requires the realm knowledge at decision making levels in government.

- ‘Room for the river’ has been a common concept globally for decades (Rijke et al., 2012). In Greater Melbourne waterway offsets are challenged by the pace of development planning processes. Identifying waterway offsets early, including for areas outside of the urban growth boundary (particularly in headwater streams) requires evidence-based leadership.

Therefore we must: a) ensure capabilities through the entire life cycle concepts through to operation, when considering new strategies, b) provide demonstration/case studies before widespread implementation (despite our best intentions for rapid progress), and c) build capacity and particularly capabilities within industry leadership. Investment in knowledge must be at all levels, and in a range of realms. It is essential that we support, retain and develop leaders with technical and discipline knowledge. We must celebrate and foster these leaders within government organisations. Technical domain and discipline knowledge will become increasingly important for decision making, as generic knowledge — advanced by agentic AI — requires verification. Equally, we must develop the skills and experience of the next generation of waterway leaders.

Economic climate and industry risk appetite

Ripple effect: *We need to promote ‘safe to fail’ organizational cultures that recognize the importance of innovation to solving current and future challenges.*

The economic environment and aversion to risk, when it comes to innovation, will continue to hamper some initiatives. Climate change will increase risks (see Natural and Human Stressors below), so risk appetites may need to commensurately increase. Given the maturing of the industry, and the need for proof-of-concept, we need more case studies and demonstration projects to improve the confidence to proceed. The need to monetise benefits will be central to future programs and activities. A near-certainty is that we will periodically see tight fiscal environments, requiring strong business cases, including clear and compelling narratives.

Given the well-known increase in streamflow and extreme event variability, funding boosts may be increasingly regular. We must make better use of reactive funding for crises management, through preparedness for these known unknowns, so that we can capitalize and realise strategic approaches. To enable continuous improvement, especially in the face of future challenges we must value and create space for innovation activities.

Enabling policy, legislation and governance structures

Ripple effect: *Be that focused, lead organisation and draw upon relevant stakeholders and agencies, whilst ensuring cross-disciplinarity and community collaboration, within an environment of enabling policy.*

Enabling policy is required: policy that encourages action, rather than restricting behavioural change. The policy must inspire holistic, cross-discipline and multi-organisational actions, and support community and culturally-led programs. The Yarra River Protection (Wilip-gin Birrarung murrn) Act 2017 (the Birrarung Act) was a major shift in the formal recognition of the Birrarung as a natural living entity. The next few decades should see this knowledge move from acknowledgement to genuine integration at the heart of decision-making.

The next stage of this evolution is the granting legal personhood to rivers — exemplified by New Zealand's Te Awa Tupua (2017) and similar movements internationally — which, given the recent trajectory, will be integrated into Australian law within coming decades. This shift will reshape governance structures, redefine protection mechanisms, and transform the community's relationship with waterways from one of resource management to one of custodianship. Equally, the ‘room for the river’ concept is beginning to gain traction in Melbourne, with waterway offsets now in policy and

actions, following more advanced progress worldwide (Rijke, 2012). This requires a fundamental change in institutional arrangements at all levels.

As we see the democratization of data, knowledge and engagement platforms, the community will increase in awareness of, and involvement in, decision making for waterway management. The challenge will be to incorporate a broad range of actors whilst reduce vested, singular interests. Equally, we hope to see a continuation of holistic management, such as the nexus of waterway environments, water supply, and energy where cross disciplinary and cross-jurisdictional responsibilities are broadened to develop system-scale solutions.

Strategic management frameworks

Ripple effect: *Holistic strategic planning should build upon successes, provide explicit targets, regularly re-prioritise based on improved inputs and knowledge, and be developed and implemented with the community*

As noted by Russell et al. (2023) ‘long-term thinking is required to continue the emerging trend away from reactive management to proactive and strategic planning’ (p.9). This is particularly important for how we respond to the known unknowns, such as natural disasters, and climate and environmental change.

The evolution of waterway management actions (Table 1) highlights that holistic, nature-based solutions will become standard within strategic documents. The economic and ecological case for nature-based solutions — floodplain reconnection, room for the river, wetland restoration, and living infrastructure — will become impossible to ignore as the costs of climate-driven flood and drought damage accumulate. ‘Hard engineering’ will likely lose the default status. Engineered infrastructure will evolve, as will the terms we use for this, incorporating nature-based solutions. Guidance must reflect this. This shift will require not only technical capability but sustained investment in community engagement, as these approaches often require more space, longer timeframes, and greater tolerance for uncertainty than their hard-engineered counterparts. This shift requires strategic, medium to long-term planning, and adaptive management.

As we have seen with the Healthy Waterway Strategy (Melbourne Water 2018), strategies will increasingly be founded on principles of co-design and co-delivery with all stakeholders. With a view to catchment-scale, stakeholder attention may lead to more focused, site-based activities, which we know to often provide the strongest business case for wider adoption.

Collaborative research

Ripple effect: *Long-term collaborative research, integrated within strategic government teams, is critical to improve the efficacy and efficiency of management actions.*

Domain knowledge, and specific and advanced technical knowledge, will be required to drive continuous improvement at all levels and in all realms of the waterway management our industry. This has been well demonstrated by the Melbourne Waterway Research Practice Partnership (Melbourne Water and Melbourne University) and the CRC for Water Sensitive Cities (e.g. Chee et al. 2020 and Water Sensitive Cities Australia (2022). Collaborative research and ‘trusted advisors’, across partnerships between government staff, academics and consultants will be increasingly critical to address validation of information. The proliferation of tools that explicitly link management actions to physical or ecosystem responses will be information that assists, but also one that will require increasing human validation.

We are coming to realise that we will either have more time to consider, learn and develop the way forward as agentic AI delivers the more mundane tasks or conversely just try to speed up the day-to-day processes to achieve more. Either way, technology will be central to our waterway management future. For decades, adaptive management has been more aspiration than practice, constrained by the cost and infrequency of monitoring, and sometimes tenuous links between what is collected and what is most useful. The convergence of real-time sensor networks, environmental DNA, satellite remote sensing and AI-driven analysis fundamentally changes this. Within 30 years, continuous landscape-scale ecological monitoring will be routine, enabling managers to detect change early, test interventions rigorously and adjust programs in near real time. The profession must build the analytical capacity and institutional culture to act on what this data will tell us, and how to correctly interpret it.

The role of research will be to identify and address knowledge gaps that support objectives in our waterway management strategies, including better understanding future risks and management opportunities, assessing the effectiveness of waterway management interventions, demonstration of innovative approaches and providing the underpinning data and information to support business cases for industry change.

Industry champions

Ripple effect: Industry ‘champions’ are essential – they require support – and their ‘regeneration’ depends on supporting development of next generation leaders.

As noted, domain knowledge across all realms of leadership leaders will be critical to our industry, but ‘industry champions’ that inspire and facilitate solutions are the key to industry advancement. These champions might be individuals, or collectives (such as institutions or ‘think tanks’). Reflections on the past 30 years in Greater Melbourne consistently reveal that transformative progress can be traced to a select few committed individuals, and small collectives — champions who drove change through persistence, vision and relationships. This dependence on individuals (or small collectives) is also a structural vulnerability; progress too often stalls or reverses when champions move on. One of the most important challenges for the next 30 years is to solve this problem institutionally: building organisations, training pipelines, and professional cultures that identify, elevate and sustain leadership as a systemic capacity rather than a fortunate accident.

Our industry champions will be those who can work through the layers of a problem; understanding the details *and* possess an ability to distil key messages into clear and compelling narratives to a wide range of audiences. To develop our future champions, as recommended by Russell et al. (2025): we must invest in people as deliberately as we invest in projects; build the collectives not just the individuals, and; close the awareness-action gap so that we build the conditions that bring ideas (and demonstrations of those ideas) to life. Where will these champions come from? Given funding shifts we must look beyond academic institutions to find emerging champions from all realms.

Natural and human stressors

Ripple effect: Draw upon evolving opportunities in scenario testing to develop crises arguments and ideas, before they are required.

We have seen a substantial shift in waterway management (and funding). These are often linked directly to events, such as the Millenium Drought and multiple floods. With projected events becoming more frequent and severe under climate change, climate change scenarios will cease to be one scenario among many and will instead become the defining frame for all waterway management decisions. Altered flow regimes, increasing extreme event frequency, and shifting species distributions will force a fundamental rethinking of restoration targets, thresholds and the need for adaptive

planning. This will trigger alternative management pathways — including with Traditional Owners — on the merits of building adaptive capacity, resilience and, in some catchments, managing deliberate transitions to conditions distinct to historical. Managers who plan for the climate of 2055, not 2025, will be best placed to deliver sustainable outcomes.

The consistent modelling for rainfall across southern Australia predicts less winter rainfall, with lower winter and spring rainfall translating to significant reductions in runoff. The median projection is for reductions in mean annual runoff in far southwest and far southeast Australia of 50% and 20%, respectively by 2046-75 (under a high emissions scenario, Hongxing et al., 2024). Whilst 90% of models simulate an increase in extreme precipitation (Grose et al., 2020). Given we are an industry group focused on streamflow and its effects, this is arguably the single most important driver for the next 30 years. We can prepare for these known unknowns (e.g. floods, droughts), because we know they will occur, we just don't know when, or how big. As noted by a senior Environmental Water Planner in Melbourne Water “We must respond to drought, like we are in it”. We require the will and bravery to proactively tackle this when it is least anticipated. Technological advancements will reshape our ability to predict and inform this preparedness, and reduce consequences.

Catchment urbanisation is arguably the greatest human stressor on waterways with well-known, climate change exacerbating effects (Figure 1). Given predictions of increases in urbanisation, our overarching approach requires a ‘sponge city’ mentality (Brown et al. 2016), through nuanced catchment and streamflow management (e.g. Fletcher et al., 2014).

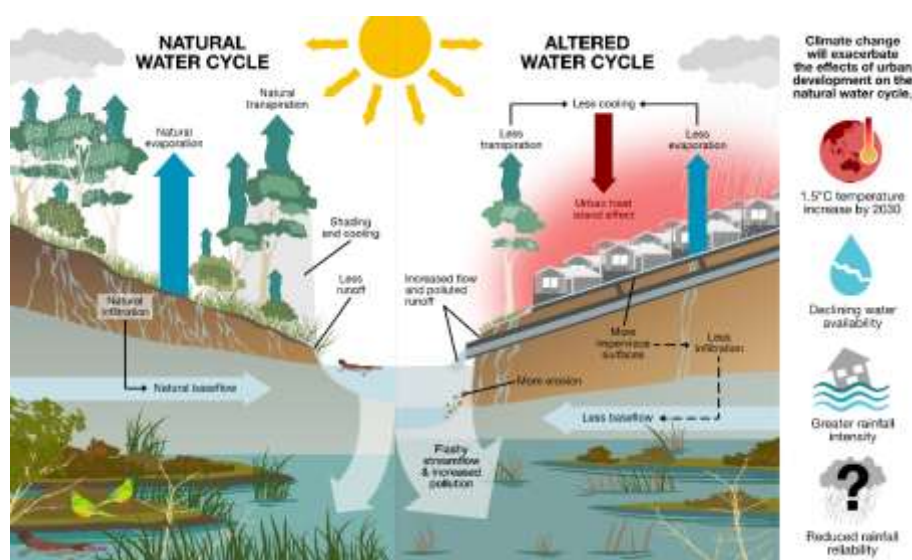


Figure 1 The relationship between stormwater volumes and the health of waterways and bays applies universally across urban areas, with the magnitude and context of growth, and its similarity to the streamflow impacts of climate change, being particularly concerning unless we move away from business-as-usual (Graphic: Streamology and Ooid Scientific)

With a focus on streamflow in urban and regional settings, some ‘smart’ solutions for the future will include:

1. Smart stormwater control measures (SCMs) – These capture-and-release-on-demand storages resolve some of the challenges with excess stormwater runoff, demand, and the variability in rainfall conditions. Smart SCMs can help to mitigate flow peaks, restore baseflows and maximise water quality treatment performance (Webber et al, 2022).
2. Smart water centres — Locating demands near sources of excess runoff - Water demands in our cities are increasing, such as with the data centre revolution. For example, by 2035 almost 20% of Sydney’s potable usage will be consumed by data centres (IPART 2025). Protecting

waterways from excess stormwater runoff is possible with storages and demands. Policy is urgently required to ensure strategic placement of these facilities, before it is too late.

3. Smart waterways — Our strategies are increasingly considering the floodplain as a critical element of the waterway (as noted above).
4. Smart catchments - The geography of streamflow water imbalances is skewed. We are increasingly recognizing inter-catchment options for storage water transfer, as we move to holistic water management, breaking down the discipline silos, whether it be in urban or rural settings (for more on smart catchments we refer the reader to Law et al. (2026) in these proceedings). Importantly, how water is moved around Country requires consideration also of ecological and cultural implications.

Conclusions

The next 30 years of waterway management will demand not just technical evolution, but a fundamental rethinking of who waterways are, who we are, who we work with and how, and ultimately, what we are trying to achieve. The profession that emerges will look quite different from the one that gathered 30 years ago — and that, if we are deliberate about the transition, is cause for genuine optimism. The ripple you start today may be a wave by then.

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Part B:

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