Mine Closure 2026 – AB Fourie, G Boggs, J Heyes & M Tibbett (eds)

doi:10.36487/ACG_repo/2615_70

Designing a national water atlas for mining regions: water supply information across the mining life cycle

Louisa Rochford [a,*], Pascal Bolz [a], Agnes Samper [a,b], Neil McIntyre [a], Nevenka Bulovic [a], Mansour Edraki [a], Claire Cote [a]

[a] *Centre for Environmental Responsibility in Mining, Sustainable Minerals Institute, The University of Queensland, Australia*

[b] *CRC TiME, Australia*

Abstract

Water is an important consideration for mine closure and post-mining land uses (PMLUs). Access to reliable water supplies can be a critical determinant of mine closure outcomes, influencing factors such as revegetation success, tailings stability and cover system performance. Water availability can also affect the range of PMLUs that can be achieved, including agriculture, renewable energy developments, industrial activities and other productive land uses. Across the mining life cycle, and particularly at closure, some mine sites may hold significant volumes of non-conventional water – such as mine-affected water or water in pit lakes – that could potentially be repurposed for beneficial use by other water users. Yet information on water supply options and entitlement pathways in Australia remains fragmented across jurisdictions, datasets and regulatory systems, and there is currently no platform that connects parties with surplus water to those seeking supply. These challenges are particularly acute for organisations without specialist water expertise, increasing uncertainty during closure planning and regional transition and limiting opportunities for re-use and broader regional benefit.

The Australian Water Atlas for Resource Extraction (AWARE) Pilot Project addresses this gap by demonstrating how a national, integrated platform could consolidate information on water sources, access pathways and entitlement requirements, and provide a platform for water sharing. Using the North West Minerals Province in Queensland as a test case, the project reviewed existing datasets and regulatory frameworks, engaged widely with industry, government and water providers, and co-designed a concept-level prototype capable of guiding users through available water supply options.

The prototype shows that a water atlas could support mine closure and post-mining transitions by making water options more visible, reducing uncertainty and enabling early identification of opportunities to repurpose non-conventional water sources. Stakeholders expressed strong support for such a tool, noting benefits for investor confidence, regional coexistence, environmental outcomes, and more efficient planning across the mining life cycle.

Keywords: *mine closure, water supply, post-mining land use, water information systems, decision support*

1 Introduction

Water availability is a critical factor in decision-making across the mining life cycle, including for mine closure and post-mining land use (PMLU) planning (Hattingh et al. 2019; Measham et al. 2024). During the mine closure phase, water may be required for activities such as rehabilitation and revegetation, tailings management, earthworks and dust suppression, as well as ongoing environmental management. After mining, access to water has the potential to support a range of possible land uses, including agriculture,

* Corresponding author. Email address: louisa.rochford@uq.edu.au

renewable energy, industry, environmental restoration and community development (Worden et al. 2024). For some mines, water availability and access can be key determinants of closure outcomes (e.g. the success of revegetation, tailings stability and cover system performance), the PMLUs that can be realised (Worden et al. 2024) and the opportunities for longer-term regional transition (Clerc et al. 2023; Worden et al. 2024). Across the mining life cycle, and particularly at closure, mines may have non-conventional water sources available, such as mine-affected water stored in dams or water stored in residual voids (pit lakes) (Sagar et al. 2025; Hattingh et al. 2019), which could be shared with other users (Cook et al. 2021). Improved accessibility to information on available water sources may facilitate collaboration across sectors, support shared infrastructure and water re-use initiatives, and contribute to more coordinated and sustainable regional development outcomes.

In Australia, access to conventional water sources such as surface water and groundwater is governed through state-based water planning and entitlement frameworks (Tan et al. 2012; Gentle & Olszak 2007). However, information on water availability, water quality, entitlements, infrastructure and regulatory pathways is dispersed across numerous platforms and varies considerably between jurisdictions. Much of this information is embedded within legislation, policy instruments and technical guidelines, which can be difficult to interpret without specialist expertise. For non-conventional water sources, including mine-affected water in dams and residual voids, available information is often limited and difficult to access as these water sources are typically managed through site-specific approval processes. Navigating these fragmented and highly technical data sources requires specialist expertise due to their complexity and the jurisdiction-specific nature of the regulatory and information landscape.

The Australian Water Atlas for Resource Extraction (AWARE) Pilot Project was commissioned to explore how information about water supply options and entitlement pathways could be better organised and communicated to support informed decision-making in mining regions. This paper presents the findings of the pilot study, with a specific focus on its relevance to mine closure and post-mining transitions. It evaluates the potential role of a water atlas, a spatial tool for identifying and evaluating water supply options in mining regions, in supporting assessment of water availability for closure activities (e.g. rehabilitation, tailings management) and PMLU options (e.g. agriculture, renewable energy). The paper also considers whether a water atlas could facilitate water-sharing opportunities at a regional scale by improving information on the availability of non-conventional water sources, such as pit lakes, and infrastructure such as water pipelines that may be available for use following mine closure (as highlighted in Worden et al. 2024 and Cook et al. 2021).

The AWARE Pilot Project has been developed within the broader research program of the Cooperative Research Centre for Transformations in Mining Economies (CRC TiME), which aims to improve mine closure and post-mining transition outcomes. The AWARE Pilot Project integrates with CRC TiME's national pit lake research, which is exploring the identification, classification and long-term management of water-filled residual voids in Australia, including their water quality and potential for re-use (Sagar et al. 2025), and with the Digital Atlas of Mine Site Renewable Energy Transitions, which is identifying the data required to assess site suitability for renewable energy developments as post-mining land uses, including associated water requirements (CRC TiME 2025).

2 Methodology

The AWARE Pilot Project was undertaken as a pilot study to inform the potential development of a national water atlas to support planning for mineral resource development (mining and processing), mine closure (safe closure and rehabilitation of the mine) and PMLU (use of the mined land after closure) in Australia. The approach involved development of a concept-level prototype water atlas tool for a case study mining region to test whether information about water supply options and entitlement pathways currently distributed across different data sources in a range of formats (including spatial datasets, time series data and legislative and policy instruments) could be integrated and communicated more effectively through a spatial decision-support tool (interactive map-based tool for identifying and comparing water supply options), with particular emphasis on early-stage mine planning and mine closure contexts.

A case study was used to develop and test the methodology within a mining region context. The North West Minerals Province (NWMP) in Queensland (Figure 1) was selected as it is a historical mining region undergoing a period of transformation, with mine closures and PMLU change occurring alongside new critical and strategic minerals development. The region's water resources are managed under multiple planning and regulatory instruments (including legislation, statutory water plans and regulations) and include both conventional water sources (surface water and groundwater) and non-conventional water sources (e.g. treated waste water, mine-affected water, desalinated water and water recovered through recycling and re-use), making it well suited to testing the water atlas concept.

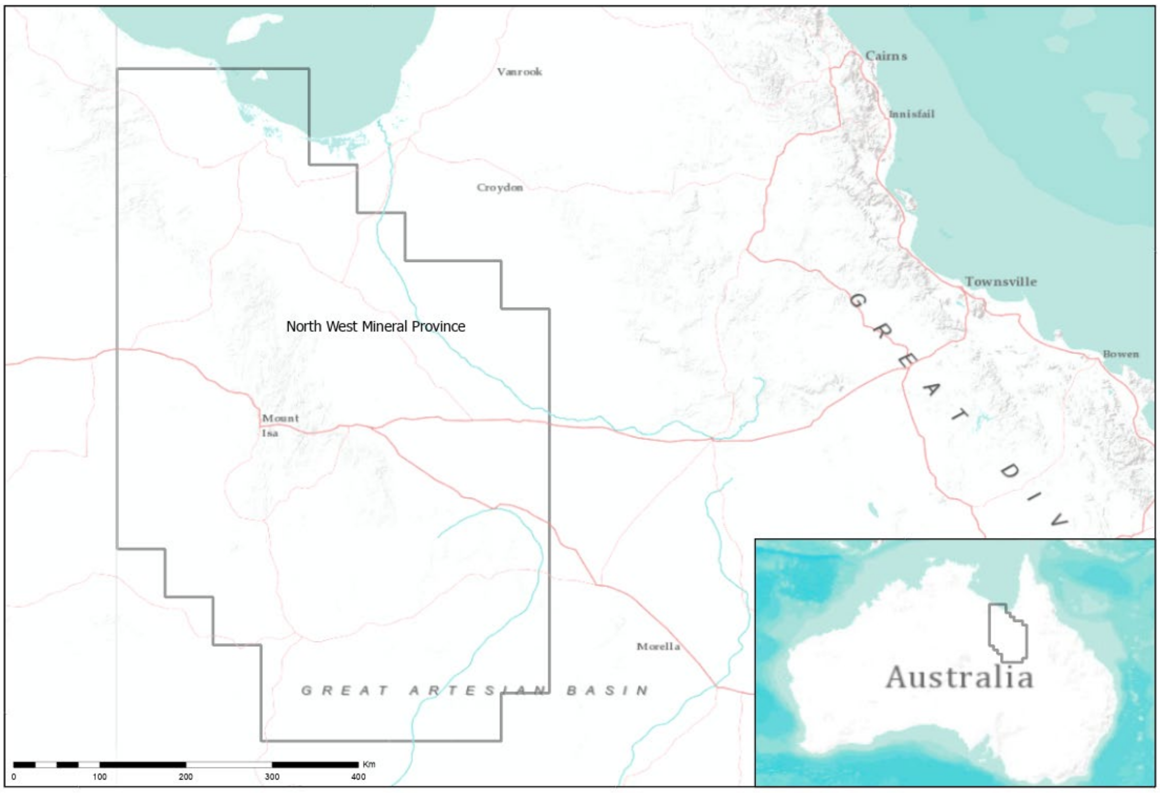

Figure 1 Case study region: the North West Minerals Province

The study began with a structured review of peer-reviewed literature (journal articles), grey literature (government reports, industry publications, technical reports), regulatory frameworks applicable to the NWMP, spatial tools and geospatial data platforms (e.g. government water information systems, groundwater databases, and environmental data portals) relevant to water supply in the selected case study mining region. This review focused on identifying the types of information on water supply options that are currently available, how that information is currently accessed, and key gaps and/or barriers that limit its practical use for mine life cycle and closure planning and decision-making. Global water risk and stress indices were explicitly excluded because they are primarily designed to assess and communicate water-related risks, rather than to support the evaluation and planning of water supply options at site or regional scales.

The concept-level prototype water atlas tool was developed through a co-design process involving key stakeholders in the case study region, ensuring that the tool reflected end-user requirements and planning needs. A steering committee comprising representatives from Queensland State Government agencies, Geoscience Australia (GA) and major mining companies was established to provide technical oversight, guide scope and priorities, and review interim outputs. In parallel, targeted stakeholder consultation was undertaken with junior miners, bulk water providers, water brokers, water market platform providers, and regional development organisations which support regional economic development, investment attraction, and infrastructure planning. Consultation sessions involved demonstration of a concept-level prototype and open discussion, enabling participants to comment on the relevance, accuracy and completeness of the information presented, and provide feedback on the tool's usability, clarity and perceived value.

The review and consultation findings informed the development of a concept-level prototype water atlas to demonstrate information architecture (the organisation of content), spatial logic (the arrangement and integration of spatial datasets and map-based functionality) and communication approach. Rather than duplicating datasets, the prototype focused on integrating and interpreting existing government and industry data sources, presenting spatial information alongside explanatory text, and providing guidance on regulatory pathways. This approach was intentionally chosen to minimise data maintenance requirements and to reflect how a future operational water atlas could remain current by linking to source platforms.

3 Data

The project commenced with a comprehensive review of publicly available, authoritative datasets relevant to water resources, mining and regional planning, with the objective of identifying what data currently exist across national, state and regional scales. This review informed the selection of a subset of datasets used to develop a concept-level prototype of the water atlas for the NWMP case study region. All quantitative data were sourced from existing government and industry datasets, with new explanatory and interpretive content developed for the water atlas. Emphasis was placed on transparency, traceability and currency, and no proprietary, confidential or newly collected field data were incorporated.

At the national scale, a broad range of datasets published by the Bureau of Meteorology (BoM) and GA were reviewed to assess their relevance and potential application within a future water atlas. For the purposes of the concept-level pilot, only the BoM Water Storage Dashboard, the BoM Water Market Dashboard, and mine location data sourced from the GA portal were incorporated (Table 1). These datasets were selected because they provide nationally consistent, readily interpretable information that is directly relevant to the case study objectives. Other national platforms reviewed included BoM Water Data Online, the Australian Water Data Service, the Australian Groundwater Explorer, the Australian Hydrological Geofabric and relevant GA spatial portals, but these were not integrated into the pilot tool. The use of additional national datasets is planned for subsequent project phases to improve national consistency and comparability across regions.

State datasets for Queensland formed the core of the prototype tool and were selected from Queensland Government open data and spatial information services. These included water plan boundaries, water management and trading zones, water entitlements and surface water infrastructure. Regulatory documents including the Queensland *Water Act 2000*, the Queensland Water Regulation 2016, and relevant water plans, resource operations plans and water management protocols, were sourced directly from the Queensland Legislation and Business Queensland websites (Table 1).

Datasets and supporting information specific to the case study region were also reviewed and, where relevant, incorporated from local providers and agencies operating within the NWMP. These included bulk water infrastructure and scheme information from Sunwater, data from local government water supply security assessments, and information from regional water assessments and future infrastructure planning. Information published by mining companies and local water authorities was additionally reviewed to improve understanding of existing water assets and operational arrangements (Table 1).

A key principle of the data approach was that the prototype water atlas would not reproduce source datasets that vary over time. Most datasets were linked directly to their authoritative platforms, with the water atlas providing contextual guidance to support navigation of these platforms and interpretation for water sourcing, regional planning and mine closure considerations. Selected data attributes that are relatively stable over the life of a water plan (typically 10 years or longer), such as dam capacity, dam operator and total available water entitlements, were reproduced in the water atlas to support usability and contextual understanding. Where datasets were outdated, incomplete, uncertain or subject to frequent updates, these limitations were explicitly identified to minimise misinterpretation and to reinforce that the water atlas functions as a decision-support and communication tool rather than a source of regulatory advice.

Datasets used to develop the prototype water atlas are listed in Table 1. The broader dataset review undertaken as part of the project provides a foundation for expansion of the water atlas to additional regions and data types, including mine-closure-specific datasets such as non-conventional water sources and residual voids, subject to regulatory requirements and confidentiality constraints.

Table 1 Data sources used to develop the concept-level prototype for the case study region

Scale	Platform	Page/layers	Link
National	GA Portal	Mines, Mining Projects and Mining Activity, Processing Plants, Mineral Deposits	https://geoscience-au.maps.arcgis.com/
National	BoM Water Data Online	Water Storage Dashboard, Water Markets Dashboard	http://www.bom.gov.au/water/dashboards/
State	Queensland Legislation	Legislation in force	https://www.legislation.qld.gov.au/browse/inforce
		Subordinate legislation as made	https://www.legislation.qld.gov.au/browse/asmade#/sl/title
	Business Queensland	Water page	https://www.business.qld.gov.au/industries/mining-energy-water/water
	QSpatial	Water plan areas – Queensland, Water Plan catchments – Queensland, Supplemented surface water trading zones – Queensland, Water Plan watercourses, Groundwater management areas - Queensland	https://qldspatial.information.qld.gov.au/ catalogue/
	Open Data Portal	Water entitlements, Groundwater database	https://www.data.qld.gov.au/dataset/
	Water Entitlement Viewer (WEV)		https://qgsp.maps.arcgis.com/apps/MapSeries/index.html?appid=610e67fd52e24dbf9168ed812137ff5c
Regional	Sunwater	Water Data Hub, Water Trading Board, Water Brokers, Schemes, Julius Dam, Pipelines,	https://www.sunwater.com.au
	Glencore Australia	Moondarra Dam WSS	https://www.glencore.com.au/operations-and-projects/qld-metals/sustainability/environment/water-resource-management
	Mount Isa Water Board		https://mountisawater.qld.gov.au/
	Queensland Department of Local Government, Water and Volunteers	Regional Water Assessment Program	https://www.dlgwv.qld.gov.au/water/consultations-initiatives/regional-water-assessment-program
		Mount Isa Regional Water Supply Security Assessment	https://www.rdmw.qld.gov.au/__data/assets/pdf_file/0003/1466670/mount-isa-rwssa.pdf

4 Results

There is no single platform that companies can use to understand their water supply options within a mining region. Relevant information is fragmented across multiple tools, reports and regulatory documents, often requiring specialist knowledge to interpret and synthesise. This fragmentation increases uncertainty, particularly during early project development and mine closure planning, and can constrain the ability of companies to identify viable water pathways in a timely manner.

Stakeholder consultations consistently identified the value of a spatially enabled water atlas capable of integrating water sources, infrastructure, entitlement rules and access pathways within a single, accessible interface. The pilot prototype demonstrated how complex regulatory and technical information could be translated into clearer, decision-relevant information, supporting structured exploration of water supply options and improving transparency in decision-making processes.

In the context of mine closure, stakeholder engagement highlighted a growing opportunity to share non-conventional water sources with other users, including mine-affected water in dams and water in pit lakes. However, stakeholders noted that data on these water supply options are not currently available or are difficult to access. In addition, while opportunities may exist for mining or PMLU companies to share this water with other users (subject to regulatory approval), there is currently no platform or mechanism to connect parties seeking water with parties that may have water available to share, limiting the realisation of these opportunities. In this context, the water atlas concept was viewed as a means to improve early visibility of non-conventional water sources at sites approaching closure, supporting earlier consideration of repurposing options and more informed engagement with regulators, First Nations organisations and other regional stakeholders.

The mining industry, State and Commonwealth government agencies, bulk water providers, water brokers, water market platform providers, and regional development organisations in Queensland and Western Australia all expressed strong support for continued development of the water atlas. Participants emphasised the importance of expanding coverage beyond high-reliability surface water to include groundwater, low-reliability and non-conventional sources, as well as the inclusion of regional 'noticeboard' functions to improve visibility of emerging availability and demand. At the same time, stakeholders highlighted challenges that would need to be addressed in future development, including data currency, differences between jurisdictions in terms of data availability and rules for accessing water, and data confidentiality constraints. Collectively, these results demonstrate that the water atlas concept addresses a recognised gap in water information availability and has clear potential to support improved mine closure planning and regional transition outcomes.

4.1 Water atlas design, content, information architecture and functionality

A key outcome of the AWARE Pilot Project was the development and refinement of a proposed water atlas tool design, including its content, information architecture and core functionality. A concept-level prototype was developed to test how fragmented water information relevant to mining regions could be structured, integrated and communicated within a single, accessible interface, and to obtain stakeholder feedback on the proposed approach.

The prototype was developed for the NWMP and focused on high-reliability conventional water sources, with preliminary groundwater content included to illustrate differences in information requirements between surface water and groundwater systems. Stakeholder feedback obtained through consultation was used iteratively to refine the proposed tool design, content, architecture and functionality.

4.1.1 Tool design

Options for tool design were considered based on the types of data and information to be included in the tool and the functionality required to communicate water supply options to users. The selected design was an interactive, web-based spatial decision-support tool, with an emphasis on clarity, interpretability and ease of use for audiences with varying levels of water expertise. The chosen design seeks to support understanding of water supply options and associated access pathways by consolidating information that is otherwise dispersed across multiple platforms and formats.

Two complementary navigation pathways were incorporated into the design. Users could choose to explore water supply options at the scale of a mining region (Figure 2) or select a specific mine site or mineral deposit and define a search radius to identify nearby water sources and associated infrastructure (Figure 3). This structure enabled navigation at region or site scale, reflecting the different ways proponents and stakeholders may use the tool.

The design incorporates digital storytelling elements that combine spatial information with explanatory text, diagrams and definitions. These elements were included to support interpretation of technical and regulatory information, particularly for users unfamiliar with jurisdiction-specific water planning frameworks.

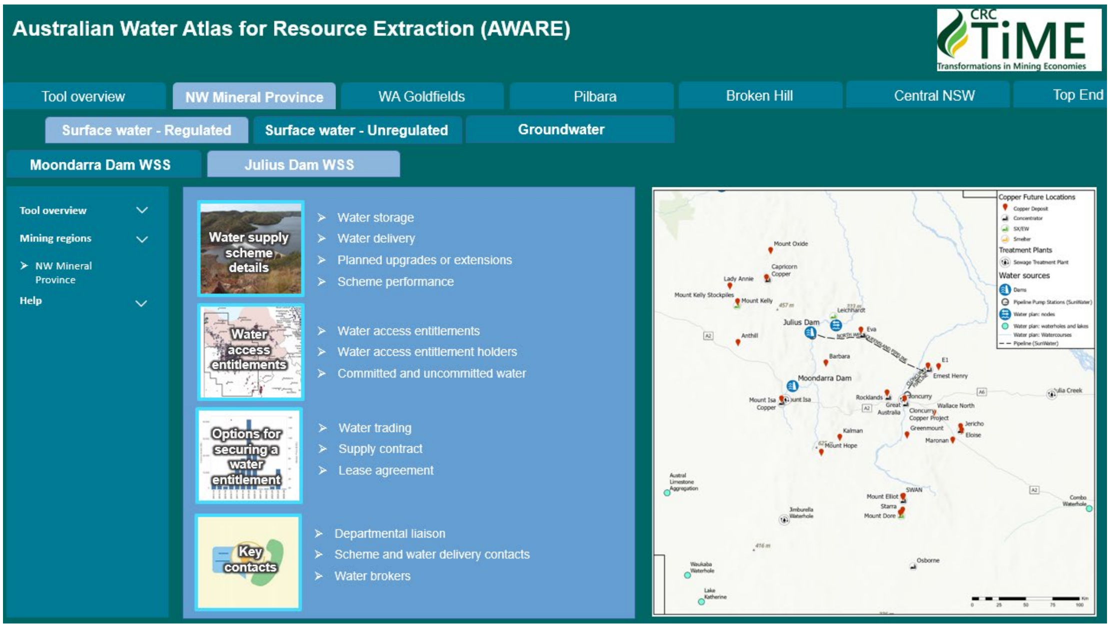

Figure 2 Prototype water atlas for the NWMP showing navigation by mining region and water source

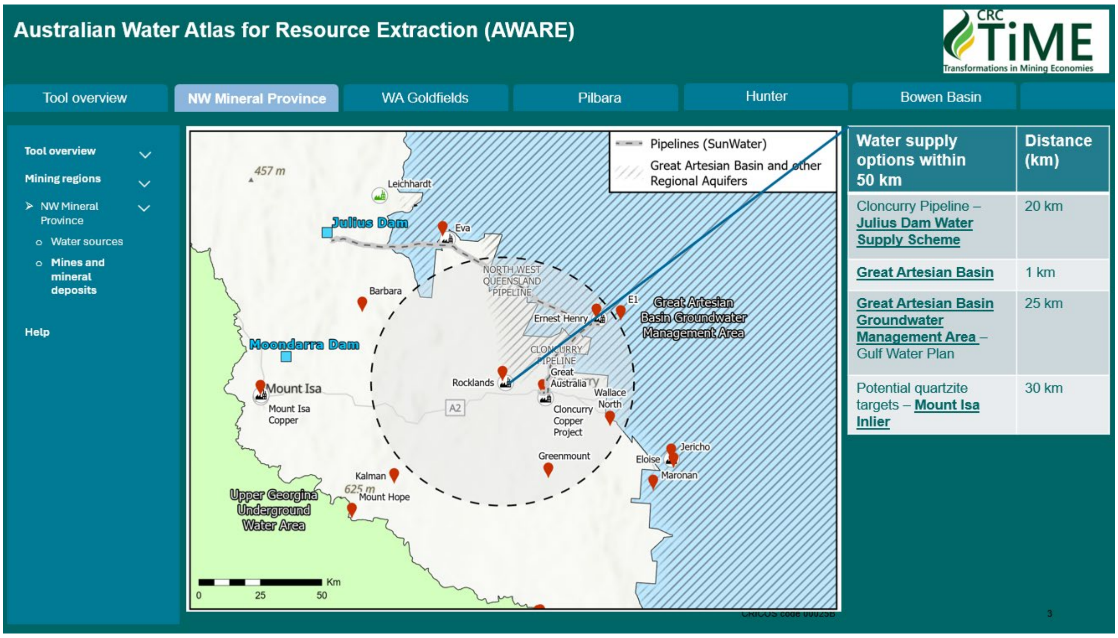

Figure 3 Prototype water atlas for the NWMP showing navigation by mine site or mineral deposit

4.1.2 Tool content

Tool content was structured around the information required to identify and evaluate water supply options. Core content areas included information on water sources, water-related infrastructure, water availability and reliability, entitlement frameworks and regulatory pathways for accessing water.

In addition to conventional surface water and groundwater sources, the tool design identified the need to incorporate content relating to non-conventional water sources, water for the environment, and water for First Nations communities in subsequent stages of development. A conceptual noticeboard function was also included in the design as an option to connect parties with water to share with parties seeking water, particularly in the context of mine closure and PMLU.

Where possible, content within the prototype was sourced from authoritative national and state government platforms. Rather than duplicating datasets, the prototype linked to external sources and provided contextual guidance to support interpretation and navigation.

4.1.3 Information architecture

The water atlas adopted a layered information architecture designed to guide users from broad regional context through to progressively more detailed, source-specific information. This structure was developed to support exploration of water supply options without overwhelming users with technical detail at the outset, while maintaining transparency about data limitations and regulatory complexity.

Table 2 summarises the information architecture demonstrated in the concept-level prototype.

Table 2 Information architecture of the concept-level water atlas prototype

Information layer	Purpose	Content demonstrated in the pilot
Overview and guidance	Establish context and support use	Tool overview, background information, definitions, guidance on how to use the water atlas and interpret results
Mining region or site selection	Define area of interest	Navigation to mining region of interest or selection of mine site/mineral deposit and search radius
Water sources and infrastructure	Identify water sources	Spatial display of surface water and groundwater sources, water related infrastructure, and categorisation by source type
Water supply details	Provide information needed to assess options	Structured panels describing water availability, reliability, entitlement requirements, access pathways, constraints
Noticeboard	Improve visibility of water supply and demand	Mechanism for displaying notices from parties seeking water and parties with water available to share, particularly relevant to mine closure and post-mining land use
Data gaps and limitations	Improve transparency	Explicit identification of unavailable, uncertain, or incomplete information
Key contacts	Support follow-up	Regulatory and operational contact details

4.1.4 Tool functionality

The concept-level prototype demonstrated a set of core functions aligned with the proposed tool design. These included spatial navigation and visualisation, interactive identification of water sources and infrastructure, and structured information panels presenting key characteristics, access rules and entitlement pathways.

To address challenges associated with data currency and maintenance, the prototype linked directly to authoritative external datasets rather than hosting data internally. Links were accompanied by short explanatory notes to support interpretation and navigation. Educational materials and plain-language explanations were included to assist users without specialist water expertise.

Collectively, these results demonstrate how the proposed water atlas design can organise and present complex, fragmented water information in a way that improves transparency, supports structured exploration of water supply options, and clarifies where further technical or regulatory engagement is required.

5 Conclusion

The AWARE Pilot Project demonstrates that a water atlas has strong potential to support mine closure and PMLU planning by improving access to water information, reducing uncertainty and enabling earlier identification of water re-use and repurposing opportunities. By making water options visible earlier in the planning process, the water atlas concept supports a transition from site-centric risk management toward more integrated, regionally informed closure decision-making.

The pilot provides a defensible foundation for the further development of a functional water atlas, highlighting both the opportunity to support responsible mine closure and the importance of transparency, stakeholder engagement and careful management of regulatory and data limitations. It is expected that continued development of the water atlas through stakeholder co-design and iterative testing will support improved closure outcomes and contribute to successful regional transition beyond mining.

Acknowledgement

This project was funded by the Cooperative Research Centre for Transformations in Mining Economies (CRC TiME) with contributions from Geoscience Australia, Queensland Government agencies and industry partners. The authors acknowledge the steering committee and all stakeholders who participated in consultations.

References

Clerc, C, Sharma, V, Pagliero, L 2023, 'Water and energy integration towards post-mine transition', in Abbasi, B, Parshley, J, Fourie, A & Tibbett, M (eds), *Mine Closure 2023: Proceedings of the 16th International Conference on Mine Closure*, Australian Centre for Geomechanics, Perth, https://doi.org/10.36487/ACG_repo/2315_005

Cook, PG, Black, S, Cote, C, Kahe, MS, Linge, K, Oldham, C, … Wallis, I 2021, *Hydrological and Geochemical Processes and Closure Options for below Water Table Open Pit Mines,* CRC TiME Limited.

CRC TiME, 2025, *Mine Pit Lake Assessment and Management: a National Initiative to Support Mine Closure and Regional Opportunities (Project 4.9),* CRC TiME Limited.

Gentle, G & Olszak, C 2007, 'Water planning: principles, practices and evaluation', in Hussey, K, Dovers, S (eds), *Managing Water for Australia: The Social and Institutional Challenges,* CSIRO, Collingwood, Victoria, pp. 59–72.

Hattingh, R, Williams, DJ & Corder, G 2019, 'Applying a regional land use approach to mine closure: opportunities for restoring and regenerating mine-disturbed regional landscapes', in AB Fourie & M Tibbett (eds), *Mine Closure 2019: Proceedings of the 13th International Conference on Mine Closure*, Australian Centre for Geomechanics, Perth, pp. 951–968, https://doi.org/10.36487/ACG_rep/1915_75_Hattingh

Measham, T, Walker, J, Haslam McKenzie, F, Kirby, J, Williams, C, D'Urso, J, … Boggs, G, 2024, 'Beyond closure: a literature review and research agenda for post-mining transitions', *Resources Policy,* vol. 90, 104859, https://doi.org/10.1016/j.resourpol.2024.104859

Sagar, N, Bekele, E, Knight, A, Davis, GB, Linge, KL 2025, *Towards Effective Pit Lake Management: A Survey of Pit Lake Classification and Pit Lake Types of National Importance,* CRC TiME Limited.

Tan, P-L, Bowmer, KH & Mackenzie, J 2012, 'Deliberative tools for meeting the challenges of water planning in Australia', *Journal of Hydrology,* vol. 474, pp. 2–10. https://doi.org/10.1016/j.jhydrol.2012.02.032

Worden, S, Svobodova, K, Côte, C & Bolz, P 2024, 'Regional post-mining land use assessment: an interdisciplinary and multi-stakeholder approach', *Resources Policy*, vol. 89, 104680, https://doi.org/10.1016/j.resourpol.2024.104680