WATER IN MINING
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Publication date: October 2017
AUSTRALIA – A GLOBAL LEADER IN WATER MANAGEMENT ACROSS THE MINING LIFE CYCLE
Your partner in sustainable water management for all mining and mineral processing needs.

Australia is a global leader in water management and innovation across the mining life cycle. Australia has a mature mining industry built on nearly 200 years of experience spanning coal, iron ore, nickel, copper, bauxite, zinc, gold, silver, uranium and rare earths. The exponential growth in mining has seen the rise of water challenges which the Australian industry has met through the early adoption of technologies and innovation.

Ensuring continuous water supplies during mine operations is a baseline requirement. Today, the Australian mining industry is at the forefront of sustainable water management recognising that environmental accountability, social responsibility and commercial success are now inseparable goals. The protection or enhancement of water resources for the environment and for communities – before, during and after mining – has become an established part of Australian practice. Increasing stress on water resources means that mining, in Australia and globally, will continue to rely on expertise and innovation in effective and sustainable water management.

Water must be managed at all stages of the mine life cycle including:
- exploration
- project planning and design
- mining and minerals processing
- rehabilitation
- closure and post-closure.

Water management decisions made at any stage of the life cycle may have effects on the subsequent stages. For example, mine planning dictates volumes and quality of surplus water generated by the mine, which may affect water treatment requirements during mining, rehabilitation and post-closure.

Australia has mines at all stages of the life cycle - from mines in current planning, to operational mature mines over 90 years old, to closed and abandoned mines that are still being actively managed to protect the environment.

Australia’s long history of overcoming the challenges associated with mining in a difficult geographical and social context has led to the development of specific water-related expertise.

This Industry Capability Report provides an overview of these key capability areas and includes examples of Australia’s specialist expertise.

Talk to your local Austrade representative for tailored advice and information on connecting and partnering with the Australian mining industry.
INTRODUCTION

WATER IN THE MINING LIFE CYCLE

EXPLORATION
- End Of Life Use/Community Engagement & Benefit
- Environmental Impact Assessments/Studies

RESOURCE ASSESSMENT
- Water Supply and Sourcing
- Ground Water (Aquifer) & Surface Water
- Water Stewardship
- Water System Design/Engineering
- Pipes, Water Machinery & Trucks
- Water Storage Tanks/Dams

MINE DESIGN & PLANNING
- Water Asset Construction Management
- Mine Site Dewatering/Tailings Management

MINE CONSTRUCTION
- Water Recovery, Recycling & Reuse
- Water Stewardship
- Water System Design/Engineering
- Pipes, Water Machinery & Trucks
- Water Storage Tanks/Dams

MINE OPERATION
- Wastewater Remediation & Management
- Mine Rehabilitation & Closure Planning
- Water Harvesting/Storage
- Water Recovery, Recycling & Reuse
- Water Conservation & Alternative Sources
- Water Resource/Asset Management
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MINE CLOSURE
- Water Treatment
- Water Asset Construction Management
- Mine Site Dewatering/Tailings Management

WATER IN MINING
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Australia has an abundant supply of mineral resources, including the world’s largest reserves of lead, nickel, uranium and zinc.

A world leader in the production of key mineral commodities, Australia is ranked as:

- the world’s leading producer of bauxite, alumina, rutile, zircon and tantalum
- the second largest producer of gold, iron ore, lead, manganese and lithium
- the third largest producer of ilmenite, nickel, uranium and zinc
- the fourth largest producer of black coal and silver
- the fifth largest producer of aluminium, brown coal, diamonds and copper.

This wealth of mineral resources, underpinned by billions of dollars of investment in research and development, has generated a skilled industry of professionals and cutting-edge technology. Australia’s mining sector has built a reputation as a world leader in the development and manufacture of mining equipment, technology and services (METS).

Australian firms are competitive across the supply chain, including exploration, engineering, minerals processing, environmental management, mine safety, research and development, and education and training. The METS sector is complemented by world-leading educational and research institutions, which support the mining industry through training the next generation of mining leaders and undertaking research into all areas of the mining life cycle.

The mining industry is one of the most efficient and productive water users in Australia. The contribution of the mining industry to the Australian economy, per gigalitre of water consumed, is around fifty times that of agriculture. This is largely due to the high water efficiency of Australian mines, which in total consume approximately 760 gigalitres of water per year, only 4.4 per cent of Australia’s total. Along with its low national water footprint, Australia’s mining industry has adapted to more regulatory requirements around water than most other economic activities.
The Australian mining industry makes strong national economic contributions through billions of dollars of investment in water infrastructure and protection while enhancing cultural, social and environmental standards.

Australian companies take pride in exporting this success to help other established and emerging mining nations improve water performance in their mining industries. A proven track record of delivering projects on time and on budget underpins this capability.

Australian water capabilities across the mine life cycle include:

- Australia is seen as a global leader in water stewardship and integrated water resources management related to mining resources, including building resilience of mining value chains to climate and weather disruptions
- Australia’s economic reliance on groundwater requires high standards and innovation in groundwater management
- Australia has developed technologies to suit specific water and wastewater treatment needs of individual mines
- the drive for environmental performance has led to Australian leadership in alternative mine water sources like recycled water and the development of water recovery technology ensuring long-term safety of tailings dams
- Australia is a leader in education and training programs for improved mine environmental performance and social responsibilities.
Earth Systems delivers safe, efficient water treatment to mines worldwide

Case Study
Earth Systems is an environmental consultancy with offices in Australia, China, Laos, England, Rwanda and Senegal. Formed in 1993, the company has executed over 500 projects in Australia, Asia, the Pacific region, Africa and South America. Its clients include Glencore, BHP, Rio Tinto, Barrick, Harmony Gold and various Australian state and federal government agencies.

Earth Systems provides water management and treatment advice, water treatment equipment and contract treatment services. The company’s multiple portable modular plants can be used to treat the water directly. Reagents are added directly to the water body (in-situ treatment) at a fraction of the cost of conventional treatment facilities. The equipment can treat stormwater, process water, groundwater and water storages for issues such as turbidity control, pH adjustment, metal removal, nutrient control (algal blooms) and odour control.

In Australia, Earth Systems provided a Neutra-Mill rapidTREAT 7000 (a portable reagent mixing and dosing system) in Western Australia to treat reactive sulfide material. When exposed to air due to dewatering or mining, acid and metalliferous drainage is generated during the operational life of the mine and post closure. Earth Systems perform routine and emergency treatment in the event of high rainfall associated with a tropical cyclone. This allows the site to rapidly and efficiently treat and safely discharge water off-site, allowing mining to recommence.

Another solution was installed at a large mining site in Kalimantan, Indonesia, where staff needed to control a high load of suspended solids in stormwater before discharging it offsite. Earth Systems supplied a custom Neutra-Mill system called Turbidity Mill (water-based portable reagent mixing and dosing system) to dispense flocculant directly into the water body to reduce the level of suspended solids. The Turbidity Mill efficiently and rapidly disperses the flocculant directly into a large water body, allowing the discharged water to meet water quality standards.

earthsystems.com.au

rapidTREAT 7000. Image courtesy of Earth Systems.
Circulation systems such as the El Niño-Southern Oscillation have varying, often strong effects across Australia contributing to swings between extreme droughts and floods. Most mines in Australia need to predict the nature of the oscillations and implement adaptable and robust water management systems to mitigate the risks associated with extreme weather.

Australian companies have developed and apply the monitoring and forecasting technologies that permit effective decision-making and planning. Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO) has also developed an innovative climate adaption tool called CRATER (Climate Related Adaptation from Terrain Evaluation Results) for the mining industry. This tool identifies flood-potential hot-spots around a mine and helps to select suitable adaptation options.

Australian companies similarly provide infrastructure and operational management solutions that ensure a mine can respond in a timely manner to changes in weather with minimal loss of production and within regulatory parameters.
HEC delivers reliable water forecasting model for mine management

Case Study

Based in Brisbane, Hydro Engineering & Consulting (HEC) provides hydrology, water supply and water management services. The company investigates, assesses, designs and manages water resources for public and private sector organisations.

HEC has extensive experience in the resource development and management sectors. This includes designing water supply schemes (groundwater and surface supplies) and water management systems; undertaking water balance modelling; designing waste disposal systems; developing environmental approvals documentation; providing onsite environmental advice; and assisting with rehabilitation planning and design.

A major gold miner engaged HEC to complete a water supply and water infrastructure sizing assessment for an operation in Australia, which was located in an environmentally sensitive area. The company was selected for the project after undertaking a similar assessment for the client’s operation in Indonesia some years earlier.

HEC provided a user-friendly, predictive water balance model for the life of the operation that can be used by site personnel as a short- and long-term forecasting tool. It can also be used to plan future mine infrastructure development to support expansion plans.

The HEC tool ensured the client could continue operating through a recent drought and wet period. The client is now using the tool to determine water supplies for a planned mine expansion.

hecons.com

Evaporator technology for water removal from mine site. Image courtesy of HEC.
WATER MANAGEMENT IN REMOTE LOCATIONS

Many of Australia’s mines are located great distances from urban centres, requiring major infrastructure projects to support mine operations including the supply of water. This involves the construction of new water supply well fields to access aquifers and construction of long water supply pipelines.

For example, the BMA–Bingegang mine pipeline in Central Queensland supplies water to many stock and domestic users along its path of several hundred kilometres which contributes to the social licence of its mining operations.

Australia provides expertise in implementing automatic control systems to continually assess performance of water infrastructure at remote sites. The safe management of excess groundwater in remote, arid areas where no natural receptors of the excess water are present is also a common requirement.

Australian expertise, therefore, has provided innovative water supplies and beneficial re-uses to meet the needs of mines and communities in remote areas.
Akwa-Worx installs wastewater treatment plant at remote PNG mine

Case Study

Akwa-Worx is a privately owned water and wastewater treatment original equipment manufacturer (OEM). The Queensland-based company offers Australian-designed and manufactured systems for the Australasian mining market. Its product range includes small, medium and large modular-style water and wastewater treatment systems, which have the flexibility to accommodate changes in conditions and engineering to suit long-term requirements.

Akwa-Worx specialises in remote sites and delivery in cross-cultural settings. One of its most successful commissions was the design, construction, fit-out and delivery of a 1,000 ep (350 kl) sewage treatment plant (STP) for the mining industry in Papua New Guinea.

In developing the design, Akwa-Worx had to consider the site’s remote location. The STP is located in Hidden Valley, a four-hour drive or a one-hour flight from Lae, the second-largest city in PNG. The company also had to address limited local knowledge and the requirements for ongoing plant management.

The STP incorporated multiple reactors for the Biological Nutrient Reduction system, together with pump and ultra-filtration containers to produce Class A reclaimed water. It is also equipped with bagging units for the safe disposal of de-watered sludge. The client requested the bagging unit due to the remoteness of the location, and to adhere to best practice environmental guidelines.

This plant follows on from a previous 1400 ep STP supplied to the same client as part of the Hidden Valley/Morobe Joint Venture.

akwaworx.com

Hidden Valley mine site, Papua New Guinea. Image courtesy of Akwa-Worx.
MINING IN SENSITIVE ENVIRONMENTS

Most mines in Australia are located in sensitive environments with shared water resources. Sensitivity arises when cultural and economic water assets, such as the Great Artesian Basin and the Murray Darling Basin, are accessed by multiple users including traditional land owners. Mines must adopt water solutions that respect the sensitivity of the water environment and community values, and where possible contribute positively.

This has led to particular capability in all aspects of water stewardship including:

• water efficiency
• contributing to urban and pastoral water supplies
• ecological restoration schemes
• water monitoring
• prediction and reporting systems
• development of governance and engagement frameworks.
ReGen works with Indigenous community to complete surface water management works

Case Study

ReGen offers complete solutions for mine closure and mine site rehabilitation, as well as progressive rehabilitation and standalone water infrastructure and management. The company provides bulk earthworks, civil capacity, revegetation, and monitoring and maintenance services. As a division of Downer Group – Australia’s most diversified mining services provider – ReGen has access to Downer Mining’s extensive equipment, management and engineering capability.

In 2014, ReGen and Karlayura Enterprises, a 100 per cent owned and managed Pilbara Aboriginal Business, formed the Karlayura ReGen Joint Venture (KRJV). KRJV’s Governance Committee, made up of three members from each JV party, oversaw high-level operation and management of the JV. All decisions made by the Committee had to be unanimous, ensuring outcomes were in the best interest of KRJV.

In 2014, KRJV embarked on a project to undertake surface water management works at Fortescue Metals Group’s (FMG) Christmas Creek mine. The scope of work included constructing levees and a floodway, elevating a haul road and upgrading four turkey nest dams, to ensure FMG complied with regulatory requirements regarding surface water movement at the site. The project was undertaken in the middle of the wet season, increasing the risk of flooding if it rained.

One of KRJV’s goals was to employ at least 25 per cent of its project workforce from the Indigenous community. Skilled management and a thorough recruitment process that involved input from Traditional Owners ensured KRJV mitigated potential social and cultural issues. The project achieved a 40 per cent Indigenous employment rate, providing the local community with jobs and skills development opportunities.

KRJV met all key performance indicators for safety; environmental requirements and Indigenous participation, and completed the project on time and within budget. The joint venture framework was so successful it now serves as ReGen’s template for subsequent future ventures with Indigenous businesses.

“KRJV recruited personnel, secured equipment and mobilised to site to commence works in good time to meet the construction deadlines. Our experienced site management team worked with Indigenous personnel to provide a balanced crew that worked well with the client’s site team. The early establishment of such good teamwork provided the basis for the success of the whole project,” said Marcus de Haas, Project Manager, ReGen.

mineregen.com.au

Image courtesy of ReGen
INTEGRATED MINE WATER MANAGEMENT AND MONITORING

The Australian mining industry has demonstrated experience in bringing together the concepts of environmental accountability, social responsibility and commercial success across the mine life cycle. This also extends to expertise in catchment-scale water management, environmental flows and evaluating and predicting hydrological and water-balance change critical to a mine ecosystem.

Australia is a world leader in developing conceptual models for evaluating direct and indirect impacts from mining, designing and implementing monitoring programs, assessing the consequences of pollution risks and providing advice and solutions on management for improved environmental and social performance.

To ensure the highest water management standards are achieved, the industry has invested heavily in personnel, training and cooperation between research organisations, government and industry. Australia’s long term investment in mining research has included the development of numerous water management and technology innovations, and specialist water in mining research centres.

The Australian mining industry works closely with government and universities to produce water management guidance and has recently published updated Leading Practice Sustainable Development Program guides. These include a Water Stewardship guide that covers the principles of leading practice sustainable water management, as well as 15 other guides that cover numerous aspects of mine water management throughout the mine life cycle. Additional information on Australian credentials in industrial water management and sustainable mining and the environment can be found in companion Industry Capability Reports available from austrade.gov.au.
GHD enhances water management practices at sites worldwide

Case Study

Founded in 1928, GHD provides engineering, architecture, environmental and construction services to private and public sector clients in the water, energy and resources, environment, property and buildings, and transportation sectors. The company employs more than 8,500 people across Asia, Australia, Europe, North America, South America and the Pacific region.

Since 2008, GHD has undertaken a water management assessment program for Centennial Coal, which operates or manages over 10 sites in New South Wales, Australia. When Centennial Coal acquired the sites, the documentation, monitoring and modelling of water management was limited and based on empirical knowledge of staff members. Little metered data was available.

The GHD team worked with Centennial Coal's operational staff to develop an understanding of water flows around different sites. The work included developing detailed water balances (GOLDSim) for existing and future operational conditions. Groundwater models (MODFLOW) were also linked to the GOLDSim site water balances to give a complete picture of site water flows.

Each of these sites now has a tool which can be progressively calibrated over the life of the mine to allow water management practices to evolve in parallel and support future decision-making processes. GHD also developed associated Water Management Plans that align with Centennial Coal's business objectives, specifically its approach to sustainability and pollution reduction.

GHD was commissioned to provide similar water management expertise to Vale Inco's Goro Nickel Project in New Caledonia. Based on a review of the proposed site water balance and optimisation of process flows, GHD identified opportunities to reuse and recycle process water, enabling freshwater demands for the plant to be almost halved. GHD also designed wastewater treatment infrastructure to help manage manganese emissions to the ocean outfall.

Managing stormwater associated with high rainfall at the Goro Nickel site is a major challenge. GHD provided hands-on commissioning support for the implementation and optimisation of site surface water management during the wet season. This included implementing the operating strategy for a series of stormwater retention ponds and updating and optimising the site's stormwater management plan.

ghd.com
Advisian provides end-to-end consulting services to Fortescue

Case Study
Advisian is the independent global consulting business of the WorleyParsons Group, an Australian company that has served local and international clients for 40 years.

With offices in 19 countries, Advisian helps clients address critical resource, energy and infrastructure challenges using a combination of strategic, management and technical consulting capabilities, delivering practical and commercially oriented solutions. Clients range from junior mining operators to state-owned enterprises and multinational corporations.

The company’s services include whole-of-cycle water planning, water source viability and quality assessments, surface and groundwater monitoring and modelling, water and wastewater treatment and system delivery, and tailings and waste management.

In Western Australia, Advisian has a longstanding relationship with Fortescue Metals Group (FMG), one of Australia’s largest iron ore producers. Advisian has provided services from the early days of development through to ongoing operations. The services include:

• port and mine site drainage system design
• pit-lake hydrogeological modelling to support mine closure
• drilled deep artesian water bores to support approval applications needed to secure the water supply for a proposed mine site
• 2D flood modelling across two of FMG’s mine operations to assist with mine planning, surface water management and approvals
• detailed design of river diversions and flood protection measures at the port and mine sites to minimise risk of interruptions to iron ore production
• concept and detailed design of bridge culvert and waterway crossings for over 260 kilometres of railway
• dewatering system design, monitoring and compliance reporting during the construction of FMG’s train unloader at Port Hedland.

advisian.com
Hydrus Consulting delivers a sustainable mine water management plan in Ukraine

Case Study

Hydrus Consulting has extensive Australian and international experience working with mining and energy companies to manage environmental impacts and secure sustainable water supplies for their projects. Its consultants have worked throughout Europe, Africa, the Middle East, South America and Russia.

The company provides consulting services in water resource and supply studies; integrated and adaptive water resource management; groundwater and surface water impact assessment; and tailings facility and site-wide environmental monitoring and assessment. It can also align clients’ existing environmental monitoring and reporting activities with international reporting frameworks, helping them gain access to new markets, address investor concerns, and drive innovation and new business opportunities.

Hydrus Consulting’s work with Ferrexpo Poltava Mining in the Ukraine provides a good example of the company’s capabilities in sustainable water management. Its hydrogeologists worked in-country with local mine management to develop an integrated water management plan for the planned expansion of Ferrexpo Poltava Mining’s Yeristovskoye mining project.

The project included identifying a reliable mine water supply and assessing potential social and environmental impacts on a major transboundary river system. The consultants adopted an integrated approach to assess the whole-of-site water balance, incorporating tailings storage facilities, pit dewatering and ore processing.

Based on the assessment, the company’s consultants developed an integrated water management plan that identified sustainable water reuse options throughout the mine’s construction and operational life and reduced waste discharge from the project. Its consultants formed part of a multidisciplinary team of environmental experts that produced the project’s Environmental and Social Impact Assessment and established a Project Environmental Plan to ensure construction activities were conducted to international environmental standards.

hydrusconsulting.com.au
WATER STEWARDSHIP

Australia is seen as a global leader in water stewardship and integrated water resources management. Together, Australian industry and academia have developed and refined the Water Accounting Framework, which is applied by most multi-national mining companies to report and assess water performance in a consistent and transparent manner. The Water Accounting Framework is now a key part of the International Council on Mining and Metals guidance on Water Stewardship with links to the Global Reporting Initiative (GRI).6

Australian experts also have a reputation for integrated water resources management. Currently CSIRO is providing advice in South America on how to integrate mining into sustainable catchment management in the Copiapó river basin.7

Where mining co-exists with communities, agriculture and other important ecosystem services, Australian water managers have shown how river basin partnerships are a key element of successful water stewardship. For example, the Fitzroy River is the largest river flowing into the iconic Great Barrier Reef and there are various parties with vested interests in the water ecosystem. The Fitzroy Partnership for River Health has used a unique approach of pooling existing data collected by its mining industry and government partners. This dataset now contains more than 1.6 million sample results from over 200 sites.8

Another example is Australia’s unique salinity prediction and trading scheme in the Hunter Valley that illustrates how river basin partnerships can assist with protecting ecosystem assets in mining regions. Australian control system expertise and innovation including monitoring, modelling, telemetry and reporting, has permitted this unique and highly successful salinity management system.

The business case for water stewardship is emerging quickly in the mining industry, and there is growing demand for services that will allow mine projects to contribute to catchment water management. Australia continues to invest in applying and transferring its water stewardship expertise through a number of collaborative water research centres that include specialisation in water stewardship and mine water management. These include the CSIRO, the University of Queensland’s Centre for Water in the Minerals Industry and the National Centre for Groundwater Research and Training.
CSIRO’s expertise improves water stewardship in southern Peru

Case Study

Southern Peru Copper has significant operations in Tacna in southern Peru, an arid region often at risk of drought. In 2016, with the assistance of the regional government and National Water Authority, the mining company engaged CSIRO – Australia’s national science agency – to develop a drought management plan for the basins in the region.

CSIRO is developing an Integrated Water Resources Management Model to assess the availability of water resources (including individual and interconnected basins) for different users in the catchments. The model will include infrastructure and management rules, and will identify key indicators and thresholds of drought by surveying baseline conditions such as current climate. The model will then be used to evaluate use and management practices for a range of climate and development scenarios, for all key sectors.

Using this evidence base, CSIRO is working with Southern Peru Copper, other key users and local authorities to develop risk reduction strategies and equity measures to support more sustainable water-sharing practices in the Tacna region. This includes reviewing current and future supply and demand, structural and non-structural investment options, and capacity-building measures.

A key aspect of the project is its participatory approach, where the regional government, a major university and water, natural resources and environmental management institutions are working together to agree on primary responsibilities and operational protocols. These protocols will be integrated into a decision support system to improve water management before, during and after drought.

The project has two-way benefits: it will improve outcomes for business, communities and natural systems in the Tacna region; and provide insights to improve practices in Australia. CSIRO sees potential to use the project to take its services to other regions of Peru and the region more broadly, as well as to play a role in Tacna’s broader economic development.

csiro.au
GROUNDWATER MANAGEMENT AND MONITORING

Australia is not only economically dependent on the preservation of aquifer resources but also deeply tied to the environmental and cultural values of groundwater. Mines avoid groundwater impacts through minimising the depressurisation of aquifers caused by the dewatering of mine pits and limiting mine-affected water seepage into groundwater.

The intersection of mining activities and groundwater resources has required the Australian mining sector to achieve excellence in:

- predicting dewatering volumes
- designing mines to minimise dewatering requirements
- designing groundwater pumping
- re-use or disposal systems.

Australian companies provide design expertise and innovation advice on groundwater monitoring systems to international clients. The aim is to minimise the impact of mining operations on mine personnel, ecosystems and community water supplies by providing early warning notifications of the potential impacts.

Australian companies have decades of experience in identifying suitable artificial recharge sites and overcoming the associated hydrological, geochemical and engineering challenges. Artificial recharge schemes - also known as artificial aquifer recovery - involve re-injecting surplus water into aquifers. This is a sustainable approach to storing surplus water that uses the natural storage capacity of aquifers.

Injection has particular appeal for mines with large water surpluses and those that experience water shortages in times of drought. This allows the surplus water to be re-used as a regional groundwater resource which is invaluable when there is water scarcity.

Where mines operate in dry conditions, importing groundwater from outside the mine site is often essential for ensuring continuous operation of the mine.

Australian companies have extensive experience in exploring, designing, constructing and operating well fields and associated water supply infrastructure. This expertise includes the supply of water from complex aquifer systems through hydrogeological and well field engineering, and innovation in water well design and construction.
Airwell helps mining client maintain leachate recovery from storage dam

Case Study

Based in Western Australia, Airwell Group provides pumping solutions to the oil and gas, mining, industrial, environmental and agricultural sectors. The company’s pumping solutions address issues such as salinity management, leachate recovery, pollution and hydrocarbon recovery.

The mining industry spends time and millions of dollars minimising the impact of their mine operations on the environment. Monitoring, controlling and recovering potential leaks and/or seepage from tailings dams is a major challenge.

Airwell has provided many clients in Australia and overseas with automated leachate recovery pumping solutions. One Australian client discovered a partial open-cut pit wall had destabilised due to leakage from a leachate dam. Pit expansion over time had resulted in active mining being undertaken closer to the dam.

Airwell worked closely with the client and their environmental consultants to identify the issues and provide a solution. Issues included variable flow rates that made conventional pumping methods unusable; the high cost of installing and maintaining permanent infrastructure to power electric submersible pumps in multiple locations; the safety risks associated with installing live electrical cables across active mine sites; and ensuring the quality of leachate recovery water.

The unique features of Airwell’s leachate recovery pumping systems addressed all identified issues. Airwell pumps can achieve flow rates of up to 1 L/S to 0.00 L/S without damaging the pump. Airwell pumps can also handle fluids containing grit and sand without being damaged. An Airwell pump made from SAF 2205-grade stainless steel was supplied to the site to handle the highly corrosive water.

Airwell pumps use compressed air to operate, which can be transferred over many kilometres through small-diameter poly pipes. One suitably sized air compressor can operate many Airwell pumps. Using poly pipes on active mine sites also eliminates the risk of accidental contact with power sources. Repairs are simple and inexpensive to undertake.

There are now up to 50 Airwell pumps operating at the mine site at any one time to maintain leachate recovery from the dam. The project is considered to be highly successful.

airwellgroup.com.au
WATER AND WASTEWATER TREATMENT

The Australian water industry is highly skilled in the development and delivery of water treatment strategies for each stage of mine life. This includes the mine ramp-up through to peak production, post-closure and remediation of abandoned sites. Treatment strategies are tailored for each mine site to ensure the provision of fit-for-purpose water treatment in an environmentally and financially viable manner.

Australia’s expert practitioners ensure that water treatment solutions meet high safety and quality standards, maintain regulatory and process compliance, ensure robust and reliable technical performance and support optimal productivity throughout the mine life. Remote working environments, harsh operational settings, variable climatic conditions and stringent processing requirements are just a few of the challenges Australian water treatment specialists are adept at managing.

Australian water treatment providers offer a portfolio of technological solutions including membrane bioreactors, reverse osmosis, ion exchange, electrolysis, zero liquid discharge and thermal hydrolysis. Innovation is ongoing in this sector. Recent advances in water treatment technologies developed by Australian companies include:

- **Virtual Curtain** – developed by CSIRO, it uses hydrotalcites to remove metal contaminants in mine wastewater and reduce sludge by up to 90 per cent
- **Continuous flow electrolysis** – developed for the treatment of industrial effluents, Micromet’s continuous flow electro-chemical processes are energy efficient and significantly reduce treatment time
- **Optiflox** – the OptiFlox system, developed by SciDev, continuously measures particle characteristics of coal tailings slurry in order to maintain optimal flocculation conditions
- **Brine Squeezer** – the Osmoflo Brine Squeezer recovers up to 99 per cent of water from reverse osmosis plants and features innovative design and operational strategies to manage fouling and scaling of membranes.

Remediation of seepage plumes from mine sites is another task in which Australian companies excel. Services range from characterisation of the problem and identifying solutions to innovative low-cost treatment technologies.
Virtual Curtain turns wastewater into rainwater with patented technology

Case Study

Australian company Virtual Curtain Limited is treating a variety of mining and industrial wastewaters in Australia and China using the CSIRO-developed Virtual Curtain technology. Developed over a number of years, this patented technology relies on the in-situ formation of a mineral known as a hydrotalcite, which can simultaneously incorporate a range of contaminants into its structure.

In Australia, in two separate applications, over 100 ML of acidic, metal-laden mine pit water has been treated in a novel ‘in-pit’ configuration at the Baal Gammon mine in Queensland. Following final treatment, around 90 per cent of the contaminated solute was of rainwater quality. The solute was released to a sensitive local environment in a matter of weeks with minimal residue, as a result of treatment incorporating the Virtual Curtain methodology.

In an Australian trial, uranium mine wastewater was treated to produce an ‘ore’ containing around 1 per cent uranium and 2.5 per cent rare earth elements. This uranium ‘ore’ was about 20 times more enriched than the original uranium deposit being mined, while the rare earth elements constitute a new, previously unrecovered commodity stream. Other trials have also highlighted the potential for the Virtual Curtain technology to produce a value from wastewaters previously considered a liability.

In China, the Virtual Curtain technology is currently used to treat around 7 gigalitres of wastewater produced from a coal gasification plant. In this application, the technology has been used to soften the water as well as remove dissolved silica and organics, leading to around a 50 per cent improvement in the performance of the expensive reverse osmosis step that follows. This treatment constitutes a major step reduction in costs for wastewater treatment at coal gasification plants in China.

virtualcurtain.com.au
Osmoflo’s emergency water solution ensures timely mine construction for Antofagasta Minerals

Case Study

Osmoflo provides tailored, turnkey desalination and water treatment solutions across the world. As the largest Australian-based designer and builder of desalination projects, the company has offices throughout the Middle East, South-East Asia, South America and India.

Osmoflo’s expertise covers the full range of treatment solutions for seawater, brackish, waste and contaminated feedwaters for applications in potable water, high purity process water, dewatering, reuse and environmental discharge. Osmoflo has designed and built over 450 plants, and operates and maintains over 100 plants and facilities for its clients around the world.

In 2013, Chilean copper mining group Antofagasta Minerals engaged Osmoflo to provide a water treatment solution at its Antucoya mine. The development of the mine and processing facilities required a constant and reliable supply of good quality water during the construction phase and for ongoing mine operations. Due to the urgent water requirement and long lead time for a permanent water treatment plant, a rental solution was deemed to be the quickest bridge solution to meet construction schedules.

With equipment readily available from its global fleet (located in the United Arab Emirates, Australia and Asia), Osmoflo was the only company capable of providing an emergency water treatment solution. Osmoflo installed and commissioned a 1,500m³/day ultrafiltration and seawater reverse osmosis plant in August 2013, ensuring Antofagasta could continue construction activity and avoid costly time delays. The plant was then handed over to Osmoflo SPA in Chile for ongoing operation and maintenance.

The mine construction was completed in 2015 and went into full production in 2016. Osmoflo was subsequently engaged to provide a permanent 3,000m³/day seawater RO plant for process and potable use at the mine. This was commissioned in February 2016.

osmoflo.com
Clean TeQ proprietary ion exchange technology enables zero liquid discharge in the Middle East

Case Study
Australian company Clean TeQ operates a mining division (www.cleanteq.com) and a water division (www.cleanteqwater.com). The company is developing the Syerston nickel and cobalt mine in Australia, which is dedicated to supplying metal sulphates to the EV battery market. Clean TeQ’s proprietary ion exchange technology is central to the production of high-quality metal sulphates and is the basis of the Continuous Ionic Filtration (CIF®) process used in industrial and municipal wastewater treatment.

Ion exchange is a water treatment process used by many industries to produce high pure water, for example, in nuclear and thermal power stations. The CIF® process extends the use of ion exchange technology to the treatment and recycling of wastewaters and by-products.

Working with mining and water treatment companies globally, Clean TeQ provides solutions for water and wastewater treatment, by-product recovery and zero liquid discharge (ZLD). ZLD is the elimination of liquid waste discharge, with the clean water reused in the process or safely discharged into waterways.

Clean TeQ’s CIF® technology is used worldwide, including in Oman at an antimony roaster wastewater treatment facility. Designed to modern environmental standards, the antimony plant undertakes the roasting of antimony concentrates to produce high grade antimony ingots, powdered antimony trioxides, gypsum and gold bullions.

Regulations ensure that roasters, smelters and power plants control their emissions to atmosphere. Flue Gas Desulphurisation (FGD) scrubbers wash to air emissions to remove sulphur dioxide and other pollutants, producing scrubber water with high concentrations of sulphate, arsenic, antimony and other toxic components. This water must be treated before it can be reused or discharged. Treatment is normally done by addition of lime, producing metal and gypsum solids which are filtered out. However, this treatment still leaves the sulphate at around 1,500 mg/L, a level that does not meet the quality specifications for most reuse or discharge applications.

At the Oman roaster, the FGD blowdown water is treated in a lime reactor and clarifier to remove heavy metals to below 0.5 mg/L. The water from the clarifier contains 600 mg/L of calcium and 1,700 mg/L of sulphate and is then further treated using Clean TeQ’s CIF® technology. CIF® reduces the calcium and sulphate concentrations to below 50 mg/L and 250 mg/L respectively, which meets the requirement for reuse or discharge. Ion exchange resins are regenerated using dilute sulphuric acid and hydrated lime, allowing the spent brine to be recycled back to the lime reactor, and resulting in a ZLD process.
WATER RECYCLING AND REUSE

Many Australian mines reduce or eliminate the dependency on external water supplies by increasing the recycling of water. Australian companies offer customised design of recycling systems and refurbishment and upgrades to existing systems.

In Australia, water recycling systems are part of integrated water efficiency programs that have provided solutions enabling over 80 per cent of mine water to be supplied from recycled or other low-quality sources. For example, since 2013, Mount Isa Mines has invested over $3 million in water conservation and $1.6 million on reducing freshwater consumption by 50 per cent across the mine operations as well as recycling 80 per cent of all water used on site. Australia is also a world leader in innovative education and training programs for water recycling, alternate water sources and sustainable water management and decision making at mine sites.

TAILINGS MANAGEMENT AND REMEDIATION

Raw tailings may contain large amounts of water. Effective tailings water management is fundamental to mining sustainability and includes:

- maximising water efficiency
- safe containment of the tailings by avoiding geotechnical failures associated with water pressure
- controlling and avoiding water seepage into the surrounding environment.

Australia is known for its expertise in the delivery and implementation of financially viable and sustainable tailings water management strategies. This consulting expertise takes into account specific tailings properties, and the local environmental and climate contexts. This capability includes:

- innovative approaches to tailings dam management
- tailings water recovery and seepage control
- forecasting, planning and implementing closure and rehabilitation strategies
- plans to protect the environment by covering and remediating tailings.

Historical tailings dam failures have demonstrated the reality of the risks associated with tailings water. Australia’s leadership in risk management is highlighted by the Australian Government’s Leading Practice Sustainable Development Program for the Mining Industry. This program, in conjunction with industry-standard guidelines developed by the Australian National Council on Large Dams, articulates the mining industry’s commitment to sustainable tailings management. This is achieved through a life-of-mine risk-based approach to design, operation, management and monitoring.

Examples of innovations in tailings water management include the advanced process controls that optimise water recovery from tailings prior to discharge into storage facilities and sophisticated liner design.

Australian companies are at the forefront of optimising water recovery from tailings by providing customised solutions involving the tailing properties and mine site environment. This ranges from conventional thickening to filter presses that permit dry stacking of tailings and development of new tests on tailings properties.
ATC Williams delivers mining tailings management in Chile

Case Study

Based in Melbourne with offices in Perth, Brisbane, Peru, Chile and the Middle East, ATC Williams provides tailings and water consultancy services, specialising in life-of-mine tailings and water management. The company also offers complementary services in areas such as geotechnical engineering, slurry transport and waste management.

Tailings management has become a critical aspect of mine planning and operation in Chile. The increase in mining activity over the past 15 years, combined with a significant grade reduction, has resulted in a large increase in tailings volume. Around 1.6 million of tonnes of tailings are produced each day in Chile. More than 80 per cent of sulphides ore reserves are located in the central part of Chile, close to the most populated, agricultural and industrially developed areas.

Water is a limited resource in these mining areas, which is worsened by global warming. Rain in the wet season does not provide enough water for drinking, agriculture and mining. This is why most new mining projects are pumping seawater despite the huge capital and energy expense. Mines are also expanding their operations to poorer hypogen primary bodies, resulting in a higher water consumption concentration-flotation process and generating increased tailings volumes.

ATC Williams has been working on tailings management solutions in Chile and Peru for the last seven years, including for Codelco’s Andina, San Antonio, Chuquicamata and El Teniente mines, and MMG’s Las Bambas mines. The company was commissioned to look at ways of improving tailings storage efficiency and water recovery.

ATC Williams continues to explore options such as a thickening tailings discharge as well as filtration, which can be an attractive option for operations with high water replacement costs and where seepage is a sensitive issue.

High density thickened or paste tailings disposal are also both effective ways to increase the strength of tailings deposits, reducing the risk of liquefaction and are generally more cost-efficient than filtration.

atcwilliams.com

Field deposition trial of high rate concentrated tailings over Talabre TSF (Codelco, Chuquicamata, northern Chile). Image courtesy of ATC.
The following table provides some examples of companies and their capabilities.

Contact your local Austrade representative for assistance connecting with the Australian businesses that best suit your requirements.

austrade.gov.au
## Organisations

<table>
<thead>
<tr>
<th>Name</th>
<th>Main Product or Service</th>
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<tbody>
<tr>
<td>Advisian (Worley Parsons Group)</td>
<td>Mining consulting</td>
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<tr>
<td>Airwell Group Pty Ltd</td>
<td>Pumping solutions</td>
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<tr>
<td>Akwa Worx Pty Ltd</td>
<td>Water and waste water treatment</td>
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<tr>
<td>ATC Williams Pty Ltd</td>
<td>Tailings management</td>
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<tr>
<td>Ausenco</td>
<td>Mining consulting</td>
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<td>Australasian Groundwater and Environmental Consultants Pty Ltd</td>
<td>Groundwater consultants</td>
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<tr>
<td>Australian Diversified Engineering Pty Ltd</td>
<td>Water truck spray systems</td>
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<tr>
<td>Baleen Filters Pty Ltd</td>
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<td>Cardno</td>
<td>Water Consulting</td>
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<tr>
<td>Clean TeQ Ltd</td>
<td>Water and waste water treatment</td>
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<tr>
<td>Coffey</td>
<td>Mining environment engineering</td>
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<td>C&amp;R Consulting</td>
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<tr>
<td>CRC Care</td>
<td>Cooperative Research Centre – Remediation</td>
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<tr>
<td>Organisations</td>
<td>Mine Design and Planning</td>
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<tr>
<td>Creative Water Technology</td>
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<tr>
<td>Commonwealth Scientific and Industrial Research Organisation (CSIRO)</td>
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<td>Earth Systems Consulting Pty Ltd</td>
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<td>Ecosoft Water</td>
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<td>GHD</td>
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<td>Global Aquatica Pty Ltd</td>
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<td>Golder Associates</td>
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<td>Hydro Engineering &amp; Consulting</td>
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<tr>
<td>Hydrus Consulting Pty Ltd</td>
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<tr>
<td>International Centre of Excellence in Water Resources Management (ICE WaRM)</td>
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<td>Ionized Pty Ltd</td>
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<td>JP Environmental</td>
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<td>MAK Industrial Water Solutions Pty Ltd</td>
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- **Creative Water Technology**: Water treatment
- **Commonwealth Scientific and Industrial Research Organisation (CSIRO)**: Mine site environmental management
- **Earth Systems Consulting Pty Ltd**: Environmental and social consulting
- **Ecosoft Water**: Water conditioner / treatment
- **GHD**: Mine and water consulting
- **Global Aquatica Pty Ltd**: Waste water treatment
- **Golder Associates**: Mining consulting
- **Hydro Engineering & Consulting**: Water management consulting
- **Hydrus Consulting Pty Ltd**: Environment and water consulting
- **International Centre of Excellence in Water Resources Management (ICE WaRM)**: Water education and training
- **Ionized Pty Ltd**: Water treatment
- **JP Environmental**: Water management planning
- **MAK Industrial Water Solutions Pty Ltd**: Water treatment solutions and plants
<table>
<thead>
<tr>
<th>Organisations</th>
<th>Mine Design and Planning</th>
<th>Mine Construction</th>
<th>Mine Production / Operation</th>
<th>Mine Closure</th>
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<tr>
<td>Minetek Pty Ltd</td>
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<td>ReGen (Downer Mining)</td>
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<td>SciDev</td>
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<td>Virtual Curtain</td>
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<td>Tru-Flo Pumping Systems Pty Ltd</td>
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<td>Waterex</td>
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<td>Worldpoly Pty Ltd</td>
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<td><strong>TOTAL</strong></td>
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<td>9</td>
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</tbody>
</table>
The following section includes some key organisations involved in the mining and water-related sectors. Contact your local austrade representative about connecting with Australian mining and water-related organisations.

austrade.gov.au

**INDUSTRY AND RESEARCH ORGANISATIONS**

**Austmine** is the leading industry body in Australia for the mining equipment, technology and services (METS) sector, with over 400 corporate members.
austmine.com.au

**Centre for Water in the Minerals Industry (CWIMI) - Sustainable Minerals Institute, University of Queensland.** The Centre for Water in the Minerals Industry conducts research towards achieving sustainable water management in the mining industry. CWIMI aims to develop key technologies for the measurement, monitoring and modelling of water in the context of mine operations, their surrounding environments and regional communities.
cwimi.uq.edu.au

**Commonwealth Scientific and Industrial Research Organisation (CSIRO)** has expertise in environmentally friendly mineral resource production and development, providing the tools and knowledge for Australia to be a global leader in the stewardship of these resources. Underpinning this is expertise in process science and engineering and mathematical, environmental and social sciences.
csiro.au/en/Research/MRF

**HunterNet** is widely recognised within Australian manufacturing and academia as the most successful industry cluster in the Newcastle region in New South Wales, Australia. The organisation involves over 200 companies active in national and international energy and resources and other critical sectors.
hunternet.com.au

**METS Ignited** is an industry-led, government-funded, growth centre for the mining equipment, technology and services (METS) sector. METS Ignited works with Australian suppliers to the mining industry, global miners, research organisations and capital providers to provide world-class clusters to generate integrated strategic opportunities.
metsignited.org

**The Minerals Council of Australia (MCA)** represents Australia’s exploration, mining and minerals processing industry, nationally and internationally, in its contribution to sustainable development and society. MCA member companies account for more than 85 per cent of Australia’s annual mineral production and 90 per cent of mineral export earnings. The MCA has led a landmark effort to better understand the industry’s water use (and future needs) through the development of a water accounting framework for the Australian minerals industry. The MCA has also developed a comprehensive water policy which provides the minerals industry’s position on water and sustainable development.

minerals.org.au/policy_focus/water_stewardship

The **Department of Industry, Innovation and Science** provides advice and policy support to the Australian Government regarding Australia’s resources sector.

industry.gov.au/resource

The **Working in Partnership (WIP) initiative**, managed by the Department of Industry, Innovation and Science, aims to support and encourage cultural change in relations between Indigenous communities and the mining industry and to promote long term, effective partnerships which benefit all stakeholders.

industry.gov.au/resource/Programs/WorkinginPartnershipinitiative

The **Mining & Energy Services Council of Australia (MESCA)** is an industry body that represents and promotes a diverse range of skilled, innovative organisations which include capital equipment providers; contractor and consultancy resources; OEM (Original Equipment Manufacturers) project management; engineering and MRO (Maintenance Repair & Operational) suppliers to the energy and mineral resource industries across Australia.
mesca.com.au
OTHER RELATED AUSTRADE PUBLICATIONS

Sustainable Mining Industry Capability Report
This industry capability report provides an overview of Australian capabilities in several aspects of sustainable mining: environmental and water management, community engagement and development. It includes examples of some of the many Australian companies with specialist expertise.


Urban and Industrial Water Industry Capability Report
This industry capability statement provides an overview of Australian capability in urban and industrial water solutions, including examples of some of the many Australian companies with specialist expertise.


Image courtesy of GHD.
REFERENCES


HOW AUSTRADE CAN HELP

The Australian Trade Commission – Austrade – is the Australian Government agency that promotes trade, investment and education, and develops tourism policy and research.

Austrade helps companies around the world to identify and take up investment opportunities in Australia as well as to source Australian goods and services.

Our assistance includes:
• providing insight on Australian capabilities
• identifying potential investment projects and strategic alliance partners
• helping you to identify and contact Australian suppliers.

W austrade.gov.au
E info@austrade.gov.au