Expert advisory services backed by technology-based solutions for sustainable management of industrial saline waste and residual brines

Impactus VAP Pty Ltd

www.impactusvap.com
Sydney, Australia

November 2022

Sustainable management of saline wastewater has increasingly become a massive global problem for many industries, governments, and communities.

Fenced off residual brine pond

The impacts….

Discharge of untreated waste to the environment is neither a sustainable waste disposal solution nor is it helping our net zero ambitions.

Impactus VAP is at the forefront of a new paradigm in offering sustainable residual saline wastewater management solutions

We are proud to be the first-choice supplier of sustainable saline wastewater treatment and salinity control solutions to global markets:

- We deliver innovative solutions for industries facing the challenge of sustainable management of residual saline waste, by reducing their impacts, whilst improving operations and profitability.
- Our specialist advisory services has an unrivalled reputation for providing technology-based and practical advice to successfully and sustainably manage intractable residual saline wastes, whilst supporting industries in adapting to new operating conditions brought upon by climate change.

Our core strengths

Our advisory services are built on our access to a proprietary technology platform developed and owned by our sister company (Pact Renewables Pty Ltd), that enables the conversion of saline waters/wastewaters into one or more value-added products (VAPs) before safe land disposal of the minimised waste via encapsulation techniques.

This approach to sustainable management of residual saline waste applies to many industries where dumping intractable waste into waterways and the sea are becoming environmentally, economically, and socially unacceptable.

Our technologies and our approach collectively enable our clients to foresee risks and opportunities associated with sustainable management of residual saline waste through our integrated whole lifecycle assessments (cradle-to-grave) and techno-economic evaluations.

Our key service areas

Our advisory services cover the following key areas related to sustainable management of residual saline waste:

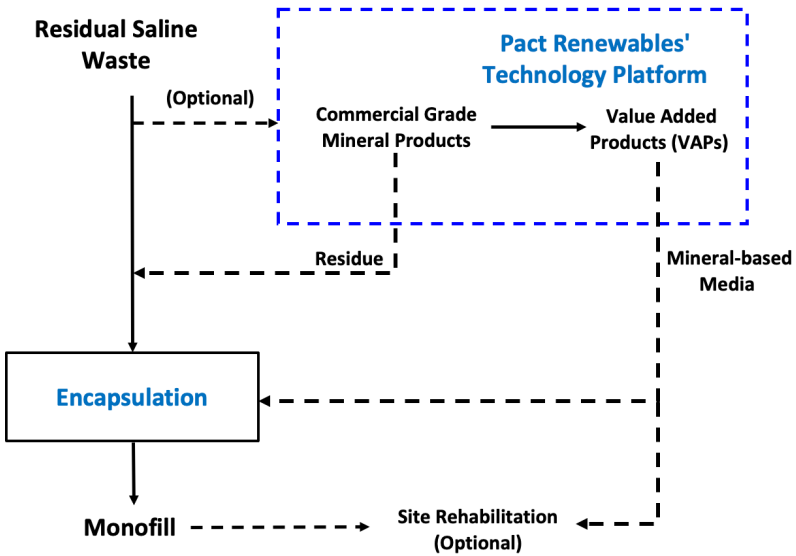
- Advice on minimisation of saline waste streams (solid, liquid, slurry) through recovery of minerals, VAPs and land application of benign material.
- Performance of integrated lifecycle assessments (LCA) and techno-economic evaluations (TEA) for identifying risks and opportunities associated with saline waste management options.
- Advice on technologies for sustainable reduction of noxious odours and greenhouse gases from odour generating and/or emanating substrates containing one or more saline waste streams.
- Advice on techniques for safe disposal of intractable/hazardous waste streams using our proprietary encapsulation techniques.
- Advice on developing and implementing verifiable methodologies for the generation of carbon credits and offsets using our proprietary technologies.
- On-site and workshop-based training to employees of our clients.

Saline waste generating industries that we assist

- Agriculture, forestry and land management
- Biogas generation (including anaerobic digestion systems)
- Construction (including construction and demolition landfills)
- Desalination (including seawater and inland desalination plants and types)
- Energy generation (including waste-to-energy, geothermal energy and lithium recovery from geothermal brines)
- Fertilisers & specialty chemicals (including potash and energy minerals recovery from salt lake systems)
- Food chain, from production to waste disposal (including cattle, livestock dairy and municipal solid waste landfills)
- Mining & mineral processing (including active and inactive tailing storage facilities and site rehabilitation projects)
- Municipal and industrial water and wastewater
- Oil and gas (including flowback impoundments associated with shale gas operations and residual salt storage ponds in coal seam gas production)
- Paper/cardboard manufacturing
- Petrochemical/metallurgical facilities

We also assist climate technologies and carbon trading platforms in developing verifiable methodologies for carbon credit generation using our technologies.

Technologies behind our saline waste and residual brine management solutions



Examples of application areas:

- Achieving zero liquid discharge through integrated recovery of minerals and additional water from reject brine of seawater desalination plants
- Improving lithium extraction processes and enhanced water recovery from geothermal brines through selective recovery of Na and Mg ions as valuable co-products
- Improving stability of tailing storage facilities in mining and mineral processing operations using water absorbing mineral-based media, produced and applied onsite, and as a cost-effective and sustainable alternative or addition to dewatering and dry stacking
- Preparation and beneficial use of benign tailing material for site rehabilitation
- Safe land disposal of often corrosive and hygroscopic residue, such as flyash from waste-to-energy operations, residual salt and flowback generated in coal seam gas and shale gas production operations, and hazardous end of line residue from mining/mineral processing operations using mineral based encapsulation methods
- Achieving quantifiable operational efficiency, water balance improvement and reduced footprint in multiple industries, faced with saline waste management challenges.

Our salinity control and brine management solutions are driven by a multitude of factors

- Ability to recover additional water for reuse in processes.
- Lack of access to conventional discharge options such as ocean and deep well injection.
- Ability to recover mineral products, selectively or sequentially, for increasing brine concentration to minimise waste volume, and where possible, achieve zero liquid discharge (ZLD) outcomes.
- Low energy consumption using renewable energy and where possible energy recovery devices for brine treatment, dry solids production and encapsulation processes.
- Flexibility in the arrangement of processes and product options, offered by our technology platform, for establishing fit-for-purpose solutions, particularly for the management of hard-to-abate and/or hazardous saline waste and residual brines.
- Ability to install treatment facility as a mobile or end-of-pipeline solution, all in one platform configuration.
- Enabling the end users of our technologies to reduce their operational footprint and optimise production operations by undertaking integrated full lifecycle and techno-economic assessments.
- Complimentary to water and wastewater treatment technologies at various technology readiness levels (TRL) for accelerating technology uptake by industry.
- Community and regulatory pressure concerned with land use, contamination risks, and operational/corporate compliance with ESG.

Key advisory service area 1

Recovery of minerals and VAPs from residual saline waste and urban salinity remediation

The challenges:

- Many industrial saline waste streams that until now have been considered “intractable waste” can no longer be disposed to waterways, seas, and land without pre-treatment.
- In view of incoming border carbon penalties and requirements for product stewardship, the need for cost effective and sustainable solutions for the reduction of saline waste pollution is more than ever overwhelming, highlighted by increasing community concerns and consumer pressure.
- Despite efforts to recover values from saline waste streams under the banner of brine mining, to the best of our knowledge the challenges and risks associated with highly concentrated and often contaminated residual saline waste remain unresolved.
- A key shortcoming that acutely exacerbates this challenge is the absence of appropriate technology-based solutions for residual saline waste streams for their safe land disposal, particularly for those that are marked with elevated concentrations of inorganic contaminants.
- Urban salinity is eating into infrastructure and iconic structures, and is further exacerbated as a result of climate change.

How we address these challenges

- By applying various combinations of our interlinking technology platform, we are able to selectively or sequentially recover valuable mineral products and produce soil-degradable composites, which we collectively identify as Value Added Products (VAPs).
- Our technology-based waste minimisation solutions can demonstrably be applied to a range of residual saline waste streams, whether in solid, liquid, or slurry forms, for minimising waste and ultimately achieving zero waste or near zero waste outcomes, through safe disposal of the residues in monofills, using our encapsulation techniques.
- We use our skills for reversing the application of technologies for removing salt buildup in built environment and redefining the makeup of new generation climate proof, salt proof mortars.
- In most cases our solutions lead to substantial carbon footprint reduction of product manufacturing industries; even making possible the generation of carbon offsets.

Potential benefits of our solutions

- Sustainable saline waste minimisation through recovery and sale of commercial grade minerals and value-added products (VAPs).
- Reduction of salt load of the waste prior to landfilling via encapsulation techniques.
- Reduction of carbon footprint and, where possible, the generation of carbon credits as well as carbon offsets for product manufacturing industries.
- Compliance with existing and upcoming waste disposal regulations leading to enhanced corporate ESG and community acceptance.

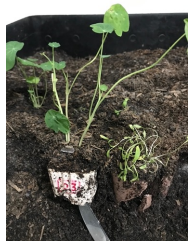
Example of our technology-based solutions for recovery of value added products (VAPs) from residual saline waste

Instead of saline effluent being discharged……..

...we treat it in our technologies to…

recover fresh/irrigation quality water

produce saleable products



and reduce impacts on the environment by avoiding discharge

Key advisory service area 2

Integrated lifecycle assessments (LCA) and techno-economic evaluations (TEA) to identify risks and opportunities associated with saline waste management options

The challenges:

- Most lifecycle assessments (LCAs) carried out for industries generating and disposing residual saline wastes exclude assessment of waste streams generated by product manufacturers, and thus only cover the cradle-to-gate component. If whole LCA is performed it will clearly show that saline waste disposal represents a significant component of operating costs, as well as high embodied carbon.
- This shortcoming is identified as a gross disadvantage for a range of industries, as LCAs limited to this cradle-to-grave approach do not reflect the true environmental footprint of their operations, products, and services. This has become acute risk for businesses that now need to assess and position themselves against the long-term implications of climate change on their waste management practices.
- The only solution to this major challenge is identification and implementation of appropriate technologies for sustainable disposal of saline waste that enable a whole LCA (cradle-to-grave) and TEA in tandem in order to enable Industry to understand and assess sensitivities and tradeoffs between different saline waste solution options.

How we address these challenges

- Despite differences between Life Cycle Cost (the total cost over the life of a functional unit including capital, maintenance, and end-of-life elements) and TEA (the technical and economic viability of a product or process), there are many parallels between the two and they are often performed in tandem.
- By way of assessing technology-based options for sustainable disposal of saline waste streams, we are uniquely placed to pave the way for an integrated whole LCA and TEA to enable our clients to fully understand and assess the potential risk associated with various waste reduction scenarios, as well as the trade-offs and co-benefits beyond the production gate. This is largely because our TEA models quantify and specify the material and energy inputs, estimated emissions, and capital materials and equipment for use in the Life Cycle Cost modelling of various production scenarios.

Potential benefits of our solutions

- Being based on a closed loop process with no residual emissions and therefore highly consistent systems, our integrated LCA and TEA approach offers industries generating saline waste a unique leverage for implementing best practices in the coming years by breaking down each lifecycle stage into key decisions that must be made in accordance with relevant ISO frameworks.
- Our integrated approach enables whole LCA to be deployed across the entire product development spectrum from concept through to commercialisation and waste footprint reduction. This benefits product developers to identify potential hotspots from early in the development cycle, and to respond accordingly and cost effectively, while the design, materials, and processes are still fluid.
- Further, our integrated approach is particularly appropriate for industries' saline waste that are large in volume and typically contain high embodied carbon, and are therefore classified as hard-to-recycle waste and often not covered by current ISO guidelines.

Key advisory service area 3

Advice on sustainable reduction of noxious odours and greenhouse gases from substrates containing one or more saline waste streams

The challenges:

- Odour generated across the food chain (from production to disposal) and ammonia from liquid digestate of anaerobic digestion systems are persisting problems.
- The health and safety risks associated with such emissions is particularly acute in peri-urban areas (i.e., those living close to landfills, poultry farms and cattle farms) that use anaerobic digestion systems for biogas production from food waste.
- Most odour reduction methods currently used in poultry farms and landfills are based on vaporisation/deodorisation processes or confined area odour capture methods, and are therefore not conducive to the capture and effective removal of odour-generating gaseous species.
- Biogas generation by anaerobic digestion of cattle waste is a relatively new industry and has yet to address the issue of ammonia emissions from liquid digestate storage ponds and risks associated with excess nitrogen release to waterways through land application of untreated digestate as a fertiliser supplement.

How we address these shortcomings

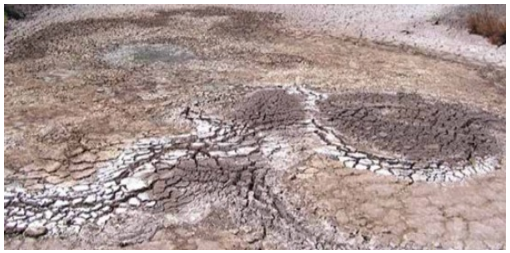
- We directly apply a proprietary formulated soil degradable media using our technology platform, for effective reduction of noxious odours and associated greenhouse gases being generated and/or emanated from a variety of substrates. Reduction is achieved by capturing and permanently sequestering the odourous gases and greenhouses through mineral conversion steps.
- Application areas cover the entire food chain, from production (including cattle, livestock dairy) to waste disposal (landfills and biogas generation).
- The efficiency of open-air odour reduction is not affected by diurnal and long-term climatic variation, nor the dynamics of field operations, such as in landfills.

Potential benefits of our solutions

- Effective reduction of noxious odour and associated greenhouses from a variety of substrates for improving the health of communities and the environment in peri-urban areas.
- Application of our media whether to solid substrates or liquid/slurry waste ponds (i.e., reduction of ammonia from secondary digestate ponds in anaerobic digestion systems) leads to production of soil degradable media that can be applied beneficially as nutritive amendments to the landscape.
- Cost effective and environmentally acceptable solutions for the reduction of ammonia and other noxious gases from liquid digestates of biogas generation systems and the promotion of beneficial uses of methane from cattle waste.

We specialise in providing operation-specific formulations for effective control of odour and noxious gases in livestock farming



Key advisory service area 4

Advice on application of our proprietary encapsulation techniques for safe disposal of intractable saline waste

The challenges:

- Saline residual waste streams generated in many industries are known to be hard to dispose of safely in landfills, and being voluminous, are the subject of strong public scrutiny on several fronts.
- Because of the high moisture content and hygroscopic nature of intractable saline waste streams, current or proposed encapsulation methods involving dewatering and dry stacking steps, are grossly unsuitable for their disposal, both in terms of sustainability and the risks associated with geotechnical instability and release of toxic leachates from disposal sites to nearby environments.
- Existing and proposed encapsulation and microencapsulation techniques are invariably expensive and unsustainable due to the use of flyash, cement, lime or other binders, with most requiring centralised disposal to become economically feasible.
- Consequentially, if full life cycle assessment (cradle-to-grave) is carried out, most existing and proposed encapsulation solutions will attract a high project carbon footprint.
- Clearly innovative technology-based solutions are needed to address the above shortcomings.

How we address these shortcomings

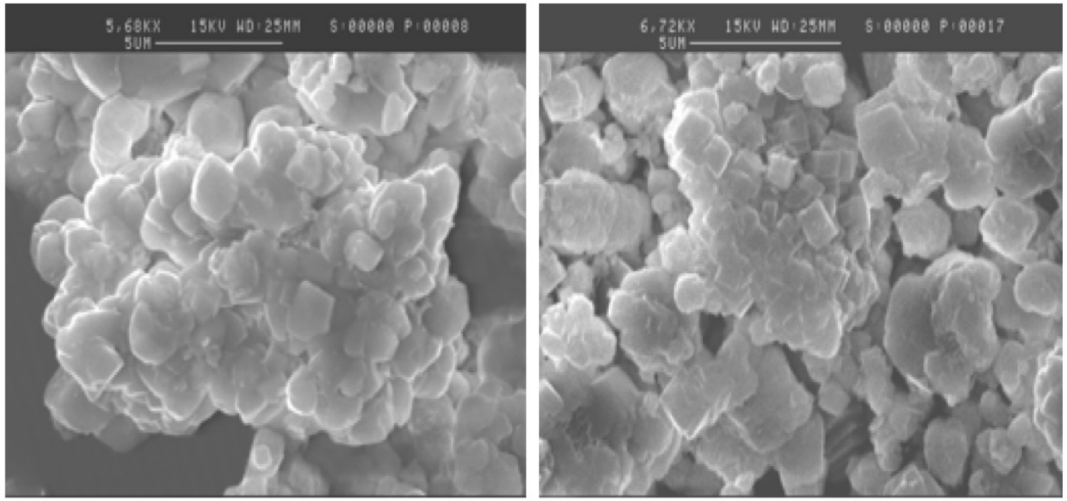
Our technology platform enables:

- minimisation of saline seepage risk through permanent solidification and stabilisation processes, using our proprietary low footprint mineral-based media,
- application at scale to multiple sites, removing the need for a costly centralised facility,
- safe and cost-effective disposal of all types of residual saline waste streams (solid, liquid, slurry) with minimal need for crystallisation, dewatering and compaction,
- optional recovery of valuable products from the residual waste prior to encapsulation, to offset establishment costs of monofils,
- optional rehabilitation of the encapsulated site by using our proprietary soil conditioners and degradable planting pots for topsoil revegetation,
- significant reduction in carbon footprint of the monofils, and
- successful disposal outcomes, backed up by the developers of the Climedec technology who are experts in saline waste management.

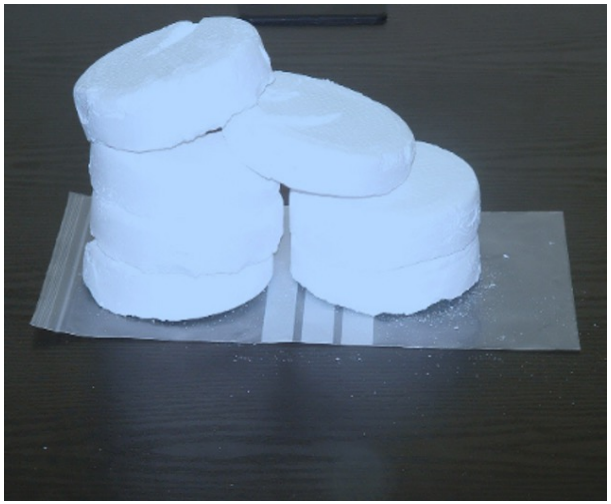
Potential benefits of our solutions

- Technology flexibility and scalability represent our key advantages for timely and cost-effective implementation of residual waste management solutions for our clients.
- Low carbon footprint, fit-for-purpose solutions for compliance with site specific conditions and regulatory requirements in line with community expectations.
- Engagement of a highly experienced project delivery team.
- Options for staged project delivery via consulting or contract R&D commensurate with client's requirements.
- Our approach for opportunistic cost reduction through selective recovery of commercial grade mineral products and optional site rehabilitation using our nutritious soil conditioners and plastic-free planting pots is unique.
- To our knowledge, our technology platform is the only one to offer cost offset options through recovery of by-products or options for rehabilitation of the impacted site.

Examples of commercial grade mineral products recovered from residual brines of coal seam gas production operations in Queensland, Australia



Close up views of high grade air-dried (left) and oven-dried (right) Precipitated Calcium Carbonate (PCC) products. PCC is a high value product, representing about 15% of the global markets for mineral fillers and pigment, with speciality paper manufacturing comprising around 70% of its total usage.



Magnesium Carbonate Light (MCL) is a specialty mineral used as a rubber/plastic filler, fire retardants, and in the production of refractories, pigments and paints.

Closeup views of microencapsulated granules and aggregates produced from various Waste-to-Energy flyash formulations which have been subjected to systematic and successful performance tests, including strength and long-term leaching trials.

Controlled dissolution trial on high solubility sulphate of potash (HS-SOP) produced from flyash residue of a European Waste-to-Energy project. HS-SOP is a highly-sought specialty chloride-free potassium fertiliser currently commanding market prices in excess of A $1,500/tonne.

Examples of field trials undertaken to assess the performance of our mineral-based media as a sustainable alternative pond liner to that of geotextiles

Key advisory service area 5

Advice on developing and implementing verifiable methodologies for generation of carbon credits and offsets

The challenges:

- There is currently a severe limitation with developing opportunities for generating carbon credits across various industry sectors due to limitations with the nature and scope of current methodologies that are verifiable and accepted by reputed carbon trading platforms.
- The absence of verifiable methodologies for carbon credit generation by direct air capture (DAC) processes is highly evident, particularly that DAC technologies have been dubbed as one of the key tools for reducing CO_2 from atmosphere to achieve global emissions targets.
- These compounding challenges are largely due to a lack of appropriate technologies to enable development of verifiable methodologies for carbon credit quantification and generation.

How we address these shortcomings

- Our technology platform can be utilised to provide a sound technical basis for developing a range of methodologies for verification and subsequent commercial deployment as a sustainable tool for generation of carbon credits from residual saline waste produced in large volumes by many industries.
- The proprietary mineral-based media produced in our technology platform have been subjected to systematic field and laboratory trials, and confirmed as a potentially suitable sorbent for permanent sequestration of CO_2 and other GHGs captured by DAC technologies.

Potential benefits of our solutions

- Generation of carbon credit projects where our technologies can provide a sound basis for establishing verifiable methodologies, that are based on performing integrated LCA and TEA, and can be shown to offer the lowest lifecycle cost for unit generation of carbon credit.
- We offer zero waste mineral-based media solutions for sequestration of carbon which is increasingly being recognised as an essential parameter for establishing verifiable methodologies for carbon credit generation with reduced footprint.
- Opportunity to create globally acceptable verifiable methodologies using our smart technologies.

Key advisory service area 6

On-site and workshop-based industry training for process and product optimisation

Technology optimisation for fit-for-purpose site specific applications often require in-house or on-site training of personnel involved with microengineering design of process components and product performance evaluations and related demonstrations. We provide such training services using our skillsets and specialized testing facilities to fast track our clients' projects.

Summary benefits of our solutions

Our technology-based solutions offer multiple benefits to clients :

✓Supported by a unique climate technology company, holding ownership of the IP assets

✓Cost effectiveness

✓Reduction of salt load of brine

✓Reduction of risks and liabilities for resource and product developers and/or users

✓Satisfaction of changing regulatory requirements and stakeholders' expectations

✓Differentiate and enhance the business pipeline and participate in transition to net zero

About us

Impactus VAP, a specialist advisory company and provider of technology-based solutions for waste management, is the consulting arm of Pact Renewables Pty Ltd. Both companies were funded and are directed by Dr Aharon Arakel, a pioneer and global expert on the recovery of values from saline waters and wastewaters, with his first patent on production of minerals from salt lake brines dating back 30 years.

Aharon has assisted many major companies in desalination and oil/gas, food and fertiliser production industries around the globe with their saline waste disposal challenges. He has advised governments in Australia, China and USA on matters related to sustainable management of saline wastewaters and has licensed his patented technologies to entities in Middle East, Japan, USA and Australia.

Our project delivery team is comprised of experts from around the globe, highly experienced in delivery of technology-based solutions, from concept to large-scale piloting and demonstration projects. The Company uses specialised in-house testing facilities as well as external laboratories for its projects.

Technology portfolio development path

Core Technologies Development → **VAPs Development & Optimisation** → **Commercial Rollout**

2012-2017

- Optimisation of product recovery processes for a variety of saline waste streams
- Feasibility studies and piloting for clients seeking solutions for saline residual waste
- Precursor minerals definition and composites process development
- Pilot production of feedstock using various mineral-based composites
- Comprehensive internal and external feedstock testing
- Techno-economic evaluations

2018-2021

- Composites process/products confirmation and IP securitisation
- Comprehensive market specific product development, testing & preparation of technical specs for registration
- Product market demand studies & off-taking arrangements
- Demonstration of process and product prototypes
- Long-term product performance monitoring (ongoing)

2022-

- Preparation of market-ready plant design packages for licensing
- Australian market introduction of high water retaining, degradable planting propagation pots
- Feasibility studies, piloting and licensing negotiations
- Contracted R&D & related assessments for clients' waste-specific solution/compliance requirements

Snapshots of our technology optimisation efforts

Closeup views of test rig-scale production of media as a feedstock for encapsulation processes. The feedstock and encapsulated products have been and continue to be subjected to comprehensive field and laboratory-based performance evaluations.

Public demonstration of technologies

Our consulting team is well-versed with public demonstration of our technology-based solutions to investors, communities, governments, industry, and product trading companies, which all form integral parts of project delivery process to our clients .

Some of the organisations assisted by Dr. Arakel and his team

bhpbilliton

OXY

xstrata

EasternStar GAS

ADM

DoloMatrix

VIROTEC

EARTHANOL WASTE TO FUEL

E&B Resources

TAKATA

Southern Nevada Water Authority

CITY OF LAS VEGAS NEVADA

AURORA

EASTERN MUNICIPAL WATER DISTRICT

Awwa Research

RAGN SELLS

ORICA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Australian Government

MURRAY-DARLING BASIN AUTHORITY

شركة تنمية نفط عمان
Petroleum Development Oman

origin

Services we provide

Desktop studies including prefeasibility and feasibility studies. As a supplier of both technology and sustainable saline waste solutions we are uniquely placed to undertake integrated lifecycle assessments and techno-economic assessments on behalf of our clients. We can also support clients' requirements for independent document reviews and recommendations to facilitate transition of their projects, from pilot to commercial production.

Piloting projects leading to technology licensing, which may include:

- Process/product optimisation for fit-for-purpose solutions
- Demonstration, product market assessments & independent audits
- Site rehabilitation / Revegetation trials
- Finalisation of plant design parameters and product specifications.

Contract R&D for generation of site-specific IP, to be owned by the client, which may include development, test work and comprehensive lifecycle and techno-economic assessments of products and processes for recovery of values from clients' residual waste streams, as a resource.

Hands-on training of clients' personnel for process and product optimisation.

Contacts

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