WATER SERVICES
ASSOCIATION OF AUSTRALIA

CIRCULAR ECONOMY FRAMING DOCUMENT

JULY 2024

Circular Economy Framing Document

Executive Summary

The circular economy describes an approach for optimising the value of resources and minimising long-term costs for the community served by water utilities. While the circular economy provides the opportunity to reduce the cost to water businesses, initiatives need to be selected with care to ensure they meet business objectives and that they create long term value.

Circular economy approaches have huge potential to drive value in the water sector, but they require appropriate assessment to select the right projects, with a different type of relationship needed with other services providers and their delivery may involve fundamental changes in the way that the water business is run. This document is intended to assist water utilities to understand some of the key considerations for establishing circular economy initiatives. The paper builds on some of the excellent work already being done in the circular economy and outlines some of the key touch points for the sector.

The primary focus of the document is on providing granular detail of key aspects of circular economy projects and how these can be managed. It contains industry case studies to help show how circular economy initiatives have been delivered. The content of the document is based on the lessons from these case studies to provide a concise summary of key lessons that will help water businesses avoid the pitfalls of others and hopefully accelerate the implementation of circular economy initiatives. It provides guidance on how to make a start with circular economy, outlining the four main areas of opportunity within the circular economy:

- The urban water cycle
- Energy and carbon
- Secondary resource management
- Environmental outcomes

The first step to embracing circular economy projects is to be clear on the context, primary considerations and aspects of each opportunity. Essential to being able to realise these opportunities is establishing effective partnerships for delivery. Often these partnerships are formed opportunistically but they require an understanding of the potential future business needs and direction to properly implement.

The other primary element for implementing the circular economy is developing the business case and ensuring that the project is a prudent investment choice for the utility. This requires consideration of the most appropriate business model, the nature of revenue and cost streams, and developing clear options for managing the internal risks. The final aspect of is supporting the project delivery and its ongoing operation.

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Background

Improving circular economy outcomes is a primary way of improving services for thriving and resilient regions. The circular economy is gaining momentum, and the water industry is well positioned to be a leading player. WSAA has already coordinated the development of two key papers - Transitioning the Water Industry with the Circular Economy and the Circular Economy Action Plan. These papers provide initial circular economy case studies and indicate the policy settings to enable the circular economy. Organisations that are just starting out on their circular economy journey are encouraged to review these two WSAA papers to develop a good understanding of circular economy fundamentals.

The Utility Excellence Committee (UEC), a subcommittee of the WSAA Board commissioned this paper to build on the Circular Economy Action Plan by providing a detailed approach to challenging the current business models and paradigms around implementation and sustainability of the circular economy for water businesses. The paper seeks to help water businesses take the next steps towards implementing circular economy initiatives by helping to elaborate two of the four strategic directions listed in the Circular Economy Action Plan:

1. **Building Circular Economy Knowledge**
2. **Establishing New Business Models**

What is the circular economy?

The circular economy seeks to decouple economic growth from primary and finite resource consumption and design waste out of the system. Circular design and use of products, services and systems seek to extend the life of resources in the market, keeping them at their highest value, enabling sharing and reuse business models to become business as usual (Circular Australia 2023). Underpinned by a transition to renewable energy, the circular economy builds economic, natural and social capital.

The circular economy is based on three principles:

- Designing out waste and pollution;
- Keeping products and materials in use for as long as possible; and
- Regenerating natural systems (Circular Economy Action Plan).

Why should we consider the circular economy?

The water sector, along with other large infrastructure sectors in the Australian and New Zealand economies is experiencing significant drivers in relation to climate change, population growth, replacement of aging infrastructure, supply chain resilience, and availability of people and capital, coupled with customer affordability and a steep rise in interest rates. All of these factors are causing the sector to take a broader look at how they can collectively improve the delivery outcomes for customers and community.

For the water sector the circular economy offers great scope: the water cycle itself is intrinsically circular and core operations can help regenerate natural capital. Adopting circular economy approaches boosts the climate resilience of water supplies through diversification by considering all source water options. Greater harnessing of the whole water cycle will improve catchment management outcomes, by improving the quantity and quality of water flowing into rivers and dams. The circular economy outcomes also align well with the Sustainable Development Goals (SDGs).

The document is formulated as follows:

Circular economy opportunities for the water sector

When looking at circular economy implementation examples. The first steps are to understand the nature of the opportunity and develop a robust business case. The water utility should seek to identify what are the areas where they can have the greatest impact and leverage support for funding and resources. Seeking to focus efforts on these areas. Noting that often the greatest community value may be achieved by starting with locally based circular economy initiatives.

In canvassing across utilities, there were four key areas of opportunity identified for the water sector (Appendix 2):

- The urban water cycle
- Secondary resource management
- Energy and carbon
- Environmental outcomes

Urban Water Cycle

Water and sewerage services are a key foundation of all urban centres, enabling thriving communities, impacting health, amenability and affordability.

Primary considerations for the delivery of the urban water cycle are:

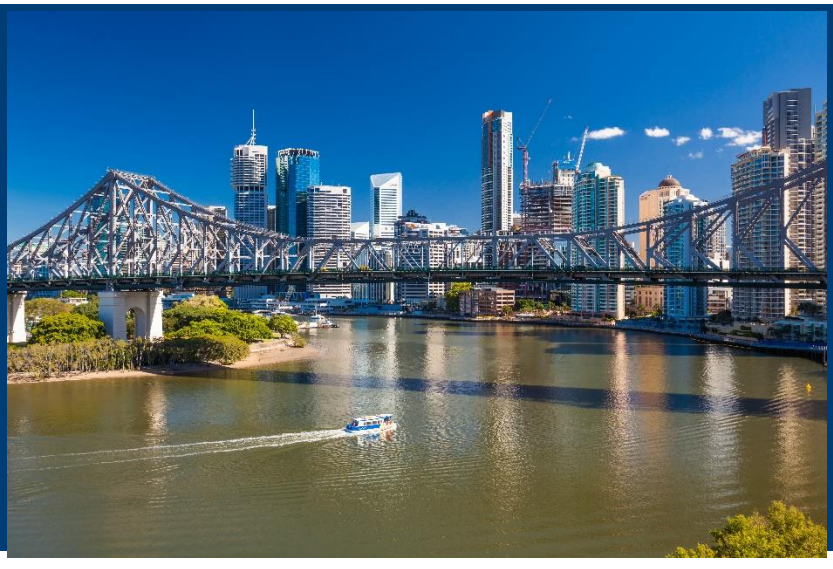
Whole of System Design. Water infrastructure cannot be delivered in isolation. The system should be designed collaboratively with others in the value chain including land use planning authorities, catchment managers and landowners, water industry regulators, local government, developers, environment agencies, indigenous landowners and other local interest groups.

Resilience. The way services are delivered should not be static. Services must be planned and delivered in a manner resilient to future changes, including climate, customer and stakeholder requirements and technology. Effective adaptive planning processes are a critical element in delivering resilience in services.

Efficiency. Delivering services efficiently and effectively is key to providing affordable services that meet customer expectations. This involves a detailed understanding to identify and develop the highest value community outcomes.

Key opportunities for partnerships and enabling the circular economy in the urban water cycle include:

- Ensuring the long-term water security and sustainability of the region through an understanding of all water source options (including alternative water sources such as recycled water and stormwater harvesting) and their environmental impacts.
- Decentralised water reuse options, particularly industrial areas. These can defer capital upgrades of water and wastewater treatment and transfer infrastructure. It can now be done in a manner that integrates unobtrusively with communities to provide local benefit.
- Addressing flooding and community amenity through understanding and better managing stormwater resources, which can also impact on wastewater transfer and treatment and provide additional water sources.



Energy and Carbon

Electricity is responsible for the majority of water and wastewater utilities' Scope 2 GHG emissions, it can also be a significant percentage of operational budgets. These financial and environmental costs can be reduced by transitioning to circular energy and carbon practices.

Primary considerations for water utilities transitioning to circular energy and carbon practices:

- *Consult the experts.* This will likely not be a core skill of the business, but each business should endeavour to build a reasonable knowledge base to implement these changes.
- *Reduce the demand.* Address the circularity of supply and recycling/reusing the outputs, considering the beginning of the cycle first.
- *Keep it close to home.* Circular economies are most successful when the loops are small, therefore it is important to consider using utility produced outputs as internal inputs instead of finding others to take them, or where this isn't possible look to the local community where they see value in the outputs.

Key opportunities for circular energy and carbon strategies for water utilities are outlined in the WSAA Accelerating to Net Zero report and include:

- Minimising energy consumption and greenhouse gas emissions by the utility. Encouraging consumers at home to do the same.
- Reusing treatment plant outputs as inputs, such as "waste" heat from treatment processes, biogas from advanced thermal treatment to power sites, and biochar as a tool for carbon sequestration.
- Transitioning to renewable energy through wind turbines, solar panels or green energy.

Secondary Resource Management

This aspect of circular economy refers not only to the management of secondary resources/outputs generated by the water utility, but also the opportunity to partner with nearby industries to either accept all or part of their output streams in a way that generates a positive resource outcome.

Primary considerations for enhancing the role of water utilities in shaping waste management outcomes include:

- *Understanding the opportunities*. These will vary within your local area depending on the nature and location of resource contributors and users. Identifying these opportunities requires a level of expertise which can either be built internally or developed through partnering.
- *Building relationships*. Seeking to understand stakeholders' objectives and requirements, seeking alignment to drive shared outcomes.
- *Strong reputation*. Building a reputation of being receptive to new initiatives and collaboratively partnering within the local community often results in the water utility being welcomed to decision making tables as more sectors move to the circular economy.
- *Commercial considerations.* Understanding competition within the market and appropriate commercial arrangements with partners, along with the appropriate business model to support the delivery of circular economy initiatives.

Key opportunities for partnerships and engaging with the circular economy to enhance waste management and recycling include:

- Identification and commercialisation of raw materials suitable for use by nearby businesses. Considerations include the following which are done a commercial scale:
    - Carbon recovery – biosolids, biochar, biocoal, organics recycling
    - Nutrient harvesting, especially nitrogen and phosphorus

More experimental options include

    - Salts, particularly from brine
    - Heavy metal recovery
- Acceptance of solid and liquid waste streams compatible with downstream market opportunities. Effectively diverting organic material from landfill in a sustainable manner.
- Identifying emerging financial and social opportunities in the local region that are driven by or occur because regulatory changes in other sectors or community expectations which drive the need for alterative disposal pathways.

Environmental management

There is usually a need to consider the overall environment in the removal and return of water resources and waste products. By taking a systems approach we can find a more efficient way to improve performance of waterways. We have reached the point in many waterways where the cost of investing in further point source pollution reduction exceeds the cost of non-point source investments. Therefore, there is the opportunity to invest in nature-based solutions This starts with minimising the release of waste to the environment. This would then progress to enhancing the natural assets on sites owned and control by the water utility. Consideration could also be given to including nature-based treatment solutions such as the use of wetlands for tertiary effluent polishing.

Over the longer term, the utility could consider options to enhance the region upstream of drinking water offtakes, seeking out partnerships with local and state government environmental agencies to broaden inputs of expertise and funding. This approach will provide enhanced protection of water quality and potentially lower treatment costs. Separately, there is great benefit in reducing the impact of diffuse pollution within waterways. The availability of nutrient offsets in some jurisdictions allows paying for changes that create wider catchment benefits than the traditional approach of only reducing point source discharges.

Primary considerations for enhancing the role of water utilities in shaping environmental outcomes are:

- *Whole of System Design*. Water utilities may seek to understand and operate their environmental management systems in the context of the broader catchment or regional environmental outcomes. This requires understanding the science, community expectations and technology associated with environmental performance in your local region.
- *Whole of System Operation*. This involves working with local authorities to determine the role of your utility in assisting with environmental management. Assisting with and potentially coordinating approaches to understanding and addressing the impact of point and non-point discharges on waterway condition. This may include the use of nutrient offsets and similar tools.
- *Alternative Approaches.* To deliver on the environmental requirements of the broader system may require a range of new approaches, including green solutions.

Implementing these alternative approaches often requires new skills, processes, and structures which could be provided by the local water utility.

Key opportunities for partnerships and engaging with the circular economy to drive improved environmental outcomes include:

- Providing community and stakeholder support in the monitoring of environmental flows, water quality and environmental change. This also includes relating information to changes in catchment management practices and using influence to reduce inputs at source to protect the environment, particularly as this affects drinking water treatment processes and costs, or downstream impacts from treated wastewater discharges.
- Providing support for new approaches and green solutions to environmental issues relevant to the water utility or their region.
- Understanding local environmental conditions related to the water cycle. Particularly how they affect water utility operation and where they present resource recovery opportunities.
- Partnering with key stakeholders to develop sustainable waterway and catchment outcomes. Working with both the community, landowners, regulators and other stakeholders to help broker best overall outcomes where these relate to areas influenced or managed by the water utility.

Partnerships to enable delivery

The delivery of circular economy initiatives is often about working in collaborative partnerships with key industry partners to deliver the opportunities. Early engagement with internal and external stakeholders is particularly important, especially when you wish to create and leverage shared assets across facilities. If you fail to engage with stakeholders early and effectively, there can be fundamental differences in design approaches and philosophy which can take significant time and money to resolve. This can be minimised by engaging broadly, early and with a clear purpose and targets, to ensure that the final concept is well understood by all stakeholders.

In looking to establish collaborative partnerships, it is important to have a good understanding of the value chain that your business is intending to operate in and be intentional about which organisations you wish to partner with or influence. Whilst some partners may emerge opportunistically, it is important that before they are engaged there is clear alignment with the business plan objectives. Potential partners include:

- Government:
    - Nationally – to understand their ambition, key policies and funding options.
    - State or Territory level, to understand their ambition and mandates. Seeking to align and promote projects that help deliver these will assist with securing funding and support.
    - Local councils have a particular focus on local solutions, particularly in relation to managing their Food Organics and Garden Organics (FOGO) and other wastes.
- Industry Partners on both supply and demand side to develop lowest cost options with highest net value.
- Regulators, to provide clarity on regulatory positions and enable development of robust and acceptable solutions.
- Communities and indigenous groups, to ensure the appropriateness of long-term outcomes.
- Universities, TAFE’s and other potential partners who can provide relevant technical expertise.
- Peak bodies, both within the sector and across sectors that can provide political, financial or technical support.

Note that working with entities who are separate to the water utility requires awareness that they operate with different constraints and drivers. For example, site footprint, commercial risk, different timeframes, pre-existing contracts. While engagement gives a broader and more positive impact there is a tension between the outcome, timing, addressing commercial risks and meeting other business commitments .

When working on circular economy projects it is important to understand the market for the products under consideration as part of building the business case. In doing this, it is important to engage suppliers to gain supporting information to ensure products meets appropriate technical specifications, standards, and quality assurance (not just in-lab results, but proof of scaled product consistency). Especially when there is no historical performance evidence the confidence of adopters is often limited.

For any process with environmental impacts, it is essential to engage the EPA early in the process. The intent is to share the proposed approach, understand potential roadblocks and agree mitigation actions. Effectively seeking to clarify their position and remove any uncertainty. In addition, by engaging the EPA early agreement can be reached in sampling and testing protocols to demonstrate that the process will meet regulatory requirements. It is also possible to challenge a regulatory position which inhibits potential opportunity. This should be done through the presentation of alternative evidence which seeks to alter the regulatory position. If this isn't possible then it will be necessary to respect the regulator's ruling and instead pursue a compliant alternative.

When engaging the local community, it is important to consider community impacts and needs, particularly the location and distances for demand vs supply facilities. Public perception is a vital consideration for the use of products that could involve direct contact with the public such as recycled water, to determine if a scheme can be established.

Seek to engage with local indigenous groups where possible to understand their needs and ability to interact with the scheme. This engagement can result in the discovery on unexpected options for material reuse in a way that benefits both the water utility and local community needs.

When looking at developing the project, examine opportunities which extend from the initial project concept. This includes options to engage with education institutions and local government to form local circular economy training hubs and showcase centres, which further promote circular economy activities within the local region.

Scalability

The majority of circular economy initiatives are best suited to being conducted in the local region. Particularly given that the materials generated are often from individual treatment plants or associated with a local expanse of waterway. There is a need to fully understand the local needs and conditions to establishing circular economy initiatives for your particular region.

Working at a regional level also helps make circular economy goals more achievable as there are fewer partners to engage, and it also supports clearly determining not only opportunities but also barriers. Doing this will then help identify the organisations that should be engaged to help remove regulatory and other blockers.

Approach to investment

A key step to establishing a circular economy initiative is alignment with the business strategy. Start small and keep things simple to minimise costs. In that way a failure is still a success because it is a low-cost learning opportunity. The best approach is a trial and the use of clear KPI's to support and develop the business case. It is essential to have good baselines and data to be able to use proof-of-concept projects to build up a portfolio of circular economy projects.

A critical aspect of circular economy projects occurs when the circular economy project is considered unregulated business. This quite a complex area which requires careful evaluation. Some of the considerations include whether the mixing of core and unregulated business creates an unfair competitive advantage with other sectors, with the unregulated business being co-funded through core business or regulated revenue. This can be managed be appropriate governance structures that ensure segregation of revenue functions whilst maintaining operational efficiency.

There are a range of business models that may be considered to deliver circular economy initiatives. These include partnerships, joint ventures, supply and offtake agreements. However, the nature of the business model needs to be tailored to suit each individual stakeholder and opportunity.

There is also a need to understand the business expertise and determine aspects that should be outsourced. This approach can assist in accelerating commercialisation, reduce risks for the business and overall reduce costs.

Key revenue and cost streams

Circular economy projects have a number of financial aspects that need to be considered when delivering the business case. These include:

- Generation of unregulated revenue. Where the revenue generation is insufficient to recover capital costs then the shortfall can be met through partnerships or seeking grant funding.
- Fulfilling political and business objectives, this includes meeting government targets. In these circumstances the primary focus may not be revenue generation but rather meeting external requirements including reducing the carbon footprint, improving carbon sequestration and eliminating waste to landfill. This also includes the need to meet regulatory obligations.
- Cost avoidance – Avoidance includes not having to pay costs associated with waste disposal and transport costs.
- Meeting customer needs - – typically a customer need for products that were traditionally classified as waste, but through product modification the waste can be transformed into a needed commodity. Key products are associated with water, energy and treatment byproducts.
- Water security - ensuring sufficient drinking water for long term community sustainability through direct and indirect water recycling.

To help overcome internal barriers it is important that there is a clear cost benefit from the initiative.

A central aspect of ensuring a commercial outcome is to understand the size of the opportunity, the risks and longevity of the potential solutions. This starts with a review or audit of current waste quantities and disposal costs. This information then needs to be used to assist with understanding the flow of materials. In visual form, this flow is typically presented as a Sankey diagram. These diagrams indicate the relative quantities of material from each source and where the materials are consumed or transformed. The diagrams are usually formulated for each particular product line. For a water treatment process these could include water, nitrogen, phosphorus, carbon and/or heat.

A Sankey diagram shows the quantity of material in each flow based on the width of the line. The thicker the line the greater is the amount of material that flows. These types of diagrams can then highlight areas where there is a shortfall or excess of material and help determine any bottlenecks or gaps in the process. Addressing the constraints to the flow allows optimisation of the process. In undertaking this process it important to understand the market maturity. Where the market is not fully developed there is a need to engage and build a market at the same time as building a product.

Working with other sectors is complex and time consuming. In addition, other sectors are not static. Yet determining whether a project is economically viable requires a lot of information and buy in from industry. This can be a slow and difficult process which depends on the level of engagement with the commercial customer base, their priorities and other competitors in the market. The main objective should be to build a coalition of the willing that will help the project mover forward effectively. Good ideas with strong business cases attract funding, even if initially the funding source is unclear.

Managing business risks and making the most of the opportunities

A rigorous technical and financial assessment of each opportunity should be undertaken to quantitatively assess the value and risks of the opportunity for the water utility and stakeholders. Using the financial and technical data combined with a multi-criteria analysis, the preferred implementation option(s) can be identified. Assessment of risks and opportunities is relatively standardised and undertaken in a manner consistent with ISO 31000.

Whilst clearly defined boundaries simplify design and management of any project, it may prove limiting for circular economy projects. This is particularly because of the interaction between different producers and consumers. A wider scope for the project allows for better identification of opportunities, delivering economies of scale, minimising input of external resources and optimising the process footprint.

A critical CE risk is the regulatory environment. Particularly when managing waste streams, a change in the regulatory or policy environment can trigger the need to revise core decisions or inhibit project delivery. This affects community expectations and can change these timeframes significantly. In looking at regulatory compliance there is a need to look at long term regulatory trends and look to go beyond current regulations to identify and manage current and future/emerging risks.

When setting up a circular economy project that builds on core water business, it is essential to first understand the intent of the asset and ensure that any circular economy project does not interfere with the primary asset function.

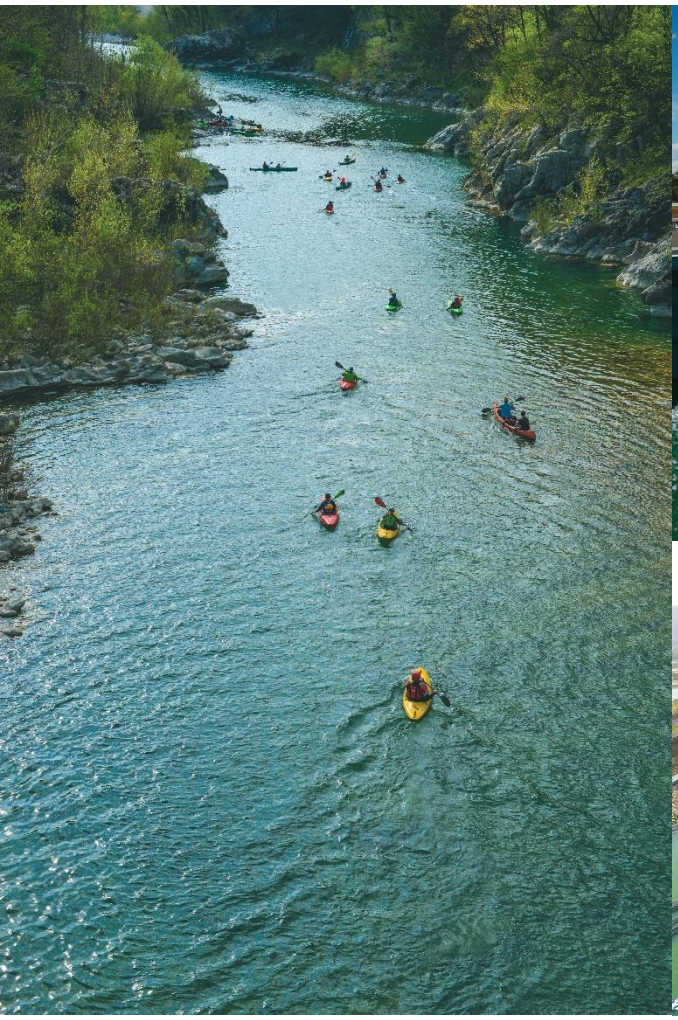
Delivery and operation

In delivering a circular economy project it is essential to bring staff along the journey, seeking to provide education and awareness that will address the disparity in their knowledge about the project and the benefits. Training needs to start from the ground up, to bring the entire utility on the journey. Doing this usually gains staff buy-in and support for the project, particularly if there are significant cost savings along with benefits to community or the environment.

The ongoing progress of any circular economy initiative is greatly assisted by having a business champion. The best champions are from the areas of the business most resistant to change. The champion assists in bringing everyone in the business on the journey.

A challenge for some water businesses is providing sufficient resourcing, particularly at the start of a new initiative. Development of the initial business case does take time and effort to do effectively, and there is often a need to allow greater time than initially predicted for initiation. An option that has been used by some organisations is to outsource the initial development stages to a third party such as a university or CSIRO.

Separately, it is important the solution is suitable for the relevant part of the water business. Often solutions don't work as one size fits all, rather it is important to understand the differences between regional areas and metropolitan centres to ensure an effectively tailored solution.



Appendix 1: Supporting Case Studies

The following represent case studies that were sourced from WSAA members. They seek to augment rather than duplicate case studies presented in the following documents:

- **Transitioning the Water Industry with the Circular Economy (WSAA)**
- **Circular Economy Action Plan (WSAA)**

To assist water utilities in applying the lessons from these case studies two summary tables have been provided. The first table summarises the studies in terms of the parts of the water cycle that they apply to assist in selection of options that are most relevant to the organisation. The second table based on the five areas of opportunity in the circular economy for the water sector, as outlined in the Framework.

Case study summary table – by system component

Utility & Project	Catchment & waterways	Wastewater treatment	Water treatment	Water reticulation	Wastewater reticulation	Customer
Barwon Water Reuse of Stock		**YES**	**YES**	**YES**	**YES**	
Greater Western Water, Circular Economy Program	**YES**	**YES**				**YES**
Hunter Water, Centralised Biosolids Treatment		**YES**				

Utility & Project	Catchment & waterways	Wastewater treatment	Water treatment	Water reticulation	Wastewater reticulation	Customer
Icon Water Spoil Reuse				YES	YES	
Lake Macquarie Council, Low Carbon Roads		YES	YES	YES	YES	YES
NE Water, CE portfolio for the West Wodonga STP	YES	YES				YES
SA Water, Recycled Glass Sand for Pipe Embedment				YES	YES	
SE Water, Functionalised Biochar		YES				
Urban Utilities Sustainable Water Schemes	YES	YES		YES		YES
Yarra Valley Water, Reducing the construction carbon footprint		YES	YES	YES	YES	

Utility & Project	Catchment & waterways	Wastewater treatment	Water treatment	Water reticulation	Wastewater reticulation	Customer
Watercare, biosolids to fertiliser	**YES**	**YES**				**YES**
Water Corporation, Circular Economy Roadmap for Desalination		**YES**	**YES**			

Case study summary table – by circular economy opportunity area

Utility & project	Energy and carbon	Environment	Secondary resource management	Urban water cycle
Barwon Water, Reuse of Stock			YES	
Greater Western Water, Circular Economy Program	YES	YES	YES	YES
Hunter Water, Centralised Biosolids Facility	YES	YES	YES	
Icon Water, Spoil Reuse		YES	YES	
Lake Macquarie Council, Low Carbon Roads		YES	YES	
NE Water, CE portfolio for the West Wodonga STP	YES	YES	YES	YES
SA Water, Recycled Glass Sand for Pipe Embedment		YES	YES	
SE Water, Functionalised Biochar	YES	YES	YES	

Utility & project	Energy and carbon	Environment	Secondary resource management	Urban water cycle
Urban Utilities, Sustainable Water Schemes			**YES**	**YES**
Yarra Valley Water, Reducing the construction carbon footprint	**YES**	**YES**		
Watercare, biosolids to fertiliser	**YES**	**YES**	**YES**	
Water Corporation, Circular Economy Roadmap for Desalination	**YES**	**YES**	**YES**	**YES**

Case study summaries

Reuse of Decommissioned and Surplus Stock (Barwon Water and Barwon Asset Solutions)

Context

Barwon Water's Enterprise Planning Delivery team (EPD) is encouraging the use of innovative and carbon smart thinking to deliver projects with lower operational and embodied carbon, to reduce environmental impact. As Barwon Water expands, upgrades, renews and replaces its assets, the EPD team is minimising future operational and embodied energy use and emissions by improving delivery practices.

An example of one of the initiatives was a full inventory conducted of Barwon Water and BAS decommissioned and surplus stock. The inventory enables the reuse of stock on upcoming projects to reduce buying new – resulting in reduced capital spend and embodied carbon.

A newly developed Carbon Smart Framework is at the centre of the drive to reduce carbon footprint of the business.

Commerciality

Liaison between multiple teams to ensure there was the appetite to reuse the stock and assessed any potential financial implications of changing the classification of decommissioned stock to used stock. It was intentional not to record the condition of the stock as manufacturers and/or suppliers will be invited to conduct onsite quality control inspections, to ensure the asset is suitable for reuse.

Drivers and enablers

The Carbon Smart Framework was the catalyst for this initiative and includes tools to implement carbon smart thinking. The cost and carbon savings were compelling reasons to implement and promote the initiative.

Stakeholder engagement

- Liaison between EPD and BAS Manager to confirm this initiative would be well received.
- Full inventory completed by Construction Specialist, Innovation and Sustainability Specialist and Construction Officer.
- Liaison with Health Safety & Wellbeing team to ensure process considers health and safety implications.
- Communicated at EPD Project Managers' meeting.
- Communicated by email to BAS, Design Consultants and Barwon Water employees via email.
- Inventory mentioned in Scope of Works (the Contract) to explain the circular economy thinking process to Tenderers, and for adherence.

Barriers

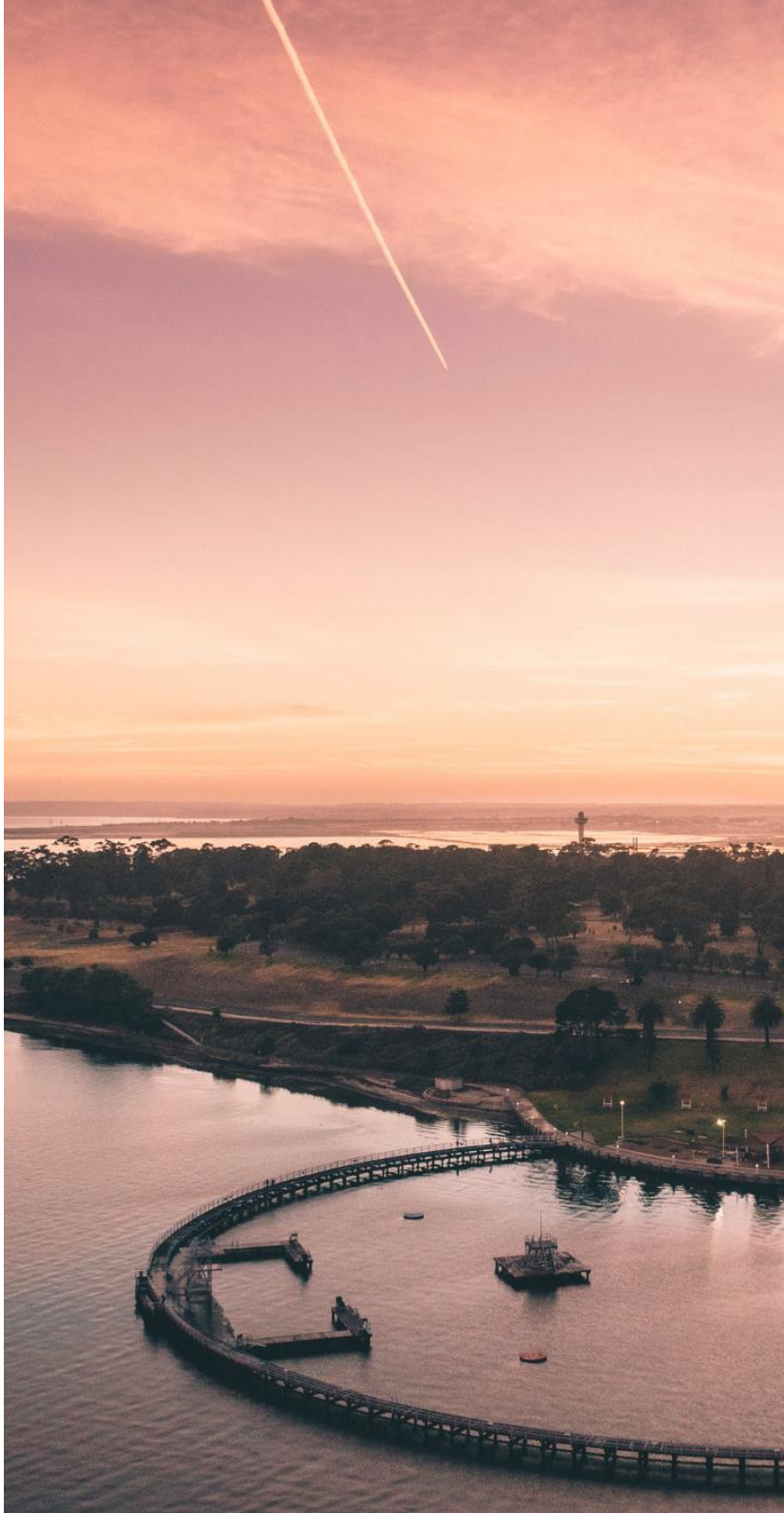
Foreseen barriers include lack of uptake, so at the beginning frequent reminder emails and explaining the ‘why’ behind the inventory encouraged awareness and uptake.

Overall benefit

Reduced embodied carbon (due to avoidance of new products/materials), reduced costs, business-wide circular thinking, demonstrating to the supply chain that the business is moving towards a circular economy.

Insights

- The inventory was more time-consuming than initially expected; however, the correct people were present to be as efficient as possible.
- The initiative is scalable beyond Barwon Water; most water corporations and councils have similar stock.
- There is strategic alignment as Barwon Water’s Strategy 2030 prioritises the delivery of affordability for customers, working towards a healthier environment and innovation.
- The initiative commenced in June 2023 and will be reviewed quarterly.



Context

There were several projects here, all aligned with core business skills and drivers:

GWW works within its 'inner loop' to find circular economy opportunities, the early successful projects have augmented already existing processes around Melton Recycled Water Plant (figure below) or have addressed another business need, ensuring the circular economy transformation is aligned with the organisation's 2030 Strategy. Key initiatives that have been explored at Melton RWP include:

- Treatment and beneficial reuse of 17ML per day of wastewater, which is used at nearby farms in the western irrigation network (WIN) including Eynesbury, Melton, Rockbank and Surbiton Park farm, as well as providing water to a first nations ceremonial tree, and Pinkerton forest.
- Use of DNA and an organic compound called ATP to learn about the bugs used to treat our wastewater;
- Energy opportunities: including electricity grid load balancing; production of green energy through solar panels and biogas produced through cogeneration with food waste and a microturbine to produce electricity and provide heat for the co-digestion process.
- Biochar trial which tested the production of a high-quality product from the solids left over from wastewater treatment processes.

Biogas production: Organic waste processing at GWW can be used to produce biogas, which can then produce electrical and thermal energy. GWW is looking at further optimising the percentage of waste to generate energy (currently at around 15% solid waste). GWW took an experimental approach, starting to find opportunities for efficiencies, which then enabled the business to fully understand the scope of opportunities available.

Land opportunities: Many STP's are on large holdings of land which act as an odour buffer and provide recycled water reuse opportunities through irrigation. A strategic approach to be considered in the future by GWW is to gain a better return on the land by using a circular economy model rather than the current linear economy approach. GWW considered how repurposing land could attract industry that could cohabitate the odour buffer, while also providing a second revenue stream.

In doing GWW could preferentially select industries to provide products that could then benefit and reduce costs e.g. GWW providing heat for greenhouses set up on their land (becoming hothouses), which can then provide organic waste back to the plant.

Commerciality

- It is critical that any circular economy opportunities explored do not impact core business.
- Decisions also need to consider the asset lifecycle to avoid disconnect between circular economy ambition and operational realities - e.g. inequity between aged assets, such as a pump station, requiring upgrade being passed over in favour of instillation of solar panels at the same site which are used to power the struggling asset.
- In seeking cost recovery/revenue there is a need to select initiatives which also enable business strategic ambitions. The initiative can then grow from the initial break from core business to benefit non-regulated returns. Doing this requires both vision and a senior business champion.

Drivers and enablers

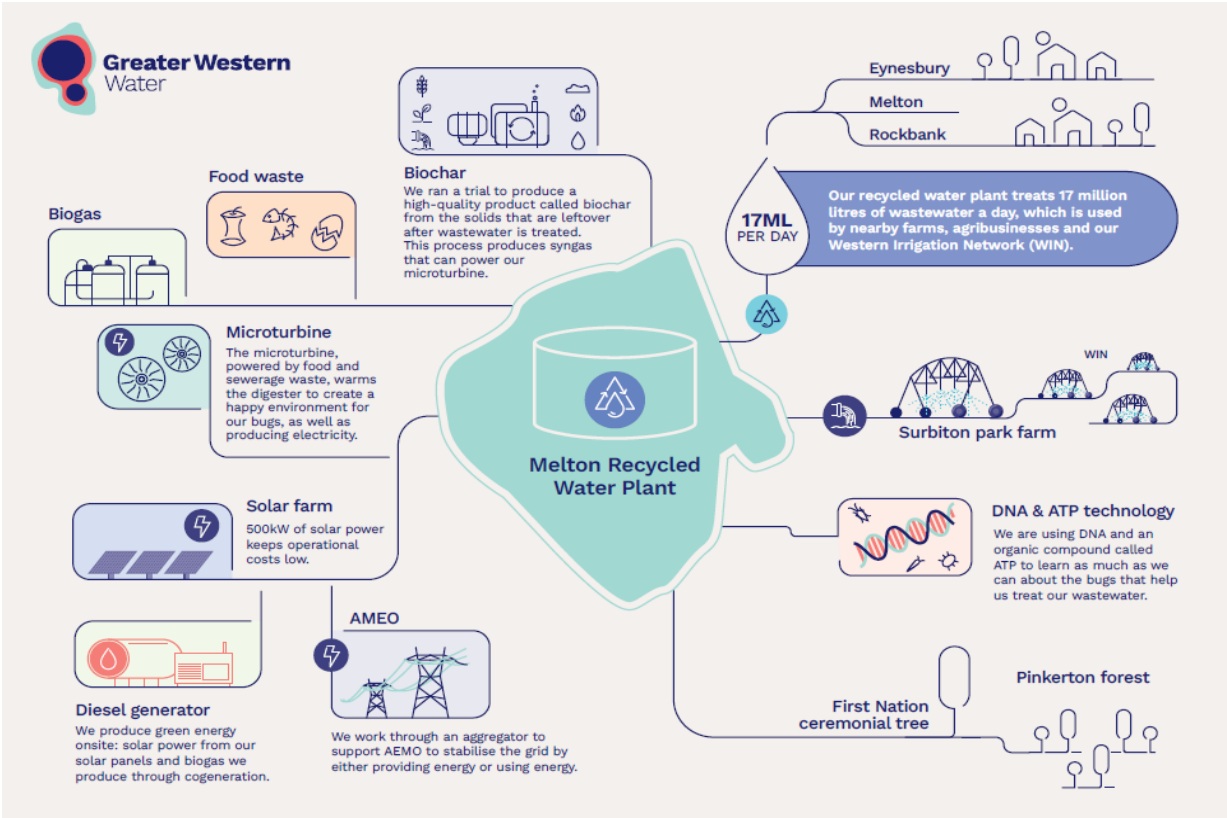
- Opportunities for unregulated revenue are becoming more attractive amidst rising operation costs and commitments to maintaining stable bills for customers.
- Need to bring the staff along the journey, looking to address the disparity in their knowledge about the project and the benefits.
- The fast growing and changing waste profiles of GWW's western growth regions are driving the need for upgrades and augmentations to plants faster than estimated asset end of life, the need for improvements provides opportunities to enact a shift to circular economy enabled technologies.

Barriers

- Realising circular economy outcomes may unlock some opportunities for unregulated revenue. However, any unregulated revenue must be appropriately ringfenced from regulated businesses. This may impact some of the efficiencies and benefits you can realise (for example having a separate waste to energy plant rather than integrating into the current plant may lead to more cost and lost opportunities in efficiencies). Hence these benefits and costs need to be outweighed with the potential revenue opportunity.
- Needs a champion – particularly in areas of the business that are resistant to change. The champion needs to come from these sections. The champion assists in bringing everyone in the business on the journey.
- Water businesses are very technical, with people having strong expertise in their subject area, however the broader knowledge about GHG emissions and electricity generation requires uplift. Training needs to start from the ground up, to bring the entire utility on the journey. GWW is establishing capability through a Carbon Busters working group to increase knowledge and connections across the organisation. The business is also increasing education regarding carbon to make better decisions.
- Regulation challenges, CE opportunities such as biochar are still currently unregulated, without a guaranteed opportunity to recapture costs.

Overall benefit

Increased unregulated revenue, improved environmental outcomes and lower business costs.



Insights

- The projects were initially pitched to the Exec and Board as trials – putting a toe in the water, not buying the whole farm. In that way a failure is still a success because it teaches you something. A full-blown business case is challenging in a conservative sector. The best approach is a trial and the use of clear KPI's to support and develop the business case.
- There are a lot of good people in water businesses, and there is a need to develop their skills.
- A failure is not a failure, just something you never knew. It is important to share, collaborate and learn from your neighbours.
- Utilising necessary business needs and changes to drive shifts to CE opportunities, increases likelihood of uptake and provides potential efficiencies.
- Customers showed, through price sub engagement, a preference for local solutions when reducing environmental impact.

Diagram displaying all circular economy projects currently underway at GWWs Melton Recycled Water Plant. These projects are: Treatment of 17ML per day of wastewater, which is used at nearby farms in the western irrigation network (WIN) including Eynesbury, Melton, Rockbank and Surbiton park farm; Use of DNA and an organic compound called ATP to learn about the bugs used to treat our wastewater; providing water to a first nations ceremonial tree as well as Pinkerton forest; Energy opportunities including electricity grid load balancing, production of green energy through solar panels and biogas produced through cogeneration with food waste and a microturbine to produce electricity and provide heat for the co-digestion process. End description.

Centralised Biosolids Facility (Hunter Water)

Context

Hunter Water has plans to construct a new centralised biosolids facility to divert sludge otherwise treated and discharged to the ocean and riverways. The project was advanced and ready to go to community consultation when the NSW EPA released new information as part of a regulatory change process that includes potential new contaminant and metals limits (including PFAS), which advanced the expected regulatory timeline by 10 or more years. While the business case outlined an adaptive planning approach that provided for a pivot to alternative technologies if needed, the potential changes may also impact the preferred location of the site and system configuration. The initial site location considered access, geography, spatial constraints, effluent colour caused by nitrogen byproducts (which may impact recycled water schemes). Consequently, a review of the business case is underway.

Drivers and enablers

- Approaching biosolids treatment capacity at treatment plants – servicing population growth and mitigating regulatory and end-use market risks.
- Sustainability – reducing energy use and GHG emissions and maintaining circular economy.
- Risk management – done well as an industry, with Australian water utilities proactive in learning, understanding & managing.
- While Australian environment regulation is relatively stringent, water utilities have been using risk assessments that may go beyond regulations to manage risks, including end use market risks.
- ANZ Biosolids Partnership (under AWA banner) working on case studies of benefits of biosolids.

Barriers

- Internal inertia for Circular Economy – maintaining the status quo is often viewed by internal stakeholders as the easiest and cheapest option
- New and immature markets – there is a need to engage and build a market at the same time as building a product
- Working with local councils is challenging as they generally operate independently with different constraints and drivers; site footprint, commercial risk, different timeframes, pre-existing contracts. While engagement gives a broader and more positive impact there is a tension between the outcome, project timeframes and meeting SDG commitments, addressing commercial risks and meeting government CE commitments.
- Regulatory unknowns – changes in policy, regulation, or community expectations can change

infrastructure requirements and investment timeframes significantly.

- Scalability of thermal technologies such as gasification and pyrolysis for biosolids treatment (in terms of what can be manufactured) is a challenge that's yet to be overcome.

Insights

- A role was created after a business level recognition that there was a need for a specific procurement role to devote to innovative & emerging opportunities and getting them approved
- Producing CE business cases can take a lot of time, and uses different skills to those for Research & Development
- The decision of regulatory bodies is less important than their stability & predictability – utilities need to know what changes are coming and that they will be retained for a reasonable period in order to best prepare and make investment decisions.

Spoil Reuse (Icon Water)

Context

Icon Water often uses hydrovac vehicles while repairing and maintaining Canberra's underground water and sewer network. This is done to not disturb gas, electricity, and other underground utilities. However, this results in the excavated material becoming a wet slurry which cannot be put back into the trench because it isn't structurally sound. Icon Water Environment and Sustainability team worked with regulators and field crew to develop processes and infrastructure to dry, test and sort the spoil, and then safely reuse it in other Icon Water excavations.

A trial was first conducted internally along with the help of the network maintenance team, engineering team and civil contracting firm while bringing EPA along for the journey which included going to the field, setting up processes, assigning responsibilities to different teams, and working collaboratively. Once it was confirmed that the project was a success it became a part of day-to-day operations.

Commerciality

Icon Water worked with regulators to develop processes and management infrastructure that enabled the drying, testing, sorting and eventual reuse of this material for other excavations. A pilot study demonstrated significant efficiencies and savings, with a saving of $98,000 in disposal costs over a 6-month period. This initiative contributes to a sustainable, circular economy in Canberra and the region.

Drivers and enablers

The driver of this project was to enhance circular economy principles, reduce waste transportation, reduce use of virgin materials along with financial savings. The wet slurry was being sent interstate leading to high transportation costs and Icon Water were ultimately buying soil leading to high procurement costs despite having a product which could be used again if stored and processed properly.

It was a mix of both financial and environmental benefits. As a custodian of the ACT region's water supply and wastewater treatment services, Icon Water has an important role to play and are very committed to sustainability as reflected through the business's core purpose - to 'Sustain and enhance quality of life'.

Stakeholder engagement

The Environment and Sustainability team worked closely with the network maintenance team (who would use the product in their day-to-day operations), engineering team (who helped to develop a product which met strict engineering requirements) along with the civil contracting firm and EPA to develop clear sorting and testing protocols and improved excavation to avoid contamination of spoil with foreign objects.

Barriers

The spoil is very wet, and the drying process proved a bit tricky to develop due to how cold winter temperatures are in Canberra. But ultimately it was understood that keeping it simple was the best solution. Hay bales and recycled crushed concrete were used to help dry the soil as much as possible coupled with an onsite sieving operation. Onsite sieving is a simple and cost-effective tool, that enables large throughput of semi-wet soil, and removes undesired materials from the soil leading to a less contaminated end product.

Overall benefit

Icon Water has a circular economy plan which emphasises the need to measure, engage and reduce its resource use and waste generation. This project is a great example of the principles laid out in the plan. It led to better communication across internal teams, improved data capturing, and enhanced process controls which were beneficial to not only internal operations but also helped form stronger relationships with both ACT and NSW EPA's along with financial benefits.

Insights

1.	Importance of communication and collaboration
2.	Keeping it simple
3.	Don't be afraid to fail.

The project was successful, but Icon Water is taking the next step in further reducing the need for virgin products. They\

have just recently started with a trial which will combine different end products from the company's operations (spoil from Fyshwick Sewage Treatment Plant and agri-ash from Lower Molonglo Water Quality Control Centre, along with water treatment solids from water treatment plants) and compost produced from food organics and garden organics (FOGO) collected from green bins in and around Canberra, to make a better soil product which would eliminate the need to procure topsoil again resulting in resource recovery along with financial savings.

The project is definitely scalable beyond Icon Water. It may depend on the exact operations of the organisation if they can use it internally or give it to other parties, but it can be done.

Low carbon roads (Lake Macquarie Council)

Context

Lake Macquarie is the region worst affected by coal-ash pollution in NSW, with two of the four coal-fired power stations that remain operational in NSW located on the banks of Lake Macquarie. These power stations generate a combined 1.9 million tonnes of fly ash per year, with 60 million tonnes sitting in dams located at the power station sites (Paul Winn, 2020, Out of the Ashes II, p iv-v).

Hunter Water, Edge Environment and Sustainability Advantage and Lake Macquarie City Council collaborated to create a tool for low-carbon emission road projects in 2011 (https://www.lakemac.com.au/files/assets/public/v/1/project-files/circular-economy/lca-comparison-roads-tool-oct2021.xlsm). The tool, co-funded by Hunter Water and the NSW Government, indicates the impacts of materials used when building new roads and infrastructure. The low-carbon road project tool allows users to input mix options and percentages for calculation. The tool included output calculations of associated electricity for the production and waste processing of specific mixes, transport emissions, lifespan of design, recyclability at end of life and cost. The tool calculates carbon emissions for project options, including a carbon emission offset cost. This is useful for engineering and procurement teams to evaluate options for projects to inform procurement decisions to meet environmental strategy targets.

The Lake Macquarie Local Government Area has a long history of circular economy product trials in road and infrastructure projects. Council has trialled circular economy enabling products in projects that involve road and pathway mixes with recycled glass, concrete, post-consumer tyres, toner, plastic, and high fly ash content in concrete.

Drivers and enablers

- Across industry support, partnering with universities, Hunter Joint Organisation, government and water utilities.
- Pre-existing tool (eTool by Cerclos) as a granular life cycle assessment software and comprehensive carbon management software to create and support business cases with less resources.
- A group within the business that focuses on innovation and circular economy.
- Policy change that requires a 2:1 replacement for any trees felled helps increase the economic business case for permeable materials
- Aligns with Environmental Sustainability Strategy for 2020-2027, which demonstrates alignment to Lake Macquarie Council's values and to UN SDG's. In particular this case study addresses their commitments.
- Maintain >57.5% vegetation cover in the city.
- 57% reduction in City-wide per-capita & total Council GHG from 2007 baseline.
- Divert 75% of waste from properties serviced by Council away from landfill.
- Increase the number of businesses in the region involved in Circular Economy manufacturing, design, reuse, repair & recycling of materials by 20% from 2019 baseline.

- Cross-industry pilot project, partnering with universities, the Hunter Joint Organisation, local and state government and water utilities.
- Third-party, cloud-based tool (Planet Price) as an organisation-wide emission and planetary boundary calculator. This program uses procurement data and artificial intelligence to perform top-down and bottom-up analysis of Council supply chains, identifying large emission-generating components of Council's supply chain, and quantifies the collective impact of these. The use of this software allows Council to estimate a baseline of the current emissions produced from its supply chain within different industries such as concrete and asphalt. The outcome of the emission data analysis by industry confirms the investment in resources and trials within Council to reduce overall supply chain emissions.
- Third party, cloud-based tool (eTool by Cerclos) as a granular project life cycle assessment (LCA) and comprehensive carbon management program. This is being used to create and support business cases for the substitution of business-as-usual (BAU) products with recycled and/or low-emission products, or reduction of resources through design.
- Steering committees, teams and groups within Lake Macquarie City Council that focuses on innovation, net zero and circular economy.
- Traditional concrete pathway installation can impact the structural zone of tree root systems of nearby trees. The impacted roots and tree must be removed for installation of a concrete pathway. An update to the tree replacement policy increased the minimum replacement for a tree removal. Tree replacement costs therefore increased, resulting in the consideration of alternative pathway products that are flexible and permeable which allow for the retention of trees and allow movement of the root systems. Most of the permeable and flexible pathway mixes are made with granules derived from recycled tyres or plastic, which results in an increase in circular products in projects.
- Aligns with Environmental Sustainability Strategy for 2020-2027, which demonstrates alignment to Council's values and to UN SDGs. This case study addresses and responds to the commitments in the Environmental Sustainability Strategy 2020-2027 including:
    - Strategic Theme 3: Creating a sustainable city and communities.
        - 57 per cent reduction in city-wide per-capita and total Council GHG from 2007 baseline
    - Strategic Theme 4: Responsible consumption and production.
        - Divert 75 per cent of waste from properties serviced by Council away from landfill
        - 100 per cent of Council tender specifications include recycled, reused and sustainably sourced products, where a functionally and economically viable alternative to new materials is available.
        - Increase the number of businesses in the region involved in Circular Economy manufacturing, design, reuse, repair and recycling of materials by 20 per cent from 2019 baseline.

Barriers

- Evaluation, monitoring, and documentation:
  - Evaluation, monitoring, and ongoing documentation of circular economy trials has previously been a challenge. Circular economy information and outcomes of trials and products previously relied primarily on verbal communication between staff. Council has implemented a process moving forward that includes a trial scorecard to assess the performance of the product against business as usual, trial monitoring schedule and an ongoing log of circular economy trials conducted to enable an overview of various trials.
- Emission calculations:
  - The carbon emission calculation of products is trailing in comparison to the rapid increase of innovative new low-emission and recycled content products in the market. The consideration of procuring circular economy products with claimed environmentally friendly, low-emission or recycled content materials without third-party endorsement of these claims and calculations can result in green washing. Environmental Product Declarations (EPDs) are a source of truth for carbon emissions and environmental impacts in products, to which organisations and businesses procuring materials can refer. EPDs involve an extensive process of the whole lifecycle calculation of the product to have an associated carbon emission. EPDs are costly and can take a large amount of resourcing to achieve a calculation in supply chain carbon emission. Council uses software to estimate certain materials without EPDs and the product's associated emissions compared to business-as-usual product emissions.
- New material and product risk and cost benefit analysis:
  - The adoption of new materials, products or process involves a level of uncertainty and risk. The business-as-usual materials are proven to perform well and to expectations due to repetition of using the products or mixes over many years. With new products entering the market with limited trials and case studies, the product poses risks associated with performance and lifespan in projects. The ownership of the risk for trialling or imbedding new products or materials in a project can become a barrier to using new innovative circular products.
  - Some circular products can have higher upfront capital costs compared to business as usual products. This can influence existing procurement strategies and weighting of considerations in project tenders which can decrease circular product adoption.

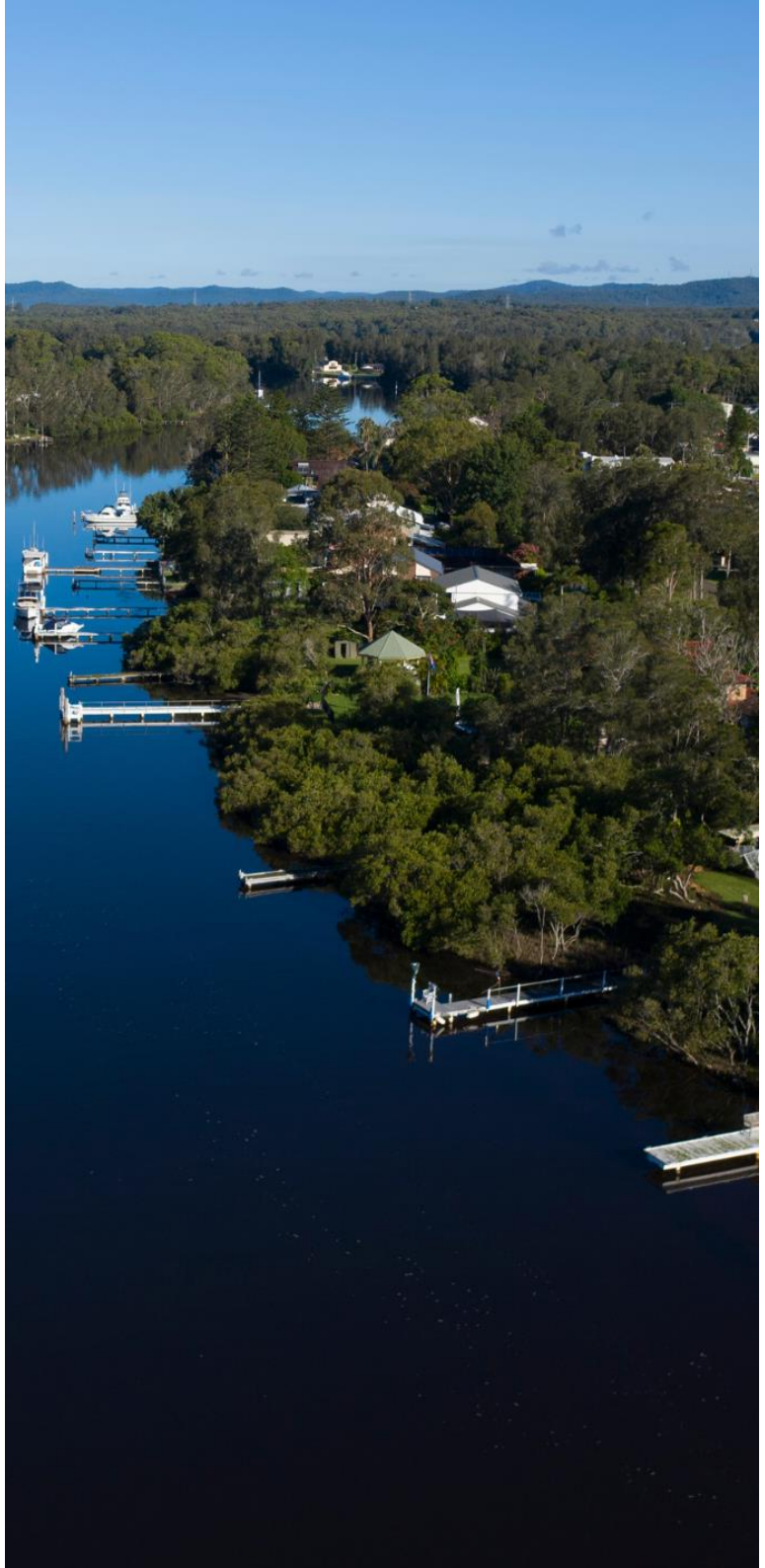
Overall benefit

- Reduces waste to landfill by redirecting waste resources into products and material for reuse.
- Reduces the volume of fly ash in dams by diverting the fly ash into concrete mix products among other materials.
- Reduces Council's carbon emissions due to supplementing material in traditional concrete and asphalt that have large material embodied carbon.
- Enables competitive local markets to establish low-emission and remanufactured products and localised solutions to waste.
- Reduces stormwater runoff, retains mature trees and root systems by installing permeable and flexible recycled content plastic or tyre crumb pavement products around trees and over root systems.

- Increases uptake in recycled content in Council projects, including post-consumer waste or by-product waste from industry.
- Informs circular economy procurement decisions of other organisations and businesses through the increased awareness and documentation of Council's trial case studies through the Hunter Circular Hub.

Insights

- Communicating with facts and figures provides a common language across the organisation to various groups including engineering teams.
- Transforming business case studies for projects from a capital cost analysis to a project lifespan and associated maintenance cost analysis enables longer term thinking and investment decisions. Circular products can have higher capital costs and investment, however the lifespan of the circular project elements and reduced maintenance required make circularity options economical.
- Communicating the specific benefits of circular products including road and footpath products that enable water permeability, stabilisation of unsealed areas, reduction of tree root impact and, by extension, the retaining of mature trees by using products derived from recycled content. The specialisation of circular products creates business sense for project environment suitability.
- Demonstrating the power of measurement of carbon emissions including the reduction in carbon emissions of products and mixes frequently procured. A scenario of road and infrastructure pavement mix options of varying circular economy elements were calculated from a cost, lifespan, environment suitability and carbon emission saving.
- Collaborative approach to creating achievable and measurable circular economy projects and action plans resulted in better outcomes and momentum to embed more circularity in future projects in teams rather than a consultation approach.



CE portfolio for the West Wodonga STP (North East Water)

Context

West Wodonga treatment plant has been developed into a circular economy hub. The project is developed around the intention to achieve net zero for scope 1 and 2 emissions, which has led to the reNEWable water portfolio, comprising of 9 distinct project components (Figure 1). The initiative is part of the regional masterplan for 2050-70, covering climate adaptation, mitigation and net zero carbon.

The key aspects include:

- Everything coming to site is reused and brings in unregulated revenue.
- Running biochar trials with solids materials containing PFAS, which are showing promising results.
- Undertaking biochar feedstock trials through a joint project with IWN and Gippsland water.
- Seeking to reduce energy consumption by 42% through the harvesting of methane from covered anaerobic lagoons. The plant has separated municipal and trade waste to generate energy for the plant overnight and produce excess biomethane. The excess is put into tube trailers and taken 2km up the road to be used in the boilers for a local manufacturer (Mars). Both organisations are able to claim ACCUS, and NE Water is also able to generate revenue. The initial driver for this component were the carbon goals of each organisation.
- Solar, NE Water have built 3MW of solar which goes into the plant. About 50% of the electricity generated is used on site, the rest is exported to the grid and used to power all NE Water Sites.
- Partnering in building a hydrogen generation plant. The value of hydrogen is maximised by having the production plant on site, which requires RO level water treatment, and the plant also uses the oxygen generated from the hydrogen plant to help digest organics and generate methane, which then puts more energy back on the grid and provides more biomethane for Mars. The hydrogen is injected into the national gas grid as green hydrogen gas. The intention is to generate 25% of green gases from hydrogen and biomethane. There is also the option of supplying the hydrogen to Mars Petcare.
- Discharged water from the West Wodonga treatment plant goes to the river, what is discharged to the river is extracted downstream and provides return flow credit under bulk entitlements. This is covered under the current Victorian Government rules which Goulburn Valley Water, Coliban Water, and NE Water are following. In drought this adds to bulk entitlements which are able to be sold on the open market, becoming part of high reliability shares.
- Solid waste acceptance – building a biochar plant that will take FOGO and NE Water waste to generate - heat, gas and energy. NE Water also grows 500T of lucerne a year, which helps reduce the powdered activated carbon demand. Enabling the manufacture of PAC equivalent material on site as an alternative feedstock through the biochar process.
- About to announce an $80m biomethane plant upgrade.
- Biochar trials are currently underway with a permanent installation to be expected to be operational by 2026-27

Additional partners - Wodonga TAFE and Victoria Uni, who are looking to work with NE Water as a circular economy training hub. The West Wodonga STP will be the first hydrogen plant built on an STP, and the largest in Australia.

Figure 1: reNEWable portfolio

KPI's are currently being developed to ensure success, particularly in relation to biomethane, renewable energy and biochar.

Commerciality

Seeking commercial cost recovery for all areas. The primary area requiring additional funds is Biomethane production and use and waste oxygen utilisation within the WWTP process, which is looking to be supported by a grant from ARENA.

Drivers and enablers

- Renewable energy – exposure to wholesale market and virtual net metering.
- Hydrogen – working with a partner in AIG and funding from ARENA.
- Biomethane – started with meeting the need for additional energy at night, to reduce costs. The project essentially paid for itself on that basis, it also significantly reduced carbon emissions. In addition, taking a proactive approach working with local businesses a need was identified for methane gas by Mars and Wodonga Rendering, and in providing this mechanism there was a way to form a circular economy solution by taking their trade waste and providing methane, and sharing in carbon credits for the mutual benefit of all parties.
- Biosolids – the rise of emerging contaminants of concern such as plastics, the improved treatment processes assist with the effective disposal of these materials.

Barriers

- Ensuring that the quantity of energy delivered back to the grid to allow an effective commercial arrangement, and 1-3 MW is a tricky size for AusNet services to manage and plan for. Needed pre-approvals for all aspects locked away prior to getting the project running. An area of concern was the electricity grid provider's trust in SCADA, it took some convincing that SCADA was equivalent to a direct ethernet connection, which would have needed to run over more than 5 km driving elevated CAPEX costs.
- Biochar and EPA – no issues with waste codes, rather it is in the interpretation of waste codes and the implications/interpretation regarding selling to the market, this is a new space and need a collaborative approach.
- PAC – needed to get the Department of Human Services comfortable with the end product and will require significant QC.
- Biomethane – There needs to be better methods under the CER to support these types of projects to generate ACCU's
- Hydrogen – still in the learning phase and looking to understand the value. Looking at ARENA funding to confirm the oxygen injection approach, particularly the system and equipment.

Overall benefit

Reuse of all materials that were previously seen as waste from the wastewater treatment plant, additional revenue generation, minimisation of environmental impacts, and net benefit to the local community. What was a wastewater treatment plant is now a resource recovery precinct.

Insights

Just make a start on a project. The more people hear that you are doing something it starts to attract others. Commencement demonstrates understanding and initiative. NE Water now have 5 hydrogen businesses approaching because they know NE Water have an understanding of the opportunity and understand the issues.

Do you think the project is scalable beyond your organisation? Yes. There are spots where the scale is worth the investment based on critical mass. Essentially the project needs enough energy, land, biosolids, water etc. It is also good to have showcases and create circular economy hubs within the system.

Recycled Glass Sand for Pipe Embedment (SA Water)

Context

SA Water appointed a circular economy specialist in early 2022 to assist in embedding circular practices across its business. An estimated 70% of SA Water's waste is generated from key business functions; residuals from water treatment, sludge from wastewater treatment, spoil from network excavation activity and construction and demolition waste. The remaining waste is made up of smaller, but significant volumes of solid waste that includes office materials, plastic bottles and containers, PPE, lab supplies, hard hats and much more. This case study outlines the use of crushed glass as a replacement for sand.

Crushed Glass Sand Case Study

SA Water is trialling the use of crushed glass as a replacement for sand in the pipe embedment process. The crushed glass sand is made through the re-processing of inert glass material that would otherwise be sent to landfill. It is originally sourced from residual materials recovery facilities from household kerbside yellow bin sources (food and beverage containers) and other glass including window glass or glass free from e-waste/hazardous waste.

SA Water has been working with a waste contractor to provide suitable material that meets its technical standard for pipe embedment material that includes the products chemical and physical characteristics. The material has a very similar consistency to sand and is collected, processed and supplied to SA Water under certified AS/NZS ISO 9001 Quality management systems.

Use of this material reduces low value glass waste to landfill and preserves raw/natural materials. Green Industries South Australia and the South Australian Environment Protection Authority support the reuse of industrial waste in commercial activities such as construction and civil work.

SA Water is working through several circular economy projects, and whilst the majority are in relation to the management of waste materials, they also cover the areas of circular procurement and sustainable infrastructure.

Commerciality

- A waste audit conducted in 2021 suggested that the business was spending millions of dollars each year on waste disposal, providing opportunities for cost and environmental savings.
- While there are research funds available at SA Water, the majority of circular programs operate by aligning with operational business units and using their capital to achieve the sustainable/circular outcome, and then any savings from that initiative are delivered back to operations.

Drivers and enablers

- The SA Water Environment Corporate Strategy (2022) includes a target of net zero waste production by 2040. The Strategy includes steps to achieve this.
- The Waste Audit conducted in 2021 adopted an approach whereby SA Water staff and partner organisations were consulted to establish and quantify the waste streams and management costs across both metropolitan operations and the 30 or so regional depots.
- A sustainable product procurement tool in the form of a spreadsheet: this lists over 260 products containing recycled content from approx. 100 suppliers that could be considered as alternative products to what is currently being purchased. It includes performance specifications with a traffic light system for performance and encourages users to iteratively build on the information in the spreadsheet as the products are further investigated for purpose or used by the business.
- Green Industries South Australia (GISA) who are responsible for promoting and supporting the Circular Economy in SA.
- SA Water is a government department and so is strongly influenced by government policies – national waste strategy for sustainable procurement, policy changes in waste strategies.
- Chief Executive driving a culture of continuous improvement and SA Water viewing circular economy as an integral component.
- District leaders travel and meet in Adelaide on a regular basis, this assists in driving cultural change at the regional depots, and an opportunity to be part of smaller-scale recycling programs (e.g. PPE, hard hats, plastic containers)
- A statewide ‘stores’ delivery system for regional depots that enables the backloading of materials that can’t be recycled locally

Barriers

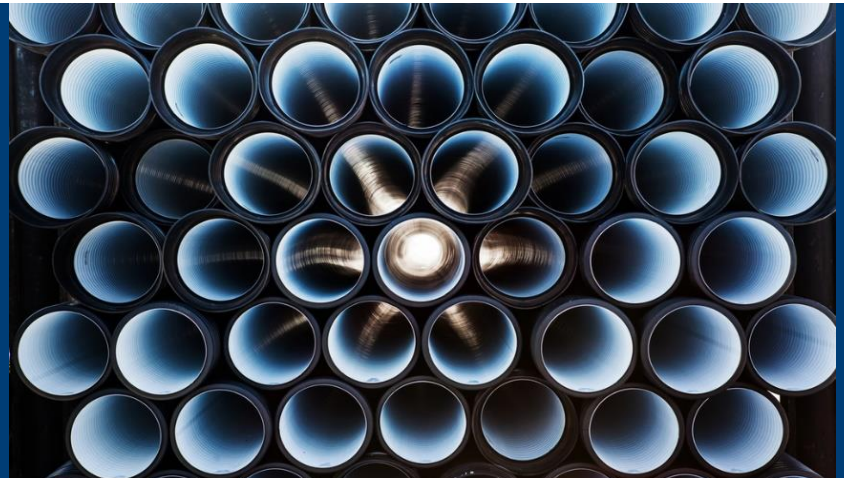
- Obtaining supporting information from suppliers to ensure a product meets technical specifications, standards, and quality assurance (not just lab results, but proof of scaled product consistency). Where there is no historical performance evidenced, the confidence of adopters could be limited. This is primarily a people/culture/accountability-based challenge.
- Resourcing. To identify and procure alternative products it requires staff's time, which is a challenge across the water sector generally
- Regional depots operate differently to metropolitan facilities, so the solutions quite often need to be tailored to fit.

Overall benefit

- Local job creation by diverting material from landfill into reprocessing and manufacturing jobs; operating a landfill requires a smaller number of staff when compared to a crushed glass recycling facility.
- Encourages recyclable materials to be recovered and diverted from landfill.
- Working towards net zero waste production.
- Develops the Circular Economy in South Australia. Creation of markets for recycled materials.

Insights

- Savings in one project can be a catalyst for broader organisational awareness of Circular Economy – SME's initiate the project, engineering team delivers, finance reports savings upward, and reaches executive level who engage communications team to advertise the good-news-story.
- Having good baselines and data is essential for proof-of-concept for Circular Economy projects



Integrated water at community-scale and functionalised biochar (South East Water)

Context

South East Water has shared 2 circular economy projects:

1. **Aquarevo – a leading integrated water and energy housing development**
    - Created in partnership with developers, houses have been equipped with a unique rain-to-hot water system for bathing; Class A recycled water from an estate treatment plant (in progress); solar panels and battery – all monitored remotely for quality and performance.
    - South East Water retain 1 demonstration house in this development to implement trials or demonstrate successful reuse programs in the home.
    - Each house in the development has 3 separate water supplies; treated recycled effluent, mains, rainwater treatment. There are easy switches between them that are monitored with OneBox®, so taps will never run dry. The outcome has led to some houses using up to 70% less of our precious drinking water, making greater use of the readily available rain and treated recycled water.
    - Perhaps the greatest learning and the key to success in this estate has been the use of digital and IoT technologies for real-time monitoring and control, so that the supply to each house is maintained at the fit-for-purpose quality and performance.

2. Functionalised biochar

- Disposal or end-use applications for biosolids is becoming increasingly difficult for water utilities such as South East Water
- In collaboration with RMIT University (inventors of pyrolysis technology), Intelligent Water Networks and other Victorian water utilities, South East Water has worked to develop and begin to scale technology that can safely convert biosolids into useful biochar.
- Currently being validated, the technology destroys contaminants, including PFAS.
- The goal is a thermally neutral process that produces high quality biochar using unique fluidised bed technology for good heat transfer and product quality.
- Various applications for the biochar include batteries, soil enhancement, construction, roadways, etc.
- Focus from RMIT is on scale-up and higher value applications and end-uses (more than applying direct to land)

Commerciality

- South East Water's wholly owned subsidiary, Iota, incubates, commercialises and attracts global partners to scale, innovations developed or proven at South East Water.
- South East Water has a proud legacy as an innovator in the global water industry and so is an ideal place to prove the feasibility, viability and desirability of innovation. Hence regardless of where the technology comes from, it must be 'proven at South East Water' before Iota will commercialise.
- Some technology can be licensed to industry relatively early in its journey while others need to be converted into products, with Iota selling directly to early-adopter customers and through partners.
- Ultimately Iota builds value in the technology with a view to transfer to industry at the optimal time in order to accelerate its uptake and return value to its owner, South East Water.

Drivers and enablers

- South East Water operates in partnerships to deliver these initiatives. South East Water doesn't possess all the necessary skills to deliver such complex circular economy projects. Both the Aquarevo and biochar initiatives engaged partners with capabilities to deliver the broader program (e.g. Villawood – housing developments, RMIT University – pyrolysis expertise).
- At times, university and federal grants are used to support the base research behind these initiatives.

Barriers

- Organisational energy is usually tied up in existing business as usual, and getting focus on CE can be challenging when it's competing with simultaneous priorities.
- Capacity to deliver projects is the limiting factor. Research at South East water is plentiful, but the translation and scale-up takes a lot of time and effort. In most cases, dedicated project teams and people need to be taken 'off-line' from BAU to focus delivering the new initiative.

Overall benefit

- Fosters collaborative industry innovation culture
- Working ahead of the market to ensure value of product into the future

Insights

- Good ideas with strong business cases attract funding, even if initially the funding source is unclear.
- Technology and engineering aren't that difficult, it is the understanding of the waste industry; economics, business model, transport, new jobs, job types. It's not a static industry and determining whether a project is economically viable requires a lot of information and buy in from the industry players. This can be a slow and difficult process which depends on the level of engagement with the commercial customer based, their priorities and other competitors in the market.
- Solutions aren't a one size fits all, even within the same business. Studies need to address geography, waste composition, and scale which are varied across the organisation.

Wianamatta Circular Economy Precinct (Sydney Water)

Context

Sydney Water (SW) is building a circular economy portfolio that spans water supply resilience, net zero carbon emissions, natural system regeneration and circular material use. A flagship project that encompasses all these outcomes is the Wianamatta Circular Economy Precinct (the Precinct).

The Precinct comprises three elements;

1. **the central element and catalyst of the precinct is Sydney Water's 28Ha Upper South Creek Advanced Water Recycling Centre (USC AWRC), which includes a 4MW solar farm.**
2. **40 hectares of greenspace (Greenspace) which is planned for biodiversity regeneration in line with the vision of Tradition Custodians.**
3. **A 12 hectare circular economy zone (CEZ) for co-location of eco-industrial enterprise that has synergies with the USC AWRC and a thematic focus on recycled water, organic waste, bioenergy, nutrient recovery and carbon abatement.**

This development is vital to Sydney Water delivering their vision of a better life with world class water services to the Western Parkland City and beyond. Sydney Water's goal for the CEZ is the creation of a thriving eco-industrial centre enabling innovation, industry collaboration and the commercialisation of circular products and services, in water, energy, and bioresources. It will leverage synergies with the AWRC to become an efficient, competitive partner to industry, whilst also contributing to a reduction in SW's carbon footprint, supporting their drive to Net Zero carbon emissions.

The CEZ is being developed in line with SW and the NSW Government's ambition to establish a circular economy in NSW. This precinct will demonstrate the benefits of embedding circular economy principles. Sydney Water have also considered ARENA's Bioenergy Roadmap and NSW Waste and Sustainable Materials Strategy. These reports have highlighted key challenges and opportunities for the precinct such as hard to abate sectors (industrial heat, transport, etc.) and emission reduction.

The project planning started in 2022. It is intended to be operational by late 2027.

The project began with an initial market engagement on a range of opportunities including;

- Organic waste to biogas (commercial & industrial foodwaste and residential FOGO)
- Liquid biofuels (particularly sustainable aviation fuel given the proximity to Western Sydney Airport)
- Industry such as protected cropping and meat waste rendering
- Hydrogen production (domestic scale)

Land-use opportunities such as those identified above were initially screened via pre-feasibility assessments that modelled the technical and commercial feasibility and mapped the industry partner needs. The finding of this modelling and qualitative assessment was then evaluated against an internal set of consistent evaluation criteria.

Following the individual assessment, several combinations were reviewed to determine any potential synergies and conflicts, to ensure that the precinct achieves its full potential. The statutory planning pathways were also reviewed to

understand any potential barriers or opportunities.

On completion of these assessments, there will be a final evaluation with internal stakeholders to identify the preferred option mix which will be recommended to the Sydney Water Board. This will be used to guide the market engagement and partnering phase. Shortlisted tenancy partners will be taken forward to detail planning, design, and commercial negotiations for implementation.

Commerciality

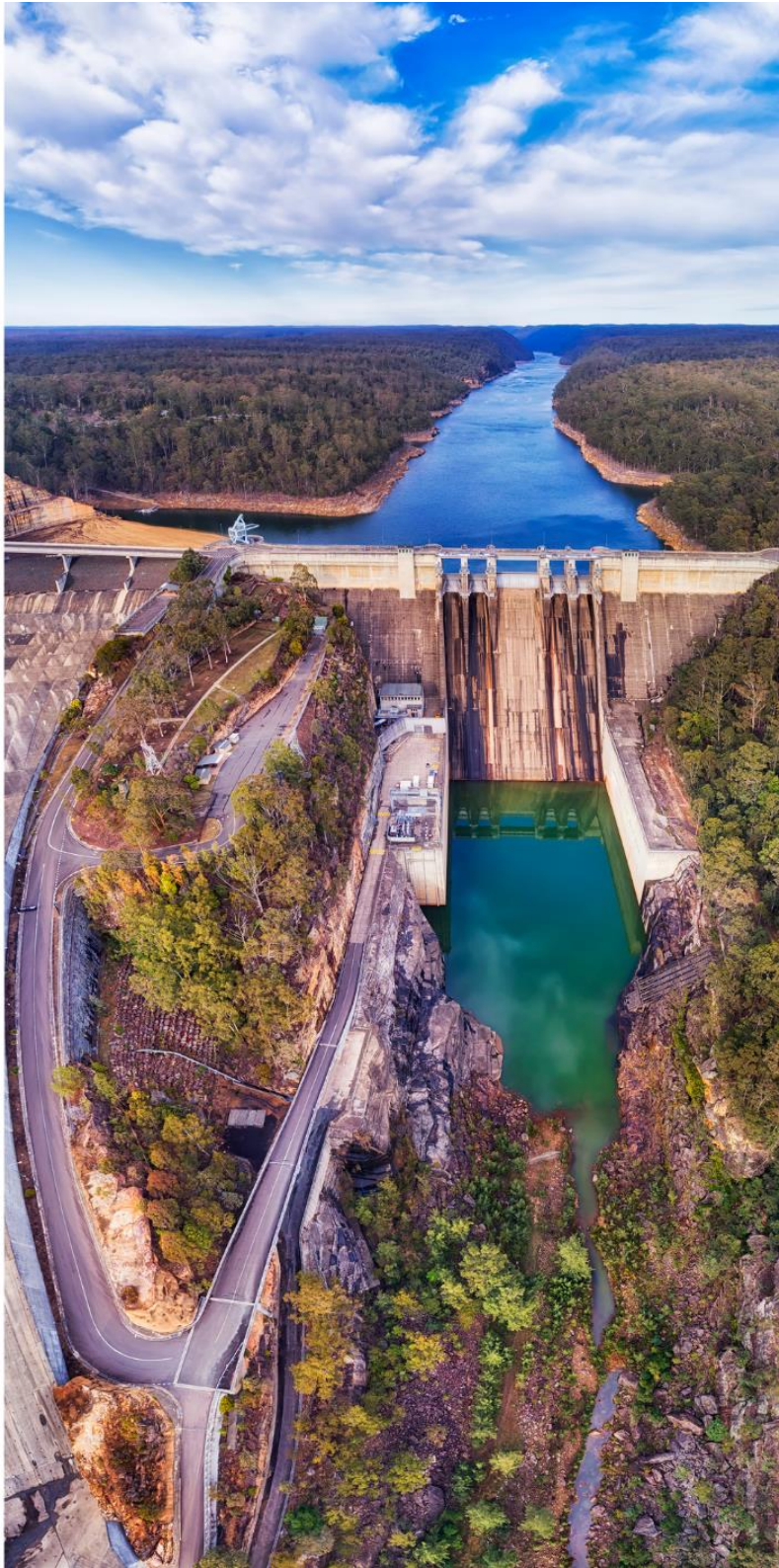
The CEZ will offer co-located industries access to mutual resources (biogas, biosolids, high quality recycled water, renewable energy). Its proximity to the new Western Sydney Airport and M12 freeway gives the site access to both the supply and demand sides of the market. These benefits position the CEZ to be competitive with surrounding industry developments.

The business model for the CEZ is yet to be finalised, however SW is focused on enabling the outcomes via a curated land lease approach. Key stakeholders and industry partners are being engaged to shape the CEZ before it goes to market, to ensure it contributes to their sustainability goals. This includes assessing a range of business models that are tailored to suit each individual stakeholder and opportunity. The models currently being assessed include partnerships, joint ventures, and a supply and offtake agreements model.

SW's revenue for the CEZ will primarily come from the land lease, waste processing fees and sale of products and resources such as biogas, recycled water, and heat.

Drivers and enablers

This project was driven and enabled by SW's early adoption of circular economy as a framework in its Corporate Strategy. It was further enabled by conceptual and thought leadership pieces published by Sydney Water such as "Unlocking the Circular Economy in the Western Parkland City" and networking efforts by individuals in the business. This process identified a range of opportunities and interested parties, and was followed by a rigorous technical and financial assessment of each opportunity. The financial and technical data combined with a multi-criteria analysis is being used to identify the preferred option mix for the hub.



Stakeholder engagement

Sydney Water actively engaged with a number of stakeholders using a variety of methods as follows:

- Government Bodies – (Actively involved - Councils) – partnering with a variety of Sydney councils to explore a range of potential solutions to manage their FOGO Waste.
- Industry Partners -Supply (Meat Rendering, Waste Aggregators) & Demand (biofuels, Meat Rendering, Glasshouse) – partnering with Industry to develop options that suit their needs.
- Urban Planners –to support the options mix assessment and development pathways.
- Government Bodies/Industry – (Supporting Roles) – Peak organisations such as Circular Australia have supported this project by acting as advocates and fostering relationship between Sydney Water and other parties.
- Regulators – Have been briefly engaged to clarify legislative positions, with a view towards more detailed engagement as the options continue to be developed.

Barriers

EPA legislation around Energy from Waste is currently presents a risk to viability of projects involving thermal treatment of organic wastes. SW's strategy to manage this risk has been early engagement with the EPA and NSW Planning representatives. If this avenue is unsuccessful, the approach is then to challenge the reasoning behind the legislation with a view to contest it based upon a lack of available infrastructure, the potential for flooded compost markets and the need for sustainable biofuels to support hard to abate industries as they attempt to reduce their reliance on fossil fuels.

Overall benefits

The project is expected to provide Sydney Water with:

- Reduction in carbon footprint, in line with business commitments towards Net Zero carbon emissions.
- Contribution to Sydney Water's and the NSW Government's goal of creating a thriving, liveable and sustainable Western Parkland City, by creating cost effective and circular services for water, energy and bioresources.
- Diversified revenue streams to ensure that Sydney Water remains a successful and innovative business.

Insights

It is hard to evaluate the long term success of the project as it is still in a planning phase. The project is currently on track, with a business case due to SW management in July 2024 seeking approval to progress to a partnering and detailed planning phase.

Early engagement with internal and external stakeholders is vital, particularly when you wish to create and leverage shared assets across facilities. If you fail to engage with stakeholders early and effectively, there can be fundamental differences in design approaches and philosophy which can result in significant time and money to resolve. This can be addressed by engaging broadly, early and with a clear purpose and targets, to ensure that the final concept is well defined for broader buy-in by all stakeholders. This will reduce the risk of costly and time-consuming redesign works later in the project.

An ongoing challenge has been managing the integration interfaces between the CEZ and the AWRC. The CEZ was separated early in the AWRC planning to avoid risking the time critical delivery of the AWRC. This decision combined with the private sector contracting model for the AWRC has created design integration and contractual complexity that could limit the full potential of the Precinct. If the boundaries were loosened to allow the development to be considered more as an interconnected facility, this could improve outcomes for the CEZ including reduced cost through economies of scale, however this could introduce trade-offs with contract complexity and cost. An example of this would be consolidation of assets such as stormwater basin or solids processing line, where combined approaches would reduce cost to each project and minimise land use allowing for the greatest value from the site.

Overall, the project model is scalable and transferrable across the water industry and other bioresource industries. There are examples of industry co-location with wastewater treatment facilities both in Australia and internationally. However, it is important to note that these opportunities are highly location dependent and are often rare rather than by design. A more proactive and intentional approach to identifying and designing industrial ecosystems is needed to catalyse a circular economy transition.

The circular economy precinct aligns with Sydney Water Corporate Strategic Goals. It will support the achievement of Net Zero carbon emissions targets and embed circular economy principles in operations.

Sustainable Water Schemes (Urban Utilities)

Context

Over 10 years ago, when Urban Utilities (UU) was operating as five separate councils, there was a need for a number of their Resource Recovery Centres (RRCs) to be creative in the ways that they managed reclaimed water. In SE Queensland regions, some RRCs have a “zero discharge license” which means they are not able to discharge treated effluent to the nearby waterways. Dating back as far as 40 years ago, there have been several sustainable water schemes in effect with nearby customers to manage this license requirement.

Commerciality

Many of the UU sustainable water schemes were initiated by the customers. They were seeking a lower cost, sustainable (ESG) and local option for their water supply needs. Often, they were willing to fund the infrastructure required for UU to supply them with sustainable water, which could then be used to facilitate other nearby sustainable water schemes. For other schemes UU directly approaches customers whose industry and location suit alternative local and sustainable water supply. This approach seeks to build the required infrastructure and recoup the costs over the long term. For regional RRCs, UU often provide the service for free as it helps achieve zero-discharge license requirements.

Six of the 26 RRCs are allocated to the Western Corridor Recycled Water Scheme (WCRWS). Under this scheme, UU provide treated effluent to advanced water treatment plants managed by Veolia, who are able to provide purified recycled water (PRW) back to Wivenhoe Dam for drinking, once commissioned.

Drivers and enablers

There are a number of drivers for this type of project. There was first the need to find an alternative pathway for treated effluent at some Resource Recovery Centres, rather than discharging to waterways, due to the zero discharge licenses. Then, there was the demand from customers for a cheaper product to use for irrigation; alternatively, some customers sought a product that had been treated by reverse osmosis, as mains water wasn’t suitable for their purposes. There was also a desire for a sustainable option to satisfy ESG targets.

More recent drivers include relieving strain on the potable water network to ensure water security (especially the commissioning of the WCRWS during the Millenium Drought), capitalising on existing sustainable water infrastructure, keeping water closer to home to ensure maximum value reuse (won’t evaporate being transported over long distances), and transitioning to a circular economy.

Stakeholder engagement

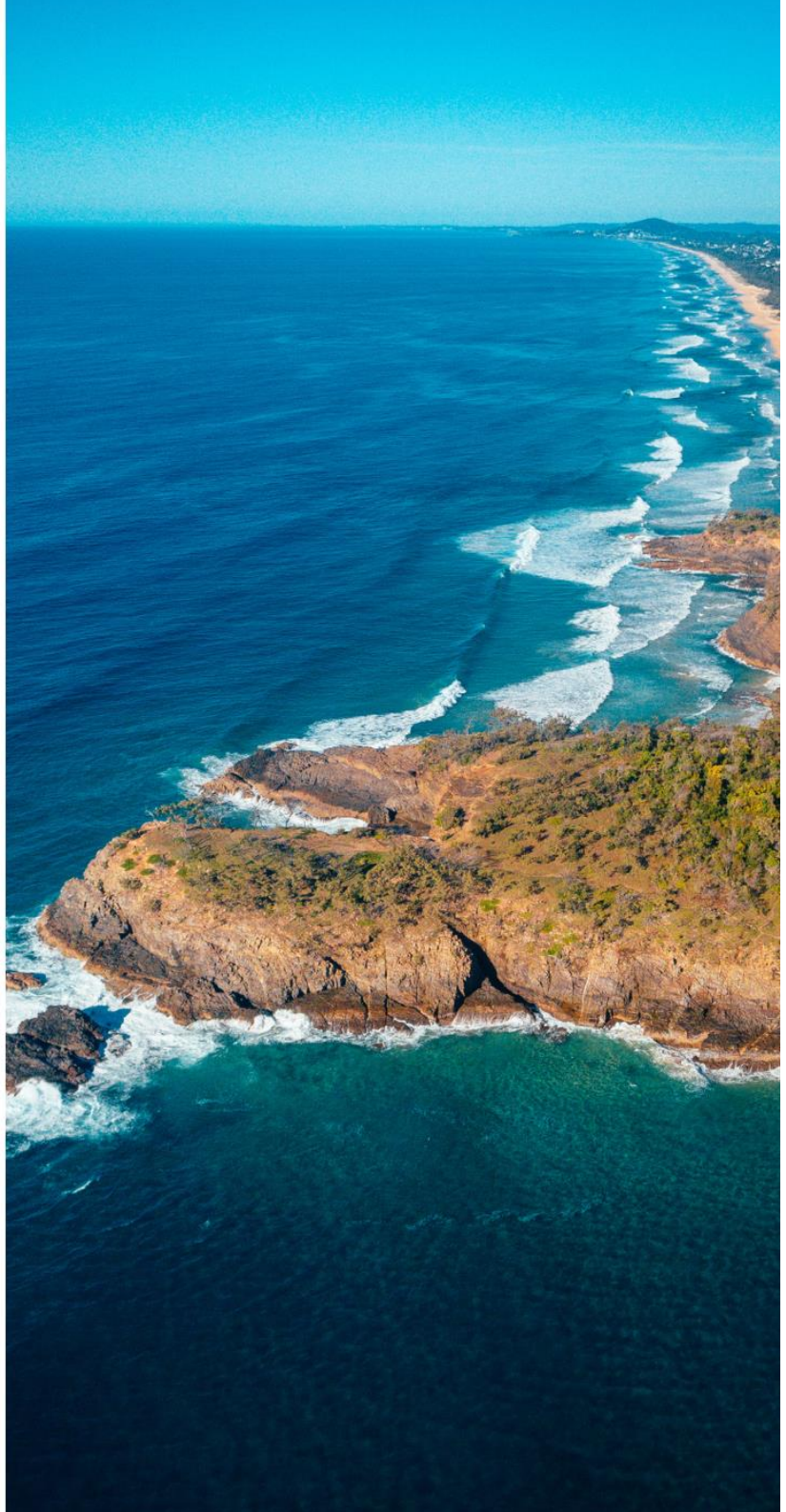
The main stakeholders for these schemes are the customers (industry, universities, golf courses, sporting fields) and the local councils. UU communicates with stakeholders and shareholders through designated stakeholder management teams, as well as key commercial account managers. Engagement with customers can be through customers approaching UU, or through approaching customers through incentives such as a cheaper and more sustainable water option. When customers approached UU, they worked to find solutions for those customers who

approached UU, although sometimes there were no feasible options at that stage. UU approached councils for support through drivers such as improving liveability, affordability and drought resilience of their communities. This is also a long-term strategy to enable inputs into land use planning, allowing for more efficiently designed hubs with sustainable water infrastructure already in place.

Barriers

There are a number of barriers that are encountered when considering expanding or adding sustainable water schemes. These include the location, dictating which Resource Recovery Centre would be a potential supplier. Leading to questions about whether or not the treatment technologies produce sustainable water suitable to the customer's needs (irrigation, cooling towers etc). Then, the location of the customer in relation to the RRC will determine whether there is existing infrastructure in place to transport the sustainable water to the customer, or if the distance is short enough to consider building new infrastructure. If not, co-funding can be considered to commission the infrastructure, otherwise it is not viable. The demand vs supply needs to be considered for the RRC, to check whether there is spare capacity to allocate to the potential customer, and whether or not their required volumes would sustain the viability of the scheme. Finally, public perception of the use of sustainable water at these businesses (golf courses, sporting fields, farms etc) can determine if a scheme can be established.

The WCRWS is not currently online due to a lack of demand and public acceptance of PRW for drinking water. Indeed, recent strategic plans for SEQ include the upgrade and commissioning of new desalination plants instead.



Overall benefits

- Transforms a waste into a valuable product
- Maximises the value of the product by keeping it close to home
- Reduces the impact on the receiving environment
- Reduces costs for customers
- Provides an alternative option for customers (better quality or sustainable option)
- Contributes to water security in SE Queensland and reduces reliance on a primary resource
- Capitalises on existing infrastructure
- A good step in the right direction toward a circular economy (focussing on a core skill of the business)

Insights

- The market for sustainable water is not fully mature; demand for sustainable water and PRW for drinking is still low, resulting in unused capacity
- There is a need to tread carefully as to which non-drinking opportunities are pursued, being particularly conscious of public reception
- Water utilities should actively participate in changing public perception around sustainable water and PRW
- Drivers for circular economy initiatives aren't always for circular economy's sake, the often involve solving another related problem
- Circular economies need to start local, so there is a need to link with entities who are close by
- Sustainable water and PRW will become critical in the next few years to ensure water security in SE Queensland.

Circular Economy in construction - Reducing the carbon footprint (Yarra Valley Water)

Context

As part of reducing the environmental footprint of the organisation, Yarra Valley Water is exploring sustainable approaches in lowering scope 3 emissions in its construction and maintenance activities.

Our ambition in reducing our carbon footprint is delivered through our “Embracing the Circular Economy” focus in our 2030 Strategy. This has been a leading driver to understanding our carbon footprint across our activities. Material Flow Analysis showed that, after water and nutrients, the third highest carbon footprint per tonne is of construction materials (Figure 1). When considering the broader picture of material extraction, delivery and disposal, the full extent of the environmental impact becomes clear. Through circular economy principles and capital improvements, we are working with our design and construction partners to make lower carbon choices.

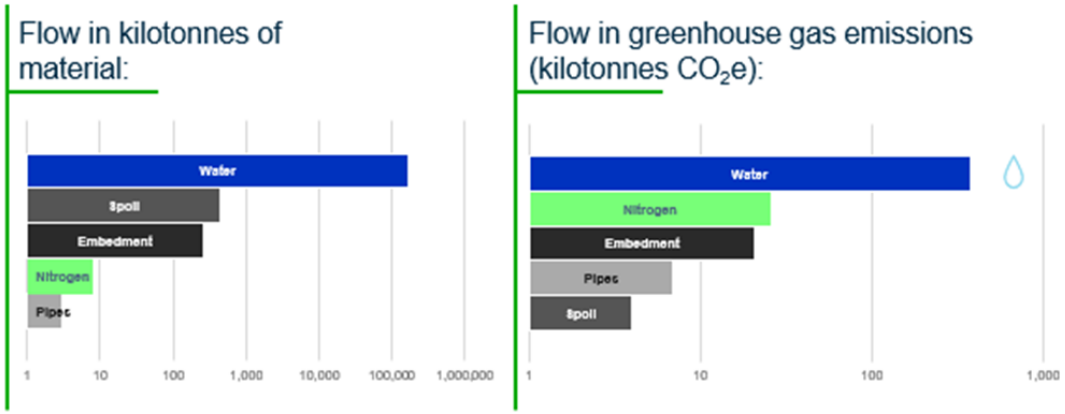


Figure 2: Material Flow Analysis, identifying carbon hotspots across our business activities.

Our collaborative partnering approach with circular economy and design consultants, construction partners, and material suppliers has helped shape our understanding of scale and variance of capital emissions and plan our decarbonisation pathways to 2030. To understand the overall impact from YARRA VALLEY WATER-led construction projects, we conducted a bottom-up assessment of 10 projects, and a top-down assessment of the capex portfolio to 2030 (see figure 3 below).

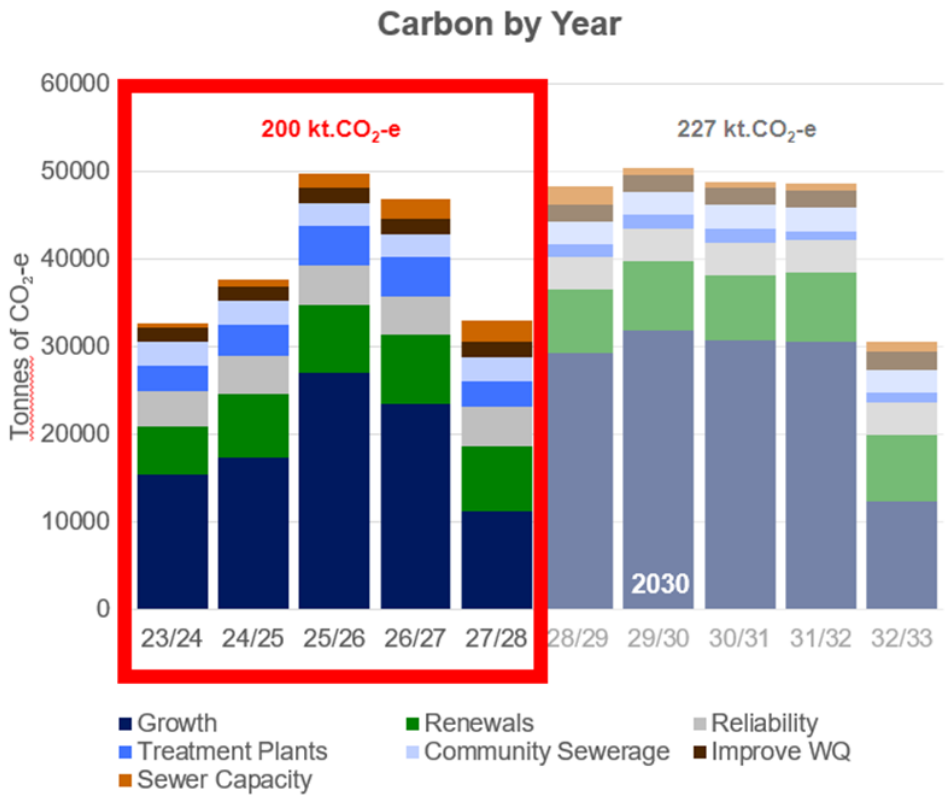


Figure 3: Top-Down assessment of capex portfolio carbon baseline.

Examples for projects underway to embrace the circular economy in construction:

- Yarra Valley Water are currently working with DEECA, Barwon Water, NE Water and IWN to expand the Metropolitan Retail Water Agencies (MRWA) database to include more recycled materials, capturing products listed in Sustainability Victoria's "Buy Recycled" database, and other more sustainable products available on the local market. The database is being revised to make the information on more recycled materials visible and available to construction managers. This project also captures material flows, and carbon emissions associated with these materials, and will provide recommendations on key sustainable procurement indicators.

- Along with North East Water and Barwon Water, Yarra Valley Water were successful in securing a Water Minister's Climate Innovation Grant, to investigate low carbon cement alternatives, with the goal of having clear guidance on available products, their carbon footprint, and compatibility with relevant standards for various water industry applications.

Figure 4: Use of recycled sand as embedment material at a Sewage Flow Control facility

Sustainable Approach

Yarra Valley Water are continuing to work closely with design and construction panels to integrate the circular economy approach with existing processes. We are also expanding from encouraging more sustainable material selection to the earlier design phases where targeting much greater carbon and cost reductions are possible. Close collaboration with design consultants, contractors and internal experts have enabled us to test assumptions and drive innovation while understanding risks and long-term viability of potential solutions.

Drivers and enablers

- Alignment with Yarra Valley Water's 2030 Strategy to embrace.
- Understanding material flows through the business to help understand materiality, costs, and environmental impacts.
- Close collaboration with both design consultancy partners in developing the carbon baseline tool, so they can both integrate this into their work moving forward.

Barriers

- ***Lack of awareness about these materials, and stories of procurement difficulties***.
  To overcome this barrier, a collaborative project is underway to make approved sustainable products by local suppliers more visible on the products list for the Melbourne Retail Water Authorities, which is used by project managers and construction firms. This will also include fact sheets on materials' environment credentials and how to safely use them.

- ***Supplier concerns, e.g. construction risks.***
  Engage early with construction partners to run trials of new products and identify any concerns they may have. Learn from their experiences to gather more evidence of successful applications to help address above misconceptions. For example, construction contractors found that recycled sand used on a sewer control facility, was easier to compact to the relevant standards than virgin sand, and so had additional benefits, in addition to the environment benefits (see pictures).

- ***Concerns about additional expense.*** To address any concerns about price difference between recycled and new materials, Yarra Valley Water requests comparative quotes to ensure the sustainable materials are priced competitively. This has led to a greater understanding of the actual cost implications and supplier differences, and facilitated more effective decision-making.

- ***High (temporary) demand for recycled materials.*** Some sustainable products are currently more difficult to procure at times because of a high local demand from other major State Government projects (level crossing removals etc.). When these projects come to an end, it's important that suppliers are ready for a potential increase in demand for sustainable products from the water industry.

Overall benefit

The overall benefits from using recycled materials are a reduction in scope 3 emissions along with a reduced environmental impact (from extracting materials from the environment, e.g. sand dredging; less waste to landfill). Applying circular economy principles from the early stages of project planning will further result in considerable cost reductions (clever design – less material, less cost). In addition, there was a lot of staff engagement at Yarra Valley Water and the consultants who were all excited to participate in this meaningful project.

Insights

- ***Target what matters most:*** First key step was to understand the "size of the prize" and materiality of different circular economy opportunities, and then the impact of construction activities to identify carbon hotspots and where we can make the biggest difference.
- ***Look outside:*** UK water sector and the Victorian transport industry have developed great low-carbon approaches and case studies using recycled materials.

Biosolids to fertiliser (Watercare)

Context

Emerge Soil Products is Watercare's umbrella brand for creating valuable soil nutrient products from materials that are traditionally landfilled. This includes struvite (branded "Emerge Fertiliser", a phosphorus rich fertiliser that also includes nitrogen), biosolids (a wet compost-like by-product from wastewater treatment), and CarbonGrow (a carbon rich sludge from drinking water treatment with significant benefits to turf systems).

These products go to landfill under "business as usual" operation. Creating valuable products means there is direct diversion from landfill, and more importantly true value creation by providing local, renewable and sustainable products that displace non-renewable fertiliser products sourced internationally. The ultimate aim is to divert more than 100,000 tonnes of biosolids from landfill, but to get there Watercare must go on a journey with Mana Whenua (Local Māori) and communities and customers and learn how to achieve this. Emerge Soil Products gives agency to this kaupapa (initiative).

Aotearoa's phosphorus is currently sourced from Western Sahara (via Morocco) by mining a non-renewable resource, with structural geopolitical challenges, and then shipped and processed with significant carbon footprint. This is being displaced by Emerge Fertiliser.

Watercare had anticipated a nationwide roll out of emerge fertiliser across 84 Mitre 10 stores by January 2024. Mitre 10 has specifically sought the product from Watercare because it aligns with how they are seeking to expand a local/sustainable product offering on their shelves. Watercare are also in negotiations with Blue Pacific Minerals and PGG Wrightson regarding distribution and product development.

Commerciality

The first commercialised product is Emerge Fertiliser – the crystal struvite. There is no known source of struvite in Australasia (as demonstrated by the export demand). Therefore Emerge Fertiliser is a unique product with a unique product proposition: a local, renewable, sustainable source of phosphorus. The cost to extract and sieve struvite crystals as a fertiliser is offset by the cost to landfill an equivalent volume of product. The downstream sales therefore provide revenue which in turn funds the ability to explore further products such as potting mix and CarbonGrow.

Figure 5: Struvite “stockpile” inside 8,000m3 digester after sludge

Drivers and enablers

Watercare produce 300 tonnes of Emerge Fertiliser per year. They have proven the demand and commercial viability of the product and are considering options to expand capacity to 3,000 tonnes per year. This would require significant capital investment.

The biosolids potting mix and CarbonGrow products have been proven at trial scale and are looking to be commercialised in 2024. Watercare's experience with commercialising Emerge Fertiliser led them to realise that they do not have distribution and direct market expertise. They are now evaluating appropriate business model arrangements to outsource that with current or new business partners.

Ultimately, they want to create value and a market for up to 100,000 tonnes of biosolids produced. Development of the Emerge Fertiliser, potting mix, and carbon grow products is all about going on a journey together: learning, building trust and telling stories about how good the residual products can be. An integral part to this journey is working together with Mana Whenua (local Māori) and local communities. Watercare anticipate that the Kaupapa (initiative) will take ten years (and of course that won't be the finish).

Barriers

Watercare are not aware of any unintended adverse impacts from Emerge Fertiliser, biosolids based potting mix, or CarbonGrow. However one ultimate goal is to undertake large scale application of pasteurised biosolids to land. This is common practice in the central North Island, as well as in Australia, USA and UK. This can only be achieved with a well understood risk / regulatory framework to ensure there are no unintended consequences (for example through poor product quality or inappropriate land application practice).

There are also cultural and social elements that need to be understood and worked through in partnership with Mana Whenua (local Māori) regarding this. These are unique to Aotearoa (New Zealand). The essence of the project to date is to provide a vehicle to start that korero through the beneficial reuse of Watercare's residual products so they can learn together about what/where/when is appropriate, sustainable, and protects the environment, or not. Key aspects of the approach include:

- **Regenerate** – Return recovered biological resources to the biosphere - literally returning nutrients and carbon to soi**l**
- **Share** – Reuse
- **Optimise** – Remove waste, literally diverting from landfill to beneficial reuse
- **Loop** – Digest anaerobically, recycle materials, extract biochemicals from organic waste (e.g. filtering struvite from sludge)

Overall benefit

There is significant interest in what Watercare are doing with developing firstly a struvite product from wastewater treatment, and secondly a branded product portfolio from wastewater residuals. Across Australasia water utilities are interested in these developments.

Ultimately this kaupapa crosses over with how Aotearoa might use recycled water from wastewater effluent - can it be used for irrigation, and other water reuse initiatives. Can it ultimately be a new source of water for communities as is the case in a growing number of countries around the world.

Insights

The first measure of success has been proving that these products work, and that there is real commercial viability and value in them. They have achieved this with Emerge Fertiliser and are now able to build on that platform to launch the potting mix and CarbonGrow products in 2024. Success in 2024 will therefore be about achieving commercially viable product offerings, and learning together, and building on the trust narrative with Mana Whenua (local Māori) and local communities.

While financial return is desirable it is not the underlying purpose of Watercare's kaupapa (initiative), they are looking at real ways of reducing the carbon footprint of Aotearoa's (New Zealand's) fertiliser use, improving carbon sequestration in soil, and eliminating waste to landfill. Ultimately, they anticipate that achieving sustainability led outcomes will naturally result in better financial outcomes and a more resilient programme for managing residual products.

Bagged product for shipping to pasture markets or turf markets

Circular Economy Roadmap for Desalination (Water Corporation)

Context

Water Corporation is committed to providing sustainable infrastructure that optimises economic, environmental and social outcomes according to its corporate goals and environmental policy. The Alkimos Precinct site in the north of Perth will be composed of Perth's next desalination plant – Alkimos Seawater Desalination Plant (ASDP) – and adjacent to an existing wastewater treatment plant which will be renamed to Alkimos Water Resource Recovery Facility (WRRF) in the near future. Water Corporation engaged Isle Utilities to undertake a global market scan on CE opportunities that have the potential to influence the future of water in the whole Alkimos precinct. Circular economy opportunities for both ASDP and WRRF were identified and prioritised through a series of workshops with Water Corporation's key stakeholders. A total of 54 opportunities were identified (26 for ASDP and 28 for WRRF), which were profiled and assessed according to their viability, desirability, and feasibility.

Another CE initiative that Water Corporation implemented in 2000 is the use of their own water treatment byproduct to reduce corrosion - Neerabup Groundwater Treatment Plant produces approximately 50-60 tonnes of calcite pellets (seeded with lime) each week as the raw water it treats has excessive concentrations of hardness (>200mg/L). At the same time they were facing significant negative impacts across their network from the low pH surface water (accelerated corrosion of cement-lined mains, elevated pH in new subdivisions, copper corrosion in domestic plumbing, and copper stain). Creation of alkaline media contactors (filter beds or reactors) at their Water Treatment Plants allowed calcite pellets to be applied. The process reduces the need to use lime, improving worker safety and capital costs, and only requires half the amount of added CO2, therefore reducing operating costs.

Commerciality

- Generally, ringfenced within Water Corp, as they cover 2.6 million square km's across the state, making this easier to do than at other utilities.
- ROI is based on positive NPV, with risk-based projects generally having preference over opportunity-based projects.
- Each initiative is sized based on the known market.
- The calcite project was delivered internally, then as a Design & Construct contract on construction upgrade at WTP's for pH control.

Drivers and enablers

- Corporate sustainability objectives to be met.
- Working with Operations and having their involvement from the start.
- Overcoming the issue of pipe degradation which then made it very cost effective.

Barriers

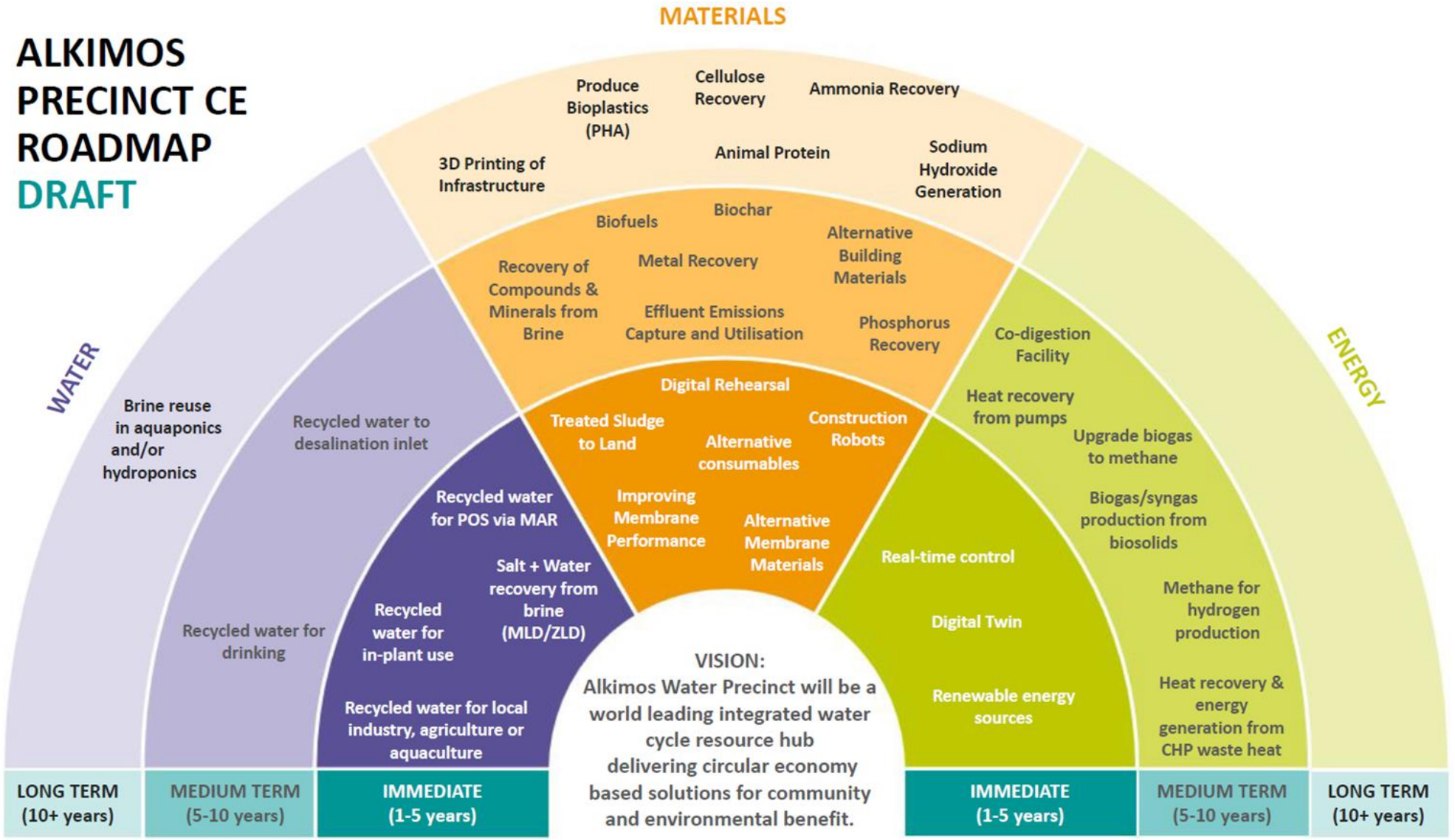
- Previous circular economy research and ideas have been driven by individuals rather than risk and strategies. They have often been hard to implement unless they have had a clear cost benefit, such as the reuse of calcite from the water treatment plant that Water Corp currently does.
- Typically, Water Corp does not have extra resources internally, so contracts a university/CSIRO to do the work and they project manage it.
- Approval from risk averse Water Quality processes.
- Risk based projects generally get preference over opportunity-based projects.

Overall benefit

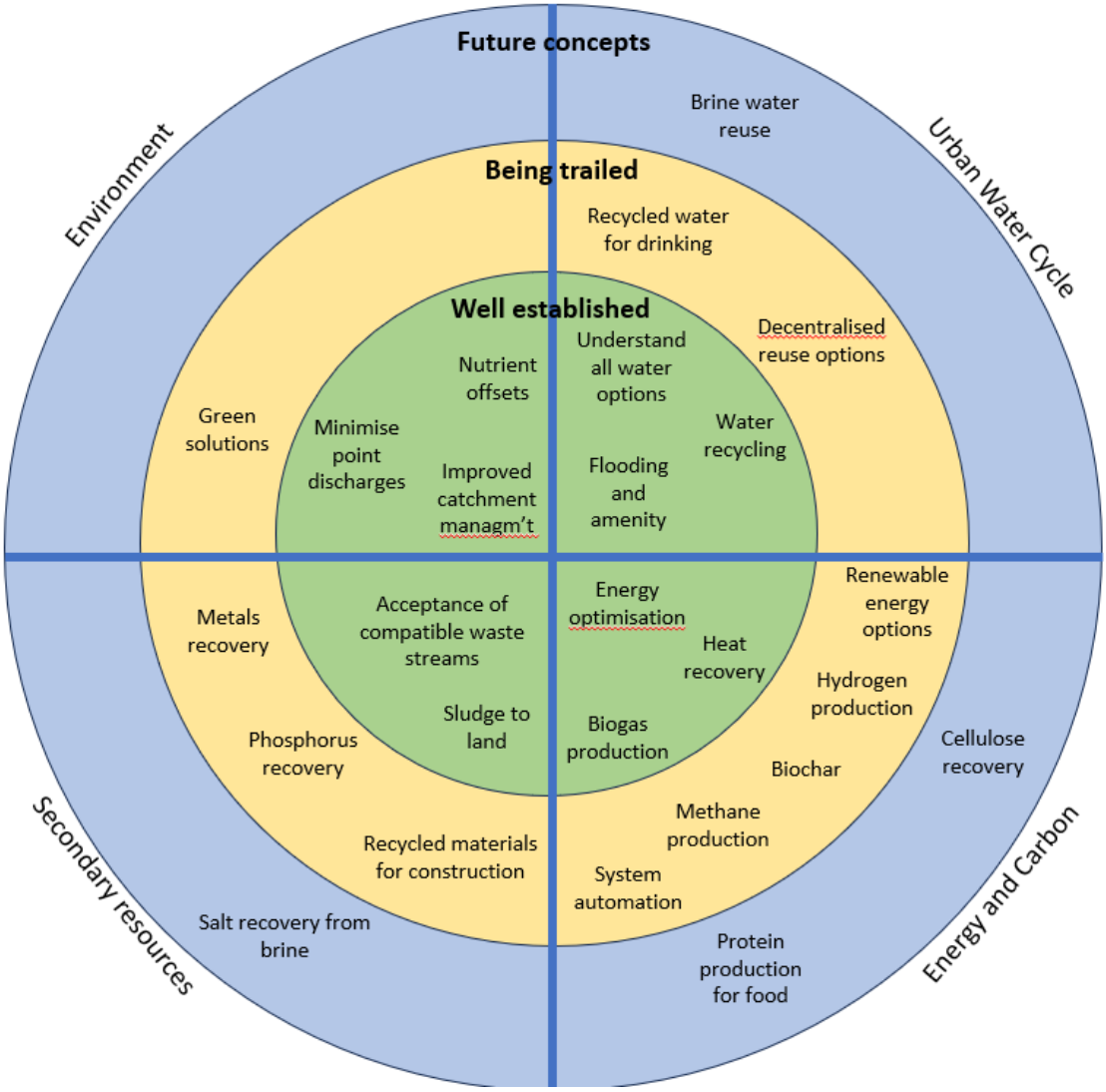
- Reduced waste as per corporate and state targets
- Reduced risk in supply chains
- Better corporate citizen and brand
- Leader in research and implementation
- General shift in culture towards innovation

Insights

New and upcoming projects present clear opportunities to incorporate Circular Economy, as the data (requirements, inputs, outputs, geography, etc) are well known so that returns on investment are quantifiable. When built into a project from the outset it offers opportunities more than just waste recovery and is aided by the momentum of the project itself.


ALKIMOS PRECINCT CE ROADMAP
DRAFT
MATERIALS
Produce Bioplastics (PHA)
Cellulose Recovery
Ammonia Recovery
3D Printing of Infrastructure
Animal Protein
Sodium Hydroxide Generation
Biofuels
Biochar
Alternative Building Materials
Recovery of Compounds & Minerals from Brine
Metal Recovery
Effluent Emissions Capture and Utilisation
Phosphorus Recovery
WATER
ENERGY
Digital Rehearsal
Brine reuse in aquaponics and/or hydroponics
Recycled water to desalination inlet
Treated Sludge to Land
Alternative consumables
Construction Robots
Co-digestion Facility
Heat recovery from pumps
Upgrade biogas to methane
Recycled water for POS via MAR
Improving Membrane Performance
Alternative Membrane Materials
Biogas/syngas production from biosolids
Real-time control
Salt + Water recovery from brine (MLD/ZLD)
Recycled water for drinking
Recycled water for in-plant use
Digital Twin
Methane for hydrogen production
Recycled water for local industry, agriculture or aquaculture
Renewable energy sources
Heat recovery & energy generation from CHP waste heat
VISION:
Alkimos Water Precinct will be a world leading integrated water cycle resource hub delivering circular economy based solutions for community and environmental benefit.
LONG TERM (10+ years)
MEDIUM TERM (5-10 years)
IMMEDIATE (1-5 years)
IMMEDIATE (1-5 years)
MEDIUM TERM (5-10 years)
LONG TERM (10+ years)

Appendix 2: Outline of key Circular Economy Opportunities



Appendix 3: Template for developing a circular economy project concept

Context

- What is the context?
- Does the project align with a core skill or value of the business? If not a core skill or alignment why is this targeted as a priority?

Commerciality

- What commercial approach are you taking (does the project stand on its own, is it a trial, does it meet regulatory requirements – e.g. carbon credits, gate fees)?
- What is the business model?
- Include the financials and cost/benefit analysis.
- Consider use of a multi-criteria analysis

Drivers and enablers

- What are the drivers of the project *(e.g. community expectations, regulator/policy driven, non-regulated revenue, stakeholder expectations, financial return, business education)*?

Stakeholder engagement

- Which partners will you engage, why and what mode of engagement will you use?
- Describe the nature of stakeholder engagement that will be undertaken?

Potential barriers

- What will enable this project to go ahead, help it succeed and reach its maximum potential?
- What do you see as the key barriers for this project?
- How will you overcome them?

Benefits

- What anticipated benefits did you see coming out of this project?
- What is the overall benefit to your organisation from this project reaching its potential?