Unlocking the Business Case for a Circular Water Economy

Factsheet

This factsheet is intended to give insight into the actions built environment organisations can take to unlock a business case for adopting circular water systems. It first delves into what circular water systems can look like at every scale of the built environment and the key barriers to investment in circular technologies. It then goes on to explore the opportunities for unlocking economic, social, and environmental value from circular technologies, presents several case studies, and finally gives recommendations for built environment organisations.

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Section 1:
What is the Circular Water Economy?

What is the Circular Water Economy?

A circular water economy is restorative or regenerative by intention and design and entails gradually decoupling economic activity from the consumption of water resources and from environmental degradation. As an economic system it seeks to minimise the waste of water and make the most of water resources and associated benefits. Under the current economic models, there is very little motivation for organisations to invest in circular water infrastructure; there is a strong need for the development of circular business cases that directly address limited freshwater resources.

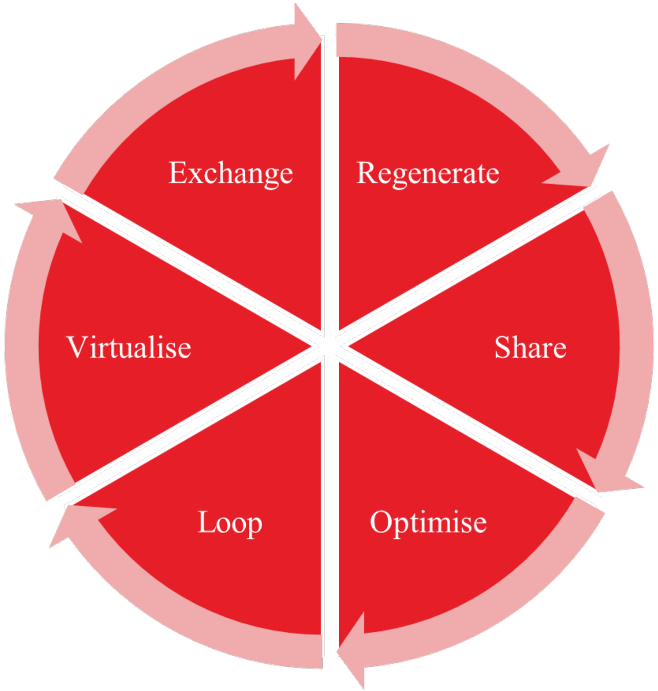
Frameworks for Assessing Circularity

To understand how circularity can be embedded into business practices, there are several examples of frameworks that help consider circularity at all scales of practices.

ReSOLVE Framework

The Ellen MacArthur provides a framework for considering water use at all scales of the built environment. The ReSOLVE Framework offers a more holistic perspective on actions that can be taken to develop circular economies. These are broken down into six categories:

- Regenerate - focuses on regenerating and restoring natural capital through the protection of ecosystems, increasing environmental resilience, returning nutrients and water to the environment, and restoring natural processes.



Ellen MacArthur Foundation's ReSOLVE Framework

- Share - focuses on developing shared infrastructure, resources or communal assets that are centralised or semi-centralised.
- Optimise - focuses on improving the efficiency of processes, including increasing the duration assets can be used, designing out waste and optimising logistics.
- Loop - focuses on keeping materials and products in the supply chain by re-purposing and recycling materials.
- Virtualise - focuses on delivering virtual services rather than in-person services to reduce the physical infrastructure and materials required to deliver a service or product.
- Exchange - focuses on shifting design choices to opt for new technologies, materials, ways or working or delivery models.

BREEAM Framework

BREEAM is a global validation and certification system, which provides a rating of sustainability for new construction, communities, infrastructure, and more considering carbon, whole life performance, circularity and biodiversity. This framework emphasises the importance of water reuse and conservation in its approach, particularly through its Water Consumption indicator. This provides explicit targets for developments to meet by assessing both elemental and total water consumption.

LEED Framework

LEED is a global green building certification, which sets out a framework for delivering green buildings, cities, neighbourhoods, and new construction. Within this framework, water in developments is given importance through LEED's Indoor and Outdoor Water Use Reduction credits and pre-requisites. This provides guidance and targets for developments to reduce indoor water usage primarily through low-flow appliances and outdoor usage through efficient irrigation and site developments that considers the water balance. There are many other frameworks available and your local Green Building Council can advise on the one most appropriate for your business.

The Scales of the Built Environment

The World Green Building Council's publication 'Building a water-resilient future' calls on the built environment industry to consider the impact of water on four scales of the built environment: supply chain, construction processes, buildings, cities, and communities.

Embedding circularity into design from the very earliest opportunities increases the amount of influence decision-makers can have over reducing water consumption in the built environment. Moving towards **a circular economy could unlock $4.5 trillion of global economic growth by 2030** by avoiding waste, making businesses more efficient, and creating new employment opportunities [1].

A circular economy could unlock $4.5 trillion of economic growth by 2030

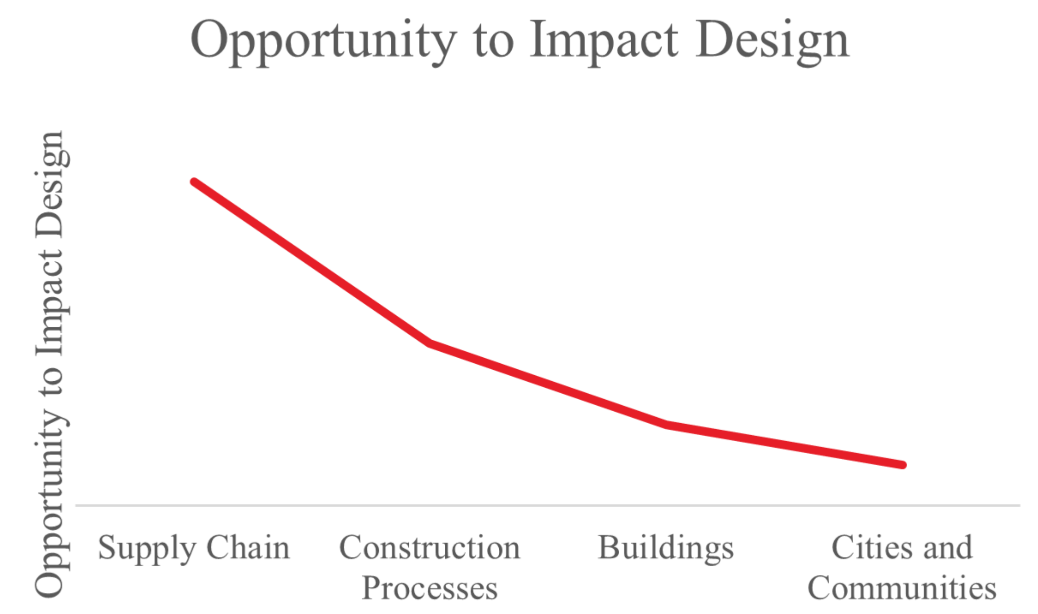


Illustration of opportunities to impact design at different scales of the built environment

Linking the ReSOLVE Framework with the Scales of the Built Environment

There are many opportunities to apply the ReSOLVE framework at each of the scales of the built environment. The table on the next page highlights some possibilities to easily integrate circular water practices into the world's infrastructure.

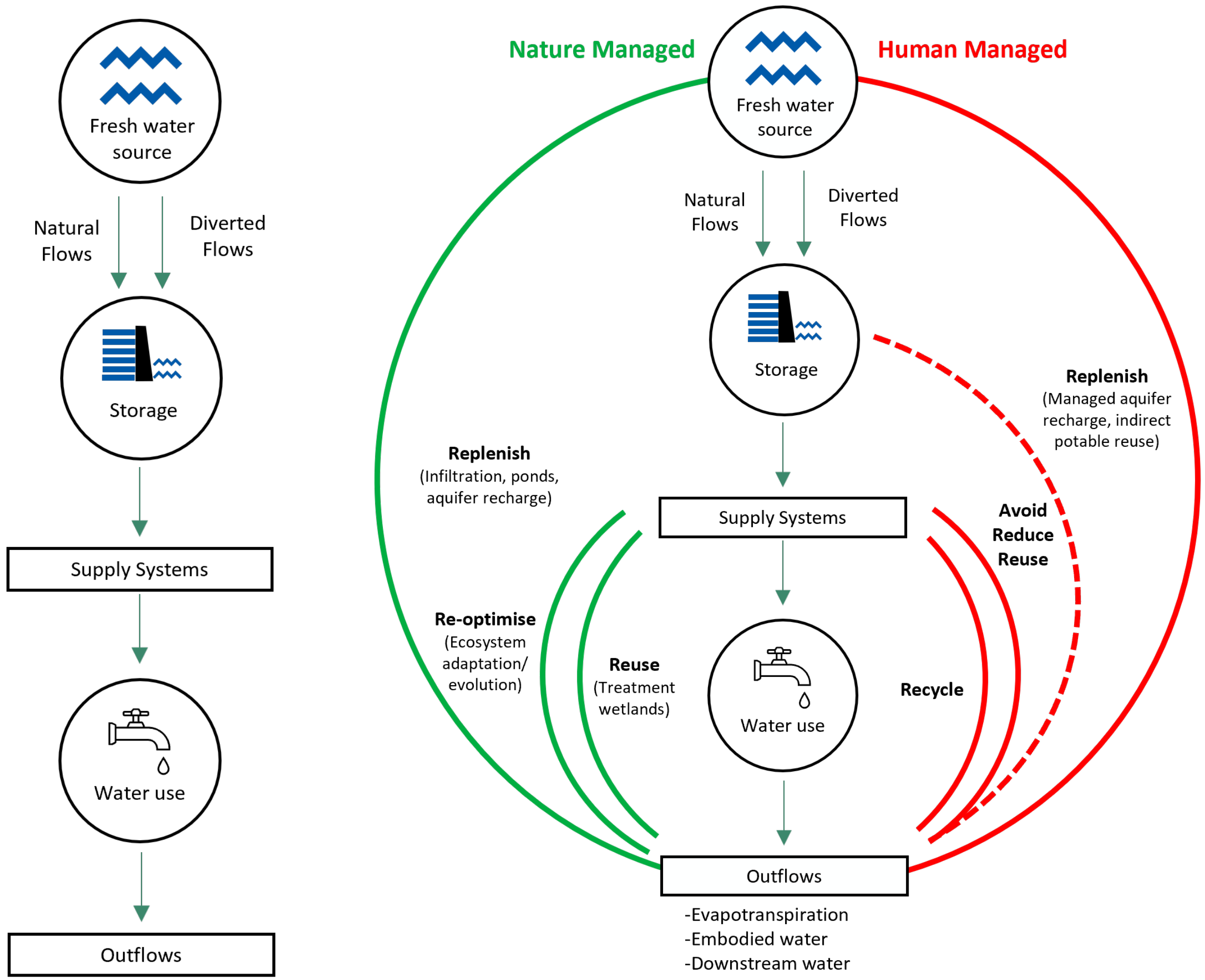
	Supply Chain	Construction Processes	Buildings	Cities and Communities
Regenerate	Opportunities to return wastewater or nutrients from manufacturing processes to the environment	Selection of construction materials with lower embodied water or that can be easily recycled, including temporary works	Installing rainwater harvesting systems. Implementation of green-blue[1] infrastructure.	Nature-based Solutions such as retention ponds, permeable paving, bioswales, and wetlands.
Share	Suppliers should reuse packaging materials to reduce embodied water	Sharing of logistical assets (e.g. trucks, warehouses) and information	Develop shared water systems at the building/ neighbourhood scales. Encourage co-living or shared working spaces to use water efficiently	Public awareness campaigns on water use
Optimise	Smart water monitoring to monitor water distribution, losses, and efficiency	Implementing water efficient construction practices	Fitting of water-efficient fixtures into buildings. Smart irrigation systems	Develop Integrated Water Management Plans to balance supply and demand. Smart irrigation systems
Loop	Use of reclaimed materials to reduce embodied water. Suppliers implementing closed-loop water treatment systems	Site based rainwater harvesting systems. Modular construction to allow for disassembly and reuse	Building level greywater recycling systems	Nutrient recovery from wastewater. Uses of salt from desalination. Use of reclaimed water to maintain public greenery.
Virtualise	Implement digital systems to monitor and optimise water use in the supply chain	Use of Building Information Modelling (BIM) to virtually model water allocation in construction	Installation of smart meters, providing real time consumption data through Building Management Systems (BMS).	Develop Integrated Water Management Plans on a city scale. Facilitate information sharing for collaboration
Exchange	Water trading platforms where organisations can exchange water rights or allocations	Develop digital passports for the embodied water in construction materials and processes	Exchanging old water use practices for new use models (see 50L Home Case Study)	Sharing knowledge on water conservation and regeneration principles between developments and cities

[1]Green-Blue Infrastructure refers to the deliberate blend of hard 'grey' infrastructure with multi-functional 'green' and 'blue' spaces (such as parks, rivers, wetlands, green roofs) to provide environmental, economic, health, and well-being benefits.

Section 2:
What are the Barriers to Creating a Circular Water Economy?

Linear vs. Circular Models of Water Use

A circular water economy (CWE) is a system that challenges linear economy models of *take, make, waste* in a linear flow and instead revolves around the principles of designing out water and nutrient waste, keeping current water resources in use, and regenerating natural systems, mirroring the world's natural processes. Linear models are underpinned by the assumption that freshwater resources are plentiful and cheap. Water is often viewed as an abundant and renewable global resource. However, most of the world has already begun or is beginning to experience water issues in the form of *too much, too little, too polluted*. Circular models place water resources at the core of their design, aiming to reduce stress on natural ecosystems and enhance the resilience of cities when facing future climate events.



Linear vs. Circular Water Use Models

Barriers to Implementation of Circularity

Circular Water Economy (CWE) strategies require favourable conditions if they are to be adopted successfully, with four main challenges facing its implementation: Technological, Economic, Socio-cultural, and Legislative [2].

Technological Barriers

Globally, inefficiencies, ageing infrastructure, and requirements for net zero can create a technological barrier to circular strategies. **Over 80% of the world's wastewater is still released into the environment without treatment** [3]. This lack of existing treatment infrastructure is a clear technological barrier to implementing circular economy, where vast amounts of water will need to be recycled [4]. The limited choices in utilising recovered water will need to be improved. AI, simulation, and big data are all innovations that can support research in implementing re-utilisation technologies so that they become reliable and can be produced at scale. Environmental protection should be baked into circularity, for example by reducing the amount of carbon needed to treat water to potable standards or by regenerating groundwater through nature based solutions. Better knowledge on availability and implementation of new technologies would empower leaders and collaborators to appropriately design and manage new circular processes while reducing carbon impacts [5].

Economic Barriers

One of the main economic barriers to circular water implementation is the inability to recognise the value of water by modern society, leading to its waste and misuse. While potable water stress is intensifying, water utility companies worldwide face massive water losses in distribution systems, with **non-revenue water making up 25-50% of the total water supply** [6]. Aligning economic incentives with resource reduction objectives in the built environment and for utilities (this could include higher costs for water use, leakage reduction bonuses or water credit models) should foster circular solutions and unlock money for further implementation and innovation [7]. This economic funding, however, usually requires high upfront investment, and low short-term profit which can drive stakeholders away, and become a barrier for its implementation. There is a strong need for the development of clear value through circular water business models to provide economic incentives for companies to enact change.

Non-revenue water makes up 25-50% of the total water supply worldwide

Socio-Cultural Barriers

A cultural change will be required to sway the mindset of people from many cultures regarding the use of recycled water from sources such as toilets and showers to be used again. Trust about water treatment methods and recycling could be improved by public outreach and information sharing campaigns. This is increasingly important given that **by 2050 the number of urban dwellers facing acute water shortages could climb to over 1 billion** [3]. This represents another socio-cultural barrier- the lack of urgency in addressing the global water crisis.

Finally, a lack of trust towards water institutions halts public faith in water quality and infrastructure. The pressure however from society to respond to climate change can drive the water sector and public outlook towards a more circular future [4].

By 2050 the number of urban dwellers facing acute water shortages could climb to over 1 billion

Legislative Barriers

The quick introduction of appropriate legislation and governance is key for a transition towards a CWE. It requires a rethinking of business models and service provisions which are built in linear models, into a system with an inter-sectoral approach that connects other sectors rather than separates them.

The complexity of environmental permits and current regulations can further prevent circularity being introduced. For example, California has an incredibly complex water permitting and regulation system due to overlapping historic water rights and the use of both riparian and appropriative water rights [21]. This limits the ability of the state to adapt to environmental issues such as drought in areas where they need to respect intensive water permits that were issued in a different environmental and social context.

A key balance is required between sustainability gains (through streamlining and implementing supportive regulation) and environmental protection (to ensure safe water treatment and standards).

Over 80% of the world's wastewater is still released into the environment without treatment

Royal Docks, London

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Section 3:
Unlocking Value from Circularity

Unlocking Value at Each Scale of the Built Environment

At each scale of the built environment process, a CWE offers the opportunity to unlock value to individuals, businesses and communities.

Globally, buildings are recognised as one of the highest users of freshwater resources, consuming vast amounts of water in both construction and operation [8]. Buildings and construction account for 50% of primary energy demand, 30% of the waste flows generated and 15% of freshwater use [9]. By embracing circular principles such as resource efficiency, sustainable consumption, and waste reduction, societies can significantly lessen their environmental impact and move closer to a regenerative relationship with the planet [10]. This transition in the construction industry requires a complete systematic change, but one that will impact the health and well-being of users, increase productivity, and save costs.

Supply Chain

In the supply chain stage, raw materials are extracted, transported, and processed into building materials. Vast quantities of water can be used to carry out these processes and manufacture materials. Materials management, including the production, consumption, transport and disposal, take a major share of global greenhouse gas emissions; this is estimated to be up to two thirds of emissions. In 2012, concrete production was responsible for 9% of global industrial water withdrawal and 1.7% of total global water withdrawal [11]. The WorldGBC's water publication explores estimates for the water footprint of other materials. Opportunities to incorporate circularity in the design are higher in developing contexts. Evidence shows that 85% of the opportunities to improve resource productivity are concentrated in developing countries [6]. In water, these opportunities often relate to irrigation optimisation, opportunities to improve water use efficiency, and adaptation of agricultural practices to regenerate ground and surface water supplies. The challenge for more developed contexts is to find ways to adapt existing processes to incorporate circularity principles and tap that remaining 15% of opportunities.

Construction Process

At the construction stage, buildings and infrastructure begin to take shape with multiple stakeholders involved in the process. Understanding how water is used at every stage of construction by every stakeholder involved could unlock a huge opportunity to create value on construction sites. This can take the form of economic value in reducing charges for potable water purchased on site and wastewater treatment charges, or opportunities to unlock social and environmental value by opting for low polluting processes that protect the natural environment. Managing losses and leakages, opting for circular technologies (such as rainwater harvesting), and choosing circular materials are all ways to create value in the construction process. Monitoring and measuring water use at the construction phase could unlock an opportunity to understand where value is being lost through linear processes.

Rainwater harvesting on a UK construction site

Buildings

The use and maintenance of the building stage is the longest-lived stage and includes the maintenance, repair and renovation of a constructed building or asset. It is here where circular water can most impactfully introduce value, by recycling, reusing and creating closed loop systems to slash water demand.

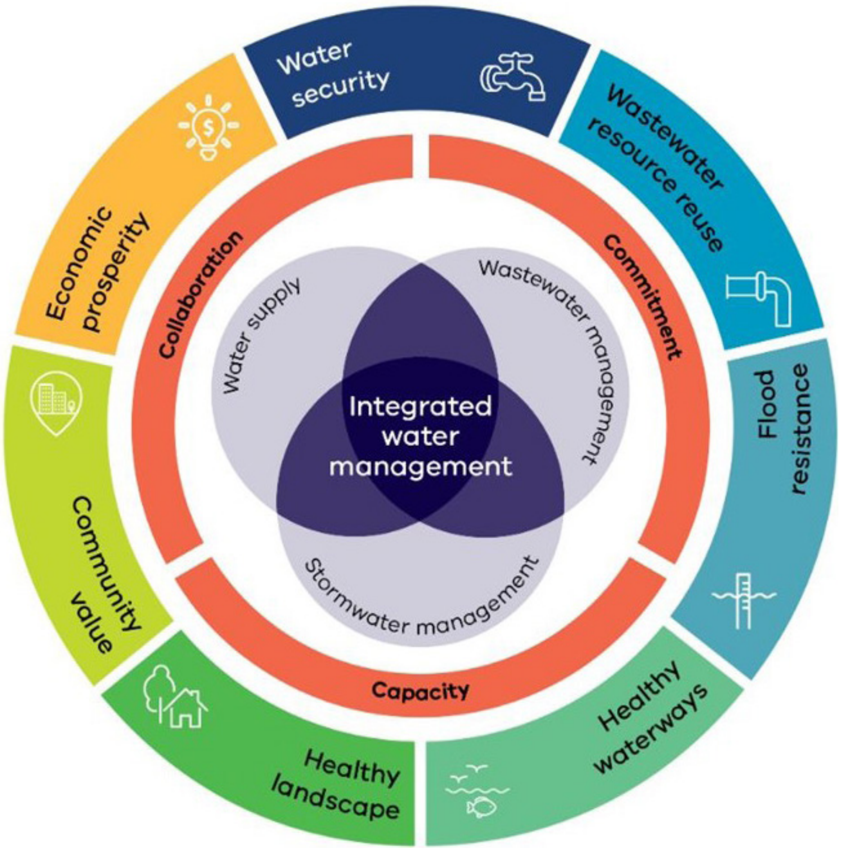
Water reuse offers a low energy, accessible, low-cost solution to communities that do not have adequate water provision at the household level. In doing so this can unlock cost savings through the reduction in water use. Improving existing buildings to extend their lives and lower their water demand makes its use far more sustainable and leads to more efficient water use.

At an operational level, implementing nutrient or energy recovery technologies in buildings can increase a building's value as these valuable resources could then be reused in the building's operation or by other sectors including agriculture and industry. This is most commonly implemented in the form of greywater recycling systems that can extract nitrogen or phosphorous from sinks and showers. Moreover, integrating renewable energy into such treatment systems reduces the reliance on fossil fuels and further aligns with CWE principles.

Cities and Communities

Implementing CWE into a wider scale is where the maximum value can be unlocked. By 2050 the global population will reach 9 billion people, with 55% living in cities. Water demand will increase by 55% worldwide as well as the demand for food and energy [12]. In many cities and communities around the world, water is already highly stressed. Integrated Water Management (IWM) principles, such as those implemented in Victoria, look at a whole city scale and consider where opportunities can be developed in every area of the built environment.

There are many ways that value can be created from circular water. On a city scale, stormwater harvesting and Sustainable urban Drainage Systems through permeable pavements, green roofs and rain gardens can help capture, treat and direct stormwater, a free resource, so that it can be used to a community's benefit. In doing so this also creates city-wide value in increasing water resilience and can mitigate the impact of low rainfall periods through groundwater replenishment and lowering reliance on centralised city water infrastructure.



IWM Outcomes in Victoria measured as part of the MERI

Centralised city scale water treatment and wastewater treatment technologies can also unlock opportunities to generate economic value from water in the form of heat recovery and nutrient recovery. **Cities with ambition to become circular could unlock green and climate finance to build new water infrastructure that future-proofs urban growth and creates jobs in the circular economy.** Cities such as Cambridge in the UK are implementing water neutrality requirements on new developments and investigating the opportunities for developing water credits in the same form as carbon credits [13]. This further protects cities from future climate events, helping put less stress on the natural environment, allowing more water to be used in natural capital such as ponds, bioswales and lakes, boosting biodiversity within cities all of which provide great value to the communities that live within them.

Section 4:
Case Studies

The ongoing climate crisis means that there is an urgency to identify sustainable solutions to deal with this pressing issue. Several projects have been looking to develop sustainable solutions that integrate circularity into the built environment.

We realise now that the current linear economic model bears most of the responsibility for these global issues. Our economies and societies are mostly based on linear resource consumption resulting in global and regional environmental problems. The CWE model instead focuses on the reduction of natural resources input to the economy and a reduction of waste production. The use of finite natural resources is optimized, while the recovery and reuse of resources becomes central in future design approach.

The adoption of the CWE model means that we change the way we think and manage our resources in order to effectively tackle climate change impacts. This approach is especially important in the water sector as circular practices are not widely adopted. The following case studies represent how Arup have positively implement circular practices to help improve the water economy.

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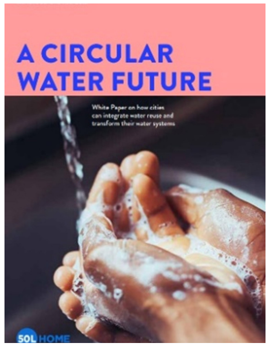
Regenerate, Virtualise, Exchange

Sponge Cities

Worldwide

Arup developed the Global Sponge Cities Snapshot to highlight the importance of understanding cities' natural abilities to manage heavy rainfall. Using their in-house TerrAIn tool, Arup assessed the amount of green and blue areas in urban centres of eight global cities. This methodology provides an easy, data driven approach to understanding the natural absorbency of cities and communities, facilitating plans to develop new regeneration through Sustainable Urban Drainage Systems (SuDS) and Nature based Solutions (NbS).



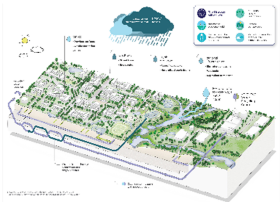
© Arup, 50L Home Coalition

Loop, Share, Exchange

50L Home

Worldwide

The 50L Home Coalition released its white paper 'A Circular Water Future' in 2021. 50L home aims to catalyse systems change and innovations in domestic urban water management that can contribute to global water security. Arup undertook a deep dive into four country case studies; China, India, Mexico and USA to understand the drivers and context of water reuse, and what the levers are for system transformation.



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Integrated Water Management in the Aerotropolis Precincts

NSW, Australia

As part of our planning partnership with Sydney Water and Aurecon, Arup is responsible for integrated water cycle management in the Aerotropolis precincts. Our plan is for stormwater to flow into natural water channels and wetlands instead of relying on buried concrete pipes or drains, as illustrated in the info-graphic. The stormwater will then be collected in wetlands harvesting, treatment and reuse as recycled water. The Aerotropolis integrated water system will be the largest stormwater harvesting scheme in Australia.

Regenerate, Optimise

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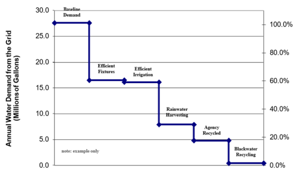
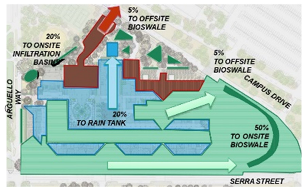
London 2012 Olympic Park Water Strategy

London, UK

As part of the Olympic Park Water Strategy to reduce potable water use by 40% across the London 2012 Olympic Park, water efficiency and alternative water supply options were investigated. Arup undertook a review of potential surface water and groundwater sources available to provide non-potable water to the Olympic Park. Arup worked with the Olympic Delivery Authority to understand the water demands, water quality and distribution around the park. The options to connect demand points with water sources and into a non-potable distribution network were designed and built.

Share, Loop, Exchange





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Stanford Rainwater Harvesting

Palo Alto, CA

This project analysed building water efficiency, site water efficiency, rainwater reuse, greywater treatment, and recycled water opportunities for the redevelopment of the Stanford Graduate School of Business. The project met regulatory requirements, Stanford water conservation and reuse sustainability goals, and credits towards LEED v2.1 Platinum Certification by managing stormwater using rainwater harvesting, infiltration basins and bioswales. The project met net zero water goals by using alternative supplies from on-site rainwater harvesting, lake water, and recycled water.

Loop, Regenerate, Optimise, Exchange

© Arup

Shanghai Urban Drainage Master-planning

Shanghai China

Arup made use of TerrAIn, its Artificial Intelligence land use mapping tool to analyse the land use types across Shanghai and develop a masterplan to introduce blue and green infrastructure measures across the city to increase the natural sponginess of the city. This has increased the stormwater management capacity of the city and the ability of the city to absorb natural rainfall and restore natural processes. In combination with this blue and green infrastructure roll out, the project has optimised the city's grey infrastructure measures.

Regenerate, Optimise, Exchange

Section 5:
Recommendations and Conclusions

Conclusions

As demonstrated throughout this factsheet, implementing Circular Water Economy principles offers the opportunity for organisations and communities to unlock value from water.

It seems clear that the environment for deriving value from water is still underdeveloped. Under the current market conditions the clear ways to unlock value include:

- Reduction in potable water use
- Reduction in wastewater production
- Design for longevity
- Unlocking strategies for building certifications such as BREEAM and LEED
- Recovery of nutrients and other by-products from water
- Reduction of leakage
- Environmental, Social and Governance (ESG) compliance
- Opportunities to co-locate and co-fund shared infrastructure

Under future market conditions, it may be possible to unlock new methods for deriving value from water. This includes:

- Water credit markets
- Financial instruments for creating social value from water

Recommendations

Recommendation 1: Measuring Data Around Water Use

One of the key barriers of industries moving towards circular water systems is the lack of insight into water data in the form of direct and indirect water consumption and pollution data. Several organisations have begun to develop methods for assessing the level of water used in different industries or the effectiveness of water management in companies. Organisations could make use of these existing standards to make the first steps towards understanding their current practices.

Alliance for Water Stewardship - International Water Stewardship Standard[2]

The Alliance for Water Stewardship has launched the second version of its Water Stewardship Standard, which is aimed at all organisations and industries regardless of size. This standard seeks to assess the site of a project, its catchment, and its indirect water use through the supply chain. This is one of the few standards that considers not only direct water use but also supply chain use.

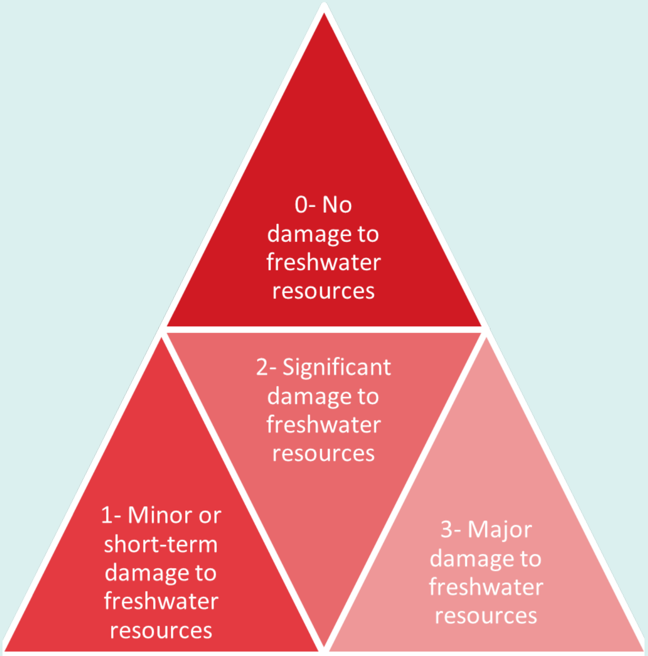
This standard provides several criteria for each step and one or more indicators of compliance. It aims to achieve five outcomes for any site: Good Water Governance, Sustainable Water Balance, Good Water Quality Status, Important Water-Related Areas, Safe Water, Sanitation, and Hygiene for All (WASH) [14]. Organisations hoping to implement circular water principles could refer to this standard to ensure they have the necessary data to truly understand their water use.

AWS Five Steps to Water Stewardship

[2] Please note, other sources of data are available, please consult your local Green Building Council for more information

Water Impact Index[2]

The Carbon Disclosure Project (CDP) has developed a Water Watch tool that makes a qualitative assessment on the impact of various industries on water supply and water quality. This offers an interesting first insight into the impact of global industries on the water environment, split into direct operations, supply chain, and product use.



CPD Water Impact Index

Recommendation 2: Embracing Innovation and Thought Leadership

Globally as increased pressure is being put on our water systems, new innovation and thought leadership is being developed. This innovative thinking could unlock new circular economy opportunities across the built environment and break down technological barriers to CWE implementation. For organisations that already have CWE ambitions but do not have the knowledge capacity or technology to enable it, thought leadership and innovation could enable its roll-out across the built environment.

Ellen MacArthur Foundation: From Principles to Practices

Arup and the Ellen MacArthur Foundation's Water and Circular Economy whitepaper explores a Circular Economy approach to water resources, with a particular focus on Water Management practitioners. This provides an initial business case for implementing circular water principles as follows:

1. A circular business is a more efficient one;
2. A circular business is prepared for a tougher regulatory era;
3. A circular business will be more innovative and find new ways to generate value.

WICER: Water in Circular Economy and Resilience

The World Bank released their WICER paper in 2021, which explores the shift towards circular economy that could happen in the water sector and the impact this could have on global resilience. This provides a framework to roll out the circular economy in the urban water sector and can be referred to as an initial knowledge building document for organisations looking to build their circular economy capacity in water.

Innovation Networks

Organisations such as the World Green Building Council offer an opportunity to be part of a partnership looking out for the latest innovations and opportunities to innovate in the built environment. Through the WorldGBC's Circularity Accelerator the latest thought leadership and innovations in the built environment can be shared and distributed to encourage built environment organisations to consider how their water use could change and become more circular. The WorldGBC's paper Building a Water Resilient Future launched the organisation's call to action for built environment professionals.

Recommendation 3: Pressure and Support from Evolving Legislation

As explored throughout this report, organisations require motivation from Technological, Economic, Socio-cultural, and Legislative inputs for adapting to circular water economy principles. To enact foundational cross-organisational change, legislation offers the chance to motivate a significant shift in the global approach to water resources. Public and private organisations should seek to align with regional and global reporting requirements, targets, and legislation and use this as an opportunity to develop circular water practices within their company.

United Nations Sustainable Development Goal 6

Since their inception in 2015, the United Nations Sustainable Development Goals (SDGs) have represented the global target for the development of a peaceful, prosperous, resilient planet [15]. SDG 6 directly addresses the use and distribution of global water resources. Reduction of water usage is addressed through its Water Use Efficiency indicator, which focuses on improving global water quality and sustainability. This provides global motivation for considering the implementation of a CWE at city or community scale to align with country SDG commitments in their National Adaptation Plans.

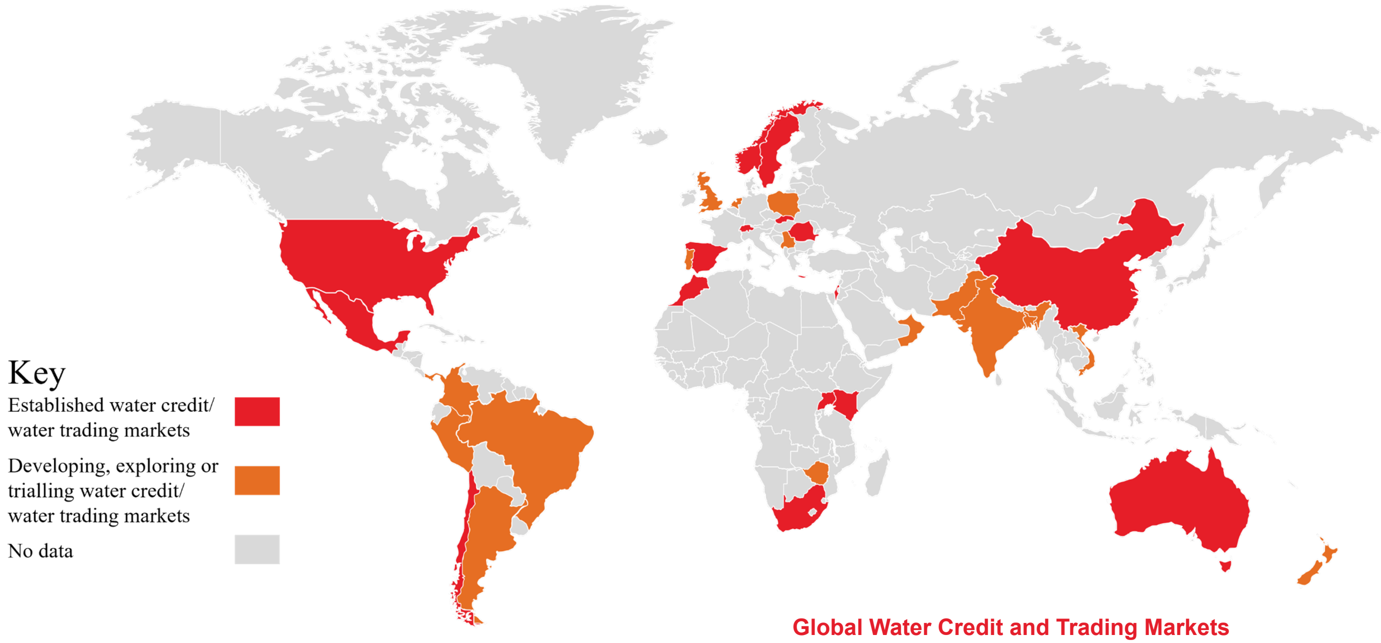
EU Corporate Sustainability Reporting Directive

The EU's new Corporate Sustainability Reporting Directive has created a new level of detail required for ESG reporting. This affects both EU companies and some non-EU companies with EU operations, giving this directive the power to shape global change in ESG reporting. Focusing on water, this requires reporting on:

- The impact and dependencies on climate, air, land, water and biodiversity.
- Information on water and marine resources.

This directive represents a significant shift in corporate accountability for water resources and will require organisations to be transparent about how they manage water resources and have implemented initiatives to reduce their water usage [16].

Enhanced ESG reporting that includes consideration of water use should motivate organisations to implement circular principles to manage their water resources and motivate investors to consider the sustainability of their investments.



Global Water Credit and Trading Markets
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Water Credits and Water Trading Markets

Across the globe, many countries have explored the development of water trading markets or water credits these arrangements can motivate organisations to reduce their water impact. This can take several forms, including water rights trading, water reduction credits or pollution reduction credits. Some global initiatives are highlighted in the figure below, which shows a strong global spread of these markets.

Some notable water credit projects include:

- **UN Water Program** - The UN's Green Water Credits has been rolled out in China, Kenya and Morocco to incentivise farmers to invest in green water management principles [17].
- **Water.org Water Credits** – Water.org has rolled out micro-financing through water credits in India, Bangladesh, Kenya, and Uganda, developing water credits in the form of micro-loans to communities [18].
- **Australia** – Australia has one of if not the largest water trading market in the world designed to protect national water rights and enable cross-state credit transfers [19].
- **United States** – Water trading is not national in the US yet, but many states have very well-established water trading markets where water rights can be sold and transferred between users [19].

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