

ARUP

# GLOBAL WATER ANNUAL REVIEW 2017-18

Inside this years review...



## URBAN WATER RESILIENCE

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## HOW A BLUE-GREEN INFRASTRUCTURE CAN FUTURE-PROOF OUR CITIES

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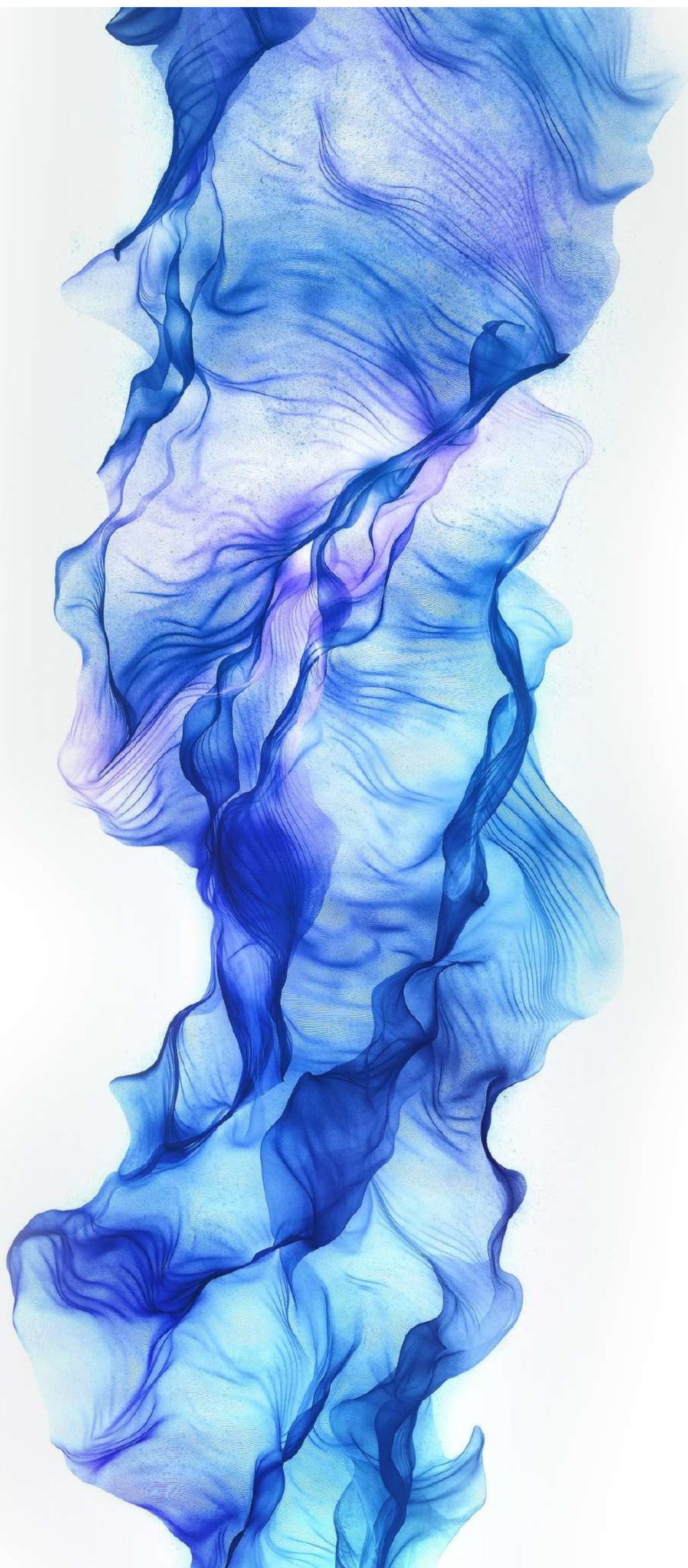
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## TACKLING FLOODING RISKS

By Will McBain

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# Welcome to our Global Water Annual Review 2017/18



Providing an opportunity for Arup’s global water team to share some of our projects, relationships and positive outcomes from around the world. This year we also wanted to weave in an element of future thinking on the water sector ‘hot topics’ which have been talking points at major conferences, such as Stockholm World Water Week and COP 23, throughout the year. Here is just a flavour of what you can expect in this year’s review.

It’s been a significant year for Urban Water Resilience within Arup and over the recent months we have had the privilege of working with such partners as Massachusetts Institute of Technology, The Resilience Shift, 100 Resilient Cities, Stockholm International Water Institute and the Rockefeller Foundation. The last of these has involved engaging with a number of inspiring cities around the world to develop a water resilience framework that will help all cities better prepare for and respond to shocks and stresses across the water cycle.

Our Digital Tide initiative has brought together Arup teams from across the UK, Australia and the USA, working closely with the UK research consortium Twenty65 to understand how digital technologies and processes can provide opportunities to deliver a better, cheaper and more resilient water future.

Arup is taking a lead, working as global knowledge partner to the Ellen MacArthur Foundation, the research and advocacy group for the circular economy, helping them to understand its implications for the built environment from a water cycle perspective i.e. ‘through a water lens’.

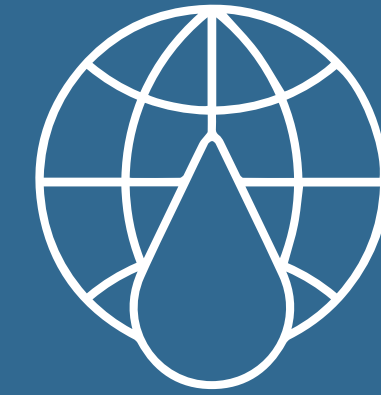
Blue-Green Cities are emerging from concept to reality to help address our modern challenges to quality of life, climate change and inequality. With nearly 70% of the world’s population set to live in cities by 2030, the quality of life experienced by this population will determine our global future. An important element is the integration of blue and green infrastructure to manage all facets of the water cycle such as stormwater, water supply and wastewater. Arup has been working with key city stakeholders to help create resilient sustainable solutions to local problems through master-planning of new cities, such as Jurong Lake District, Singapore, and retrofit of existing cities, as in Hong Kong and New York.

We are working to harness Climate Bonds to improve water issues alongside achieving 2030 Sustainability Goals through our water projects.

We continue to strive to shape a better world. I hope you enjoy the variety of projects and initiatives we have included in this year’s review. We have a great team contributing to positive outcomes across the water cycle. I am very proud to lead them and have the chance to share our work from across the world.

Mark Fletcher,  
Global Water Leader

[JURONG LAKE DISTRICT, SINGAPORE](#)  
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# Urban water resilience

By Tom Armour, Leader of Global Landscape Architecture



“Change is all around us. Climate change, population growth, urbanisation, and resource depletion are the major global challenges facing humankind, and these issues are most prevalent in our cities.”

Tom Armour

## HOW CAN WE EMBRACE THE CHALLENGE OF HIGH WATER DEMAND IN CITIES?

To move towards a more sustainable future it is critical that cities adapt in order to address these contemporary challenges.

Water systems are the lifeblood of a city and are increasingly coming under strain. Growing populations the world over, and increasing living standards, are inexorably driving a rising demand for water. Concurrently, a changing climate is making extreme events, from drought to floods, an increasingly common occurrence leaving all vulnerable to water stress. One in four large cities are already facing water stress, and demand for water is only projected to increase, up by 55% by 2050. As such, our urban water infrastructure requires extensive renewal and expansion to effectively manage water resources to meet demands. Whilst this is a significant challenge, it also provides an opportunity to revolutionise how urban water systems are designed and retrofitted, to better manage our water resources and improve environmental conditions for the benefit of all. The defining feature of this age will be our response to the increasing shocks and stresses of these global challenges.

Water is a sensitive, often contested, and shared resource and the way it is designed and managed will be critical to people and business. There is an urgent need to significantly improve conditions in many towns and cities, to not only cater for basic needs, but to promote healthier and more sustainable lifestyles.



Therefore if we are to provide towns and cities that not only cater for our basic needs, but promote safe, healthy environments to live, work and play, we must consider “blue” solutions as obligatory, and not as an optional extra.

We must understand the fundamental power of nature and how it can complement our technological solutions to tackle the greatest challenge of our time: providing enough water for people everywhere and managing it effectively to mitigate shock and stress. To build the resilience of any city, the challenge is to recognise and understand the complexity of its urban water systems, its environments, and interconnection with communities and stakeholders across the water cycle and its catchments.

Fusing insights from engineers, designers, planners, economists, managers and environmental and social scientists is the way we can rise to this challenge.

Holistic, collaborative and innovative thinking across sectors and disciplines from around the world will enable us to create sustainable solutions which integrate social, economic and environmental perspectives.

This ‘knowledge catalyst’ highlights the forward-thinking cities and those who are already helping to shape a better world through sustainable, resilient water management.

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## SLOAN BUSINESS SCHOOL MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND ARUP UNIVERSITY – RESILIENCE OF URBAN SYSTEMS

By David Mcdonald

Developing a worldwide team of experts to help cities become resilient to ‘shocks and stressors’

Arup is dedicated to developing a global network of experts who can help cities across the world adapt to the challenges ahead and be better prepared for shocks and stressors – becoming truly resilient.

Key to this is the Arup University “Masters” modules available to staff across the business, provided through our own internal experts and Massachusetts Institute of Technology. These focus on the development of the firm’s future leaders, enhancing their ability to advise clients and add resilience to our city scale projects.

The modules provide a chance for 30 members of staff per year to learn from and spend time with some of Arup’s most senior figures – including group leaders and fellows. Together studying cities around the world and working on projects which focus on real water, transport and energy systems and their challenges.

“Resilience is becoming ever more important for cities across the world as our urban environments become ever less reliable, from challenges in the economy and environment to technology and terrorism,” said David Macdonald, Head of Learning for Arup University.

At present a shock or stress hits a city and the reaction is often one of straightforward repair and recovery. Cities of the future will need to be better at becoming resilient to those shocks, stressors and perhaps even thriving in such times. Persuading cities to invest in resilience, though, isn’t easy as resilient systems tend to be expensive and the benefits only visible well beyond political terms of office.

The purpose of the Masters programme is about develop our leaders and some of our partners outside the firm to both propose technically resilient solutions and persuade city governors to invest in those.

## RESILIENT WATER GOVERNANCE WORKING WITH THE RESILIENCE SHIFT (RS) AND STOCKHOLM INTERNATIONAL WATER INSTITUTE (SIWI)

By Louise Ellis

The Resilience Shift is a Lloyd’s Register Foundation initiative delivered by Arup. It aims to shift the global approach to designing, delivering and operating critical infrastructure, to make it, and the places that it serves, more resilient.

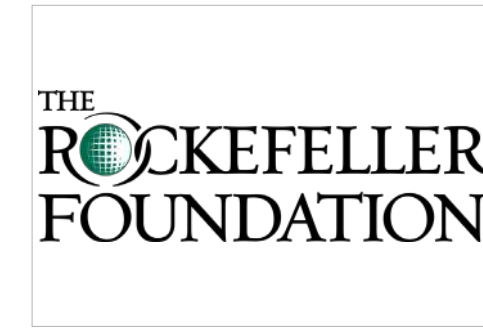
Arup are working with SIWI’s Water Governance Facility and We are Telescopic, a software developer, to spearhead the development of a global toolkit to help cities across the world better govern their water to ensure their critical infrastructure is more resilient.

There are many organisations involved in the water cycle, for example, there may be individual organisations overseeing agriculture, water supply, sewerage, drainage, fluvial flood defences, coastal flood defences and hydro-electrical power. Some of these actors may work in silos or undertake actions without awareness of the impacts on the wider water cycle.

This project is an opportunity to enable more resilience and inclusive water governance by providing a toolkit that encourages city stakeholders to come together; map their catchment functions and roles and responsibilities across the catchment; understand the impacts of their decisions as well as external shocks and stresses across the catchment; and identify their governance gaps and develop their governance approaches to improve the resilience of water systems.

The project has a Steering Group with representatives from The Rockefeller Foundation, 100 Resilient Cities, the World Bank, University of Massachusetts-Amherst, the Alliance for Global Water Adaptation (AGWA) and The Resilience Shift.

The project offers the opportunity to provide cities with the tools to make evidence based decisions collaboratively with regards their long term resilience.



## THE CITY WATER RESILIENCE FRAMEWORK (OUR WORK WITH ROCKEFELLER)

By Martin Shouler

Arup is working with The Rockefeller Foundation and five cities, which are facing a diverse range of water challenges, to develop a framework that will help all cities better prepare for and respond to shocks and stresses to their water systems.

Following an open competition process to the 100 Resilient Cities Network, which saw 13 cities apply, five cities were successful. Amman, Cape town, Mexico City, Greater Miami and the Beaches, and Hull were selected to partner in the co-development of the City Water Resilience Framework (CWRF).

They were selected because of their diversity in terms of size of population, geographic location and economic status, and because of their commitment to taking a strategic approach to resilience.

The development of the CWRF is being overseen by a steering group with representatives from The Rockefeller Foundation, 100 Resilient Cities, the World Bank, University of Massachusetts-Amherst and the Resilience Shift.

Arup has partnered with the Alliance for Global Water Adaptation (AGWA) and Stockholm International Water Institute to develop the The CWRF is aligned with the City Resilience Index (CRI) which aims to help cities come to collective planning, development and investment decisions to ensure greatest urban resilience.

In terms of water systems, the CWRF will consider impacts on a city’s water resilience from factors within the city boundaries as well as the wider water basin recognising the complexity and scale of urban water systems and all elements of the water cycle. It will aim to understand a wide range of issues in different contexts, eventually, in phases two and three, producing a framework and set of tools that will enable all cities to understand how to assess the risks they are facing, how to bring stakeholders together to make better decisions and how to prioritise action and investments to become more resilient.

At the conclusion of the field work with each of the five cities, Arup will share its findings at a Global Knowledge Exchange event, with where all cities which applied to be part of the project will be informed of the findings.

The ultimate aim is to influence cities to drive change and bring together stakeholders from across a water basin area to enhance resilience.



## WATER COMPANIES RESILIENCE – OUR ADVISORY WORK WITH VARIOUS COMPANIES

By Ian Gray

A new mindset for risk management across the water industry.

Having helped Welsh Water to develop a pioneering resilience strategy for the next 30 years to anticipate, adapt, respond to and recover from the challenges ahead, Arup is now supporting a further six water businesses in the UK to do the same.

Working with Cardiff University as an academic sub-consultant, Arup carried out a comprehensive review of best practice and workshops with the client, to create a resilience plan against a wide range of shocks and stresses in all aspects of a water business.

Drawing on our global experience of resilience planning for cities and infrastructure from our work with The Rockefeller Foundation and 100 Resilient Cities, we identified a list of around 60 shocks and stresses that Welsh Water might be vulnerable to. We applied this framework to identify areas of best practice and areas for improvement. This work created a strategic pillar for the development of their 35 year strategy Water 2050 which Arup also supported Welsh Water to develop. All this work was well received by multiple stakeholders including customers, Ofwat and the Welsh Government. This led to a series of initiatives to embed resilience into Welsh Water’s business covering people, infrastructure, finance, leadership and strategy. These fit very well with the guidance from Ofwat, the water regulator in England and Wales.

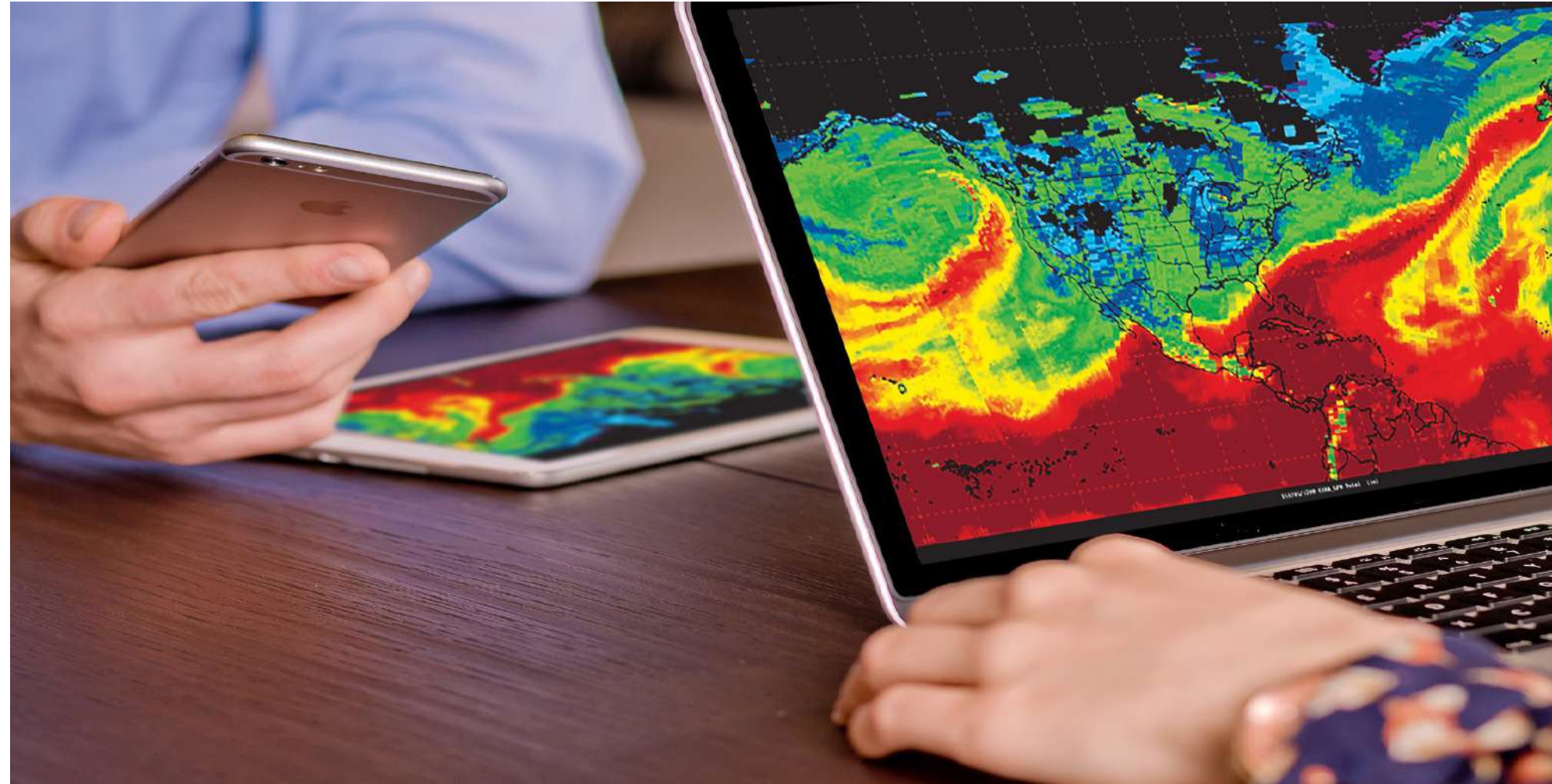
The framework provided the foundation for an entirely new way of resilient thinking at the company and has been used to identify a series of short, medium and long-term initiatives that are currently the subject of stakeholder engagement within the business. It has also created a new mindset of resilience management across the water industry, providing water companies in the UK and around the world with a model for mitigating their exposure to an ever-widening array of shocks and stresses.

Having created a strategy to kick-start the kind of innovative thinking needed to prepare for and respond to shocks and future stresses in the decades to come, we are now working with Welsh Water, Thames Water, South Staffs Water, Anglian Water, Severn Trent Water, Yorkshire Water and United Utilities to test their resilience approaches now and into the future.



# Digital disruptions are changing the rules of business

By Therese Flapper, Australasia Digital Water Leader



New scalable, digitally networked business models, like those of Amazon, Google, Uber and Airbnb are affecting growth, scale and profit potential for companies in every industry. The advent of a fourth industrial revolution clearly indicates that while this seismic shift may seem to be a distant concern to certain industries, the trend is not unique to digital start-ups and tech-superstars and will affect every business sector.

While the first industrial revolution was steam-powered; the second electrical; and the third the birth of the computer age; the fourth is the era the Internet of Things, 3D printing, genetic editing, Artificial Intelligence, Machine Learning, data-driven decision making, robotics, mobile supercomputing, big data analytics and data visualisation.

Though previous industrial revolutions liberated humankind from animal power, made mass production possible and brought computing capabilities to billions of people, this fundamental Fourth Industrial Revolution is blurring the lines between the physical, digital, and biological spheres. We now live in a world with a digital twin for every element, every facet and every component of humankind – including people.

The water sector, like every other, is not immune from the changes that are transforming communications, technology, manufacturing, the workplace and society.

Digital disruption can be considered like any other driver of change in that it acts upon a sector and there are opportunities for those ready to accept the challenge and embrace adaptation. Arup teams from across the UK, Australia and the USA have been working with the Economic and Social Research Council (ESRC) and the UK research consortium Twenty65, coordinated by Sheffield University, to understand how digital technologies and processes will act in the water sector.

Our ‘Digital Tide’ initiative is exploring disruption from both (i) a business-as-usual position; responding to the digital disruption stimuli and (ii) from a position that organisations are actively seeking to take up the benefits of that accelerating digital disruption – moving towards the digital utility of the future with ever increasing digital maturity. The latter will require new ways of thinking, collaborating and working across sectors and stakeholders. As part of this initiative Arup have identified and developed a set 40 digital disruptors cards, assess their potential impact on the water sector.



“Most utilities noted they lack a Digital Strategy or Policy and many reflected that they did not have the skills or understanding upon which to start a digitally based conversation.”

Therese Flapper

<b>SENSING</b>	Improved sensor technology, and the potential for more distributed and diverse data sources, will change the way we measure and evaluate both quantitative observations and qualitative experiences.
<b>CONNECTIVITY</b>	The connection of a vast number of sensors, objects and people into a common network presents an opportunity to exchange insights and instruction, and enable new services and interactions.
<b>DATA</b>	Technical advances in data storage and processing power promise to have a transformative effect on the speed, resolution and richness of a variety of systems.
<b>AUTOMATION</b>	Advanced digital intelligence and mechanical dexterity are coming together to create new possibilities for improved efficiency and decision-making.
<b>NETWORK</b>	Digital networks provide an opportunity for data to be exchanged for mutual benefit, shared vision, and as part of business models to produce better profiles of risk, reward and customisation.

The water sector has a considerable amount of inherent inertia built in due to its capital intensive infrastructure. However there are opportunities for those willing and able to

exploit the digital advantages of the Fourth Industrial Revolution to deliver a better, cheaper and more resilience water future. Is the water sector digital-ready?



## DAMS AND RESERVOIR WORK

By Jeremy Fletcher

Arup has been turning to new technologies to transform the way water companies manage and maintain older assets such as dams and spillways.

With many dams hundreds of years’ old, often companies have very limited accurate information on their dams, reservoirs and tunnels, meaning they are often working blind when it comes to maintenance and monitoring.

The UK reservoir industry is progressively moving from a standards-based approach to a more risk-based approach. To support this it’s key that new ways of capturing accurate data and interpreting original design intents, to monitor and maintain such assets, are developed.

Arup has been at the forefront of use of the latest advancements in technology, transforming the way age old assets are surveyed both externally and within dams and associated structures. It has seen a move from outdated and high risk methods to new techniques, using modern technology to provide updated, much more detailed and accurate information.

Arup’s clients, including Welsh Water, Irish Water, National Resources Wales and Yorkshire Water, are amongst those turning to new technology.

These have included interpreting and utilising satellite imagery, land and drone based LIDAR, Remote Operated Vehicles and 3D scans alongside more traditional techniques to survey spillways, valve towers, pipework and dam structures to build up complete 3D images interfaces between these above and below ground structures. All of these are examples of how technology is helping our teams at Arup to gather large amounts of data and inspect areas previously inaccessible for our clients.

LIDAR has been particularly useful, as it enables us to secure highly accurate 3D imagery of key sections of networks, completed in a matter of hours, to create 3D modelling of the networks and identify problems and priorities. It reduces costs and, in some locations, the physical risk associated with the traditional survey methods. These include shutting down systems for access to potentially confined spaces or areas requiring roped access.



## DIGITAL UTILITY ROADMAP, WSAA, NSW

By Therese Flapper

Creating a roadmap for water utilities to harness the digital economy.

Helping water services adapt to the ever changing digital world is far from simple, but it is something they recognise and an issue they want to address.

It was with that in mind that Arup was asked to create a ‘Digital Utility Roadmap’ by the Water Services Association in Australia (WSAA). This body that supports the Australian urban water industry to provide water and sewerage services to over 20 million customers.

Research was conducted with 18 different water utilities companies, focusing on their past and current digital position, and where they saw their digital work heading over the next five years.

It identified very different stages of digital maturity, and the water industry has a long way to go in understanding the full digital opportunity.

Whilst most acknowledged the digital age is being something they must respond to quickly, they lacked the knowledge and skills to plan forward.

They recognised that their customers’ digital expectations are rapidly increasing, as they already benefit from personalised smart-bills and mobile phone and tablet systems for communications and payments with other service suppliers.

Many reflected that they did not have the skills or understanding to plan a clear route forward, and that they had found it hard to recruit digital specialists when competing against other higher paid industries and sectors.

As a result of the research, the ‘Harnessing The Digital Economy’ White Paper has been published, essentially provide a ‘roadmap’ for water services companies in Australia and New Zealand. This will help them implement digital strategies for the benefit of their business, and for their customers and clients.

It focuses on how they can prepare for a move towards digital maturity, introduce efficiencies, integrate parts of their business through digital means, improve customer interface and integrate better with the communities they serve. The White Paper, published in November 2017, has already received interest from the UK and US.



## THE NEW ZEALAND WATER CONSUMER SURVEY REPORT AND DIGITAL TOOL 2017

By Daniel Lambert

This was the first ever nationwide survey to find out what New Zealanders think about critical issues associated with water.

Arup undertook an independent online survey on behalf of Water New Zealand (Water NZ), which provided an accurate gauge of New Zealanders’ attitudes towards water. It asked respondents to think about a range of important subjects, including drinking water quality, water security, pricing, customer service, waterways, and the future of water in New Zealand.

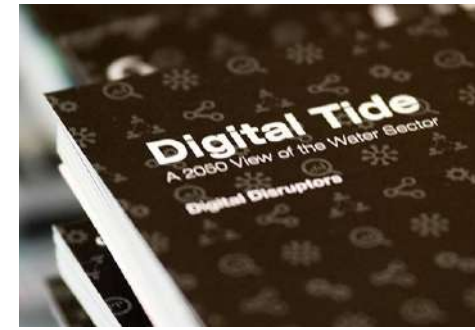
The research will now assist water utilities, councils and government to develop a deeper understanding of consumer views and subsequently tackle the challenge of creating policy that is relevant to consumers, as well as addressing their needs and issues.

Arup also developed a complementary data visualisation tool to enable interested parties to view and interrogate the survey data. This tool makes the captured data readily and easily accessible and understandable. It enables users to review the data by geography and other demographics, enabling in-depth analysis of what consumers think about water, delving into the insights from different locations, genders, ages and other demographics.

The benefit of this “first of its kind” tool has already been exhibited at the Water NZ Conference 2017, with Arup facilitating the Consumer Value Forum and delivering the report. The report and tool have gained significant media attention, particularly during Central Government elections, as a useful way to understand the consumer perspectives.

As the water industry shifts towards a more customer centric focus, from thinking of customers as “rate payers” to “consumers”, it is becoming imperative to understand the consumer and what they want. This is the first time we have seen any country develop a visualisation tool which they can share for real time assessment of data.

These considering ten key elements with regards to the digital future, which are improving sensor technology, connectivity, data collection and storage, automation digital networks.



## DIGITAL TIDE PROJECT

By David Vernon

Arup teams from across the UK, Australia and the USA have been working with the UK research consortium Twenty65 to understand how digital technologies and processes can provide opportunities to deliver a better, cheaper and more resilient water future.

With the customer and consumer at the heart of how water utilities are re-shaping themselves, it has been incredibly timely for Arup to investigate how digital and data analytics tools can enable a step change in the responsiveness of water services.

Our Digital Tide project, was designed to delve into the intersection between digital and water, recognizing that stakeholders in the water industry seeking to take advantage of the benefits presented by digital technology will require new ways of thinking. The wider impacts were also considered and implications will be widespread both for the water industry and beyond, defining new ways of working and collaborating.

The project has resulted in the development of ‘Digital Tide cards’ which provide ‘storyboard’ material to allow the water industry to map and understand the impact of digital disruption.

They provoke discussion about how emerging technologies could disrupt the way the water sector operates in the future and equips different stakeholders in diverse geographies with the tools to outline what their future could look like.

As part of this initiative, Arup identified 40 ‘digital disruptors’ and developed a set of cards which assess the potential impact on the water sector. An example of these are:

- Big data analysis
- Autonomous repair
- Cyber attacks/security
- Open data
- Advanced robotics
- Artificial intelligence
- Predictive maintenance
- Live stream satellites
- Distributed sensor networks
- Virtual and augmented reality



# Flowing in virtuous circles

By Justin Abbott, Global Water Skills Leader

## HOW THE CIRCULAR ECONOMY COULD TRANSFORM OUR WATER UTILITIES

In a rapidly urbanising world, sustainable water infrastructure is becoming a central challenge. New and growing cities either require new water infrastructure or need to radically improve the productivity of their existing assets. Pressure on water supplies is a growing issue and traditional approaches to its management have often been inefficient. For example, the UK is estimated to lose over three billion litres of water to leaks every day.

One way of meeting the sector's priorities would be to rethink how our water cycle operates, applying 'circular economy' principles across the productive process. The circular economy aims to recast the way we produce and consume the world around us, keeping materials at their highest value for longer and finding ways to conserve energy and re-use resources. It is circular because ideally this results in a productive system where almost nothing is wasted. It is economic because it's aligned to smart commercial objectives.

At many stages in the water cycle, from abstraction to treatment, distribution to discharge, a circular approach reveals opportunities for all stakeholders, including water utility companies in particular, to conserve water, capture and re-use energy, extract and reuse valuable materials and by-products, and crucially, improve commercial operations.

## RETHINKING OUR MOST PRECIOUS RESOURCE

Switching from our existing, largely unsustainable, linear mindset of 'take, make, use, dispose' to a circular paradigm requires rethinking many aspects of production. The systemic nature of the circular economy requires both the ecosystem of water management and its individual components to change. However, the good news is that many of the ideas and technologies required already exist, they're just not currently being deployed on a widespread and in a joined-up way to achieve that goal.



**"Companies that want to remain profitable in a world with increasingly scarce resources need to adapt their business models and make far greater use and re-use of materials."**

Justin Abbott

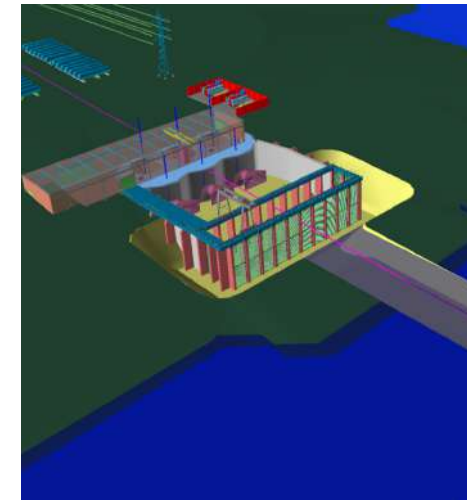
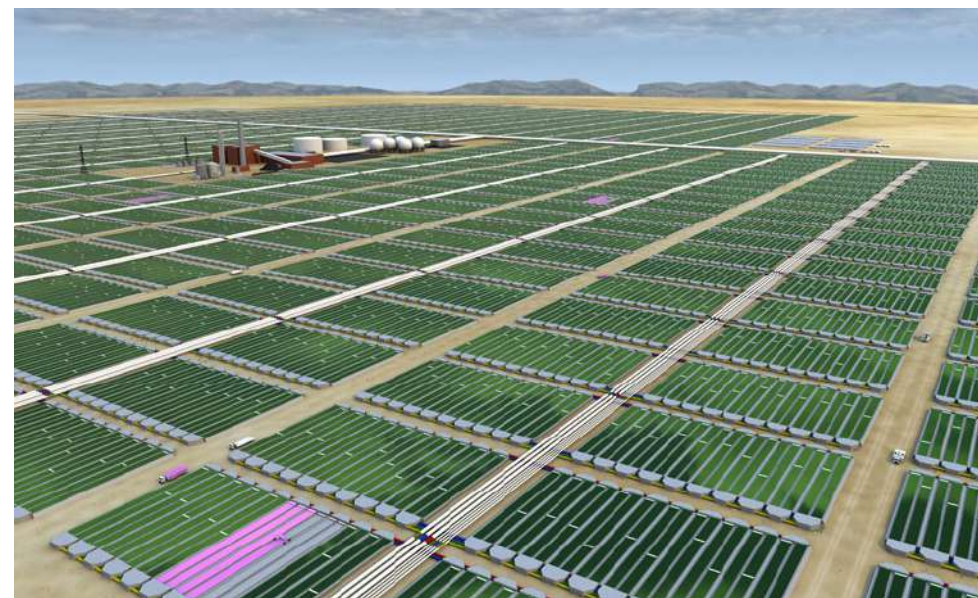
The following are three key areas of water utility operations where innovative use of technology and circular thinking could be applied:

1. Micro-hydro – from pipes to power: Drinking water moves through pipe networks using pressure reducing valves (PRVs), a process that creates energy. New in-pipe hydrokinetic systems use micro-turbines to convert this energy into electricity that can be fed back into the grid. This means lower costs and greener operation for utility firms.
2. Turning algae into energy: Algae processing bio-reactors don't just treat and clean wastewater – they also produce usable materials such as biomass (for energy production) or otherwise hard to synthesise chemicals for the pharmaceutical industry.
3. Capturing value – minerals and resources: Wastewater is often full of minerals and other nutrients that can be re-used. A number of innovative technologies have been developed that can extract heavy metals and minerals from the effluent discharges from animal farms and wastewater treatment plants. Some of these can be reused in the industry, while others such as phosphorus, can be used as fertilizer for agriculture.

## UNLOCKING THE POTENTIAL

These are still relatively new ideas in the water sector. Arup is already taking a lead, working as global knowledge partner to the Ellen MacArthur Foundation, the research and advocacy group for the circular economy, to help them to understand the implications for the built environment.

As part of this process, our researchers are currently re-imagining the water sector's underlying business model for opportunities to unlock its circular potential, making it more sustainable and commercially valuable over the long-term.



## CULTANA PROJECT, SOUTHERN AUSTRALIA

By David Dawson

Arup's experts has demonstrated the feasibility of building the largest seawater pumped hydro facility ever constructed in the world, and the first in Australia.

It will see sea water pumped uphill to a storage reservoir so that it can be released through a turbine to generate electricity at times of higher demand.

A initial feasibility study, funded by the Australian Renewable Energy Agency (Arena), was carried out to assess the merits of a new pumped hydro energy storage project at a site near Port Augusta in South Australia, a dry state with limited water and energy supply.

It concluded that such a development was technically viable and could generate 225 MW of electricity with 1770 MWh of storage equivalent by using seawater as the storage medium.

The site has many benefits for the creation of a sea water hydro facility, given it is elevated 250 metres above sea level, stands within 3km of the shoreline and within 2.5k of a high voltage transmission network. It only had one landowner also – the Department of Defence – making land negotiations relatively straight forward.

An upper reservoir with three penstocks about 3.5m in diameter, and three turbines for generation which can also be reversed for pumping, has been recommended.

Having won the initial backing of EnergyAustralia and Melbourne Energy Institute, and recommended that it is a viable option, Arup is now conducting a more detailed phase of feasibility, including detailed engineering design work, a complete environmental impact assessment, grid connection and land access arrangements.

Ongoing consultation with all stakeholder groups will continue to ensure any potential concerns or issues can be appropriately addressed.

Once all approvals are in place and the detailed engineering is completed, EnergyAustralia will be able to make a final investment decision on the project. This is expected to occur towards the end of 2018.



## SLUDGE STRATEGY

By Edoardo Piano

Arup's process engineering, operations and asset management and optimisation skills has enabled Yorkshire Water Services (YWS) to understand their biosolids operation better than ever before.

We developed a number of key tools to provide YWS with a detailed picture of how much and what sludge types are produced, where their process bottlenecks are and where the greatest potential is for disposing the end product to land.

Our 'headroom' tools brought YWS clarity for the first time on the amount and quality of sludge being produced and processed at each site.

This gave them unprecedented insight into the regional impacts of growth and how to better manage their sludge logistics.

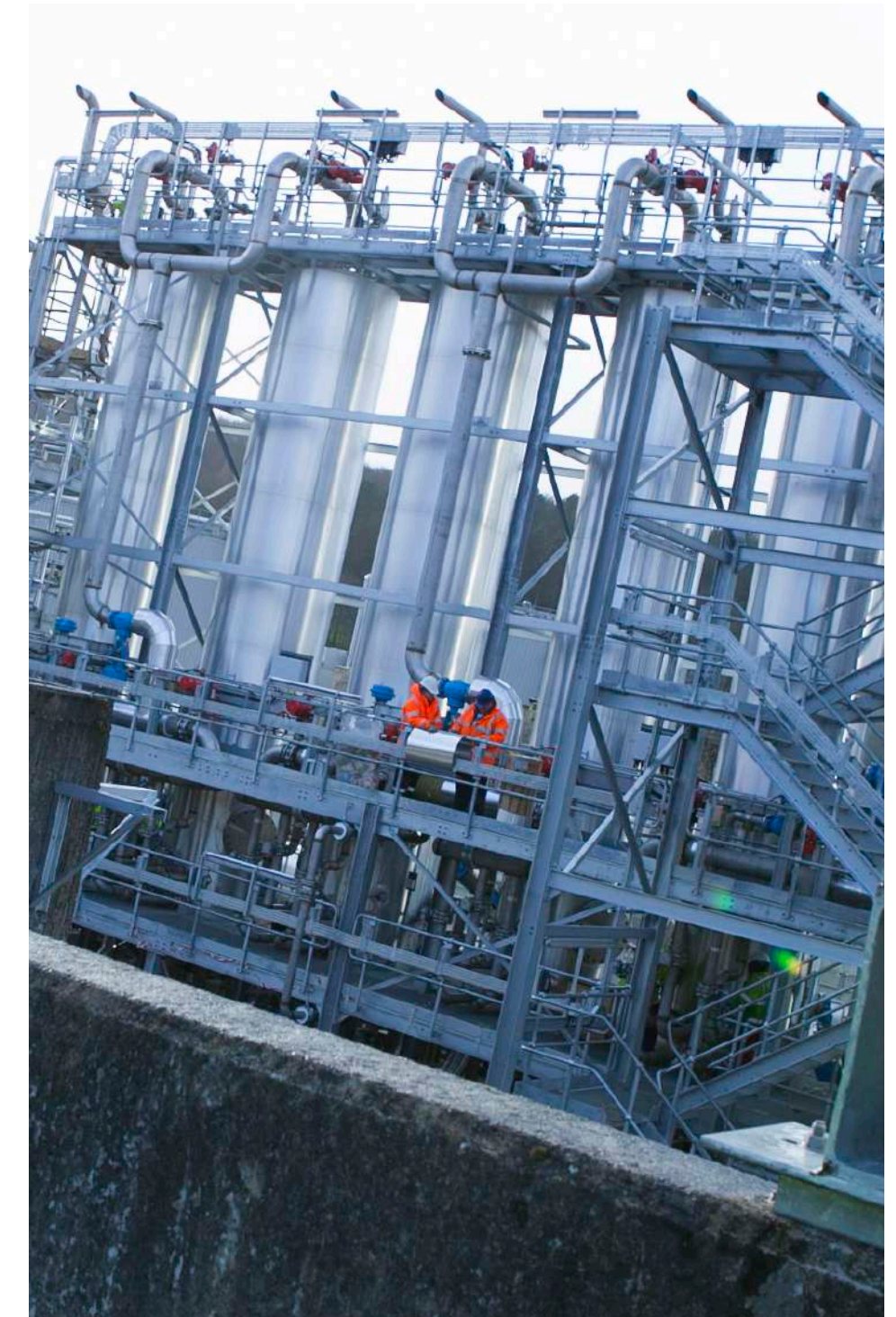
The integration of quality drivers enabled proper planning of treatment capacity, providing information to feed into discussions with the Environment Agency.

Arup also developed new, interactive mass balance tools, enabling the effect of different sludge blends and operational parameters to be assessed at treatment centres.

This tied in with the opening of the Bioresources Market instigated by OFWAT, as the tools provide key operational and cost parameters, enabling estimates and optimisation of treatment costs to be done.

We also reviewed all other key bio-resource assets, providing an overview of key bottlenecks to their sludge business, enabling a prioritised list of investments to be generated and to feed in the PR19 submission.

Arup also carried out a forward-looking review of potential risks to continued disposal of biosolids to land, helping Yorkshire Water understand risks arising from micro-plastics, antibiotics and other priority substances.



## YWS PHOSPHATE WORK

By Vincent Glancy

A collaborative online environment created, led and managed by Arup has helped increase productivity and efficiency of the Welsh Water Alliance – a group of companies entrusted to manage Welsh Water's £1.5 billion capital investment programme between 2015 and 2020.

SharePoint acts as a 'single source of truth' and live information for the Alliance's six partners - Dwr Cymru Welsh Water (DCWW), Arup, Morgan Sindall, Mott MacDonald and Bentley (MMB), Skanska and Arcadis for all projects and work. Users can upload and share all key data, from project work to Health and Safety alerts, and it has ensured vital data is effectively shared between all partners, allowing more than 700 staff to access data and documents, which are updated in real time.

The web-based common data environment provides a searchable location for Alliance staff to find the tools, information and collaboration areas they need to deliver their work efficiently.

It has also helped establish a transparent culture across the Alliance.

Ultimately, it saves time for document controllers, board members, designers, and contractors on site, as well as the client, as it reduces the risk of error and duplication of effort on such a large scale ongoing project of works, and helps all towards the ultimate aim of meeting their targets.

Without such a system, given the size and scale of projects and staff, such knowledge sharing would be limited and truly efficient working would be impossible.

Managed by Arup's Katherine Gouws, with technical support from Arup IT, it contains more than 185000MB of documents and has around 5,000 views each day. Arup received the Technological Advances award at the Institute of Water, Welsh Area Innovation Awards and upgrade options are now being considered and developed, with plans to move to a cloud-based platform, as well as improving user functionality following feedback, including a single sign on system.



# How a blue-green infrastructure can future-proof our cities

By Vincent Lee, Water Engineering Skills Leader



## HOW WILL A BLUE-GREEN INFRASTRUCTURE CAN FUTURE-PROOF OUR CITIES

Blue-Green Cities exist to help address the modern challenges to quality of life, climate change and inequality. With nearly 70% of the world's population set to live in cities by 2030, the quality of life experienced by this population will determine our global future. Keeping up with global urban growth projections for 2030 will mean developing an area the equivalent of 20,000 American Football fields per day between now and 2030.

Our precious water resources and ecosystems will be subject to the pressures of growth and urbanisation. It is increasingly cities, more than national governments that have the power to tackle climate change, fuel the global economy, deliver prosperity and alleviate poverty.

A central role which cities possess is the integration of blue-green infrastructure to manage all facets of the water cycle (stormwater, water supply and wastewater). Many cities will need to develop an integrated water management plan due to system pressures from climate change or ageing / lack of adequate infrastructure.

Less than 20 miles south of Boston, Massachusetts a new smart city is being planned. Union Point will integrate sustainability and digital technology to address demands of the stressed municipal infrastructure and projected climate change risks. The new development includes all elements of sustainable water management including water efficient buildings, water efficient landscape, smart water technology, green infrastructure, rainwater harvesting and water reuse.

In terms of retrofitting cities, more cities around the world are adopting blue-green infrastructure, which uses trees, soils and other plants to manage urban water by mimicking the natural hydrological cycle. Many places are making great use of green infrastructure. New York City is aiming to invest US\$2.4bn in green infrastructure over the next 20 years. It's planning over 7,000 "curbside gardens" in the streets to reduce combined sewer overflows. In Wales, Welsh Water are investing £80 million until 2020 for their RainScape program.

It also brings multi-faceted benefits such as beautifying neighborhoods, increasing property values, reducing the heat island effect and absorbing carbon dioxide.

These benefits are clearly linked to the aspirations of governments and city dwellers which will create blue-green cities.

For planners and engineers involved in blue-green cities, it's an exciting time. The challenge until recently was gaining consensus, developing guidelines and finding success in pilot projects; the challenge now is delivering at a scale and pace that cleans our waterways and combats climate change.

There are still some hurdles to overcome. For example, a better understanding of financial mechanisms and economic models is needed to enable that can enable green infrastructure to be adopted at a wide scale.

Appropriate models must be identified for different cities, however success will rely on identifying appropriate models for different cities.



## SMART AND EFFICIENT WATER NETWORKS TO BRING MAJOR SAVINGS

By Nick Copeland

The development of Smart Networks has been a key focus in our work for Welsh Water over the past 12 months, with smart technology bringing huge efficiency improvements and savings in Llanelli.

Like many water utility companies, Welsh Water faces challenges relating to aging assets, population growth, climate change and affordability. Traditional approaches to reducing flood risk and sewage spills like building bigger pipes, tanks and pumping stations are often not the most efficient or economically viable options, especially when existing assets are not being fully utilised. As lead designers on the development of a catchment-wide 'smart' solution (one of the first of its kind in the UK) Arup has installed a number of sensors across ten major assets, which continually measure flow and depth.

Assets such as pumps, flow controls and storage systems all have live telemetry and can 'talk' to each other and respond to network conditions, by adapting flows to protect areas under greatest strain.

For example, when storm tanks reach a high level, flow from upstream pumping stations is throttled down so that assets only spill once the entire catchment storage is full.

In future, the network will utilise weather forecasts to ensure the system is based on incoming rainfall, further optimising the storage and operation within the catchment.

We have delivered £20m in smart sewers and another £20m has been invested in a ground-breaking wastewater treatment technology which enhances treatment capacity within an extremely small footprint. All of this smart technology, combined with £60m of green infrastructure retrofit schemes, has resulted in huge improvements in performance, reducing the annual number of combined sewer overflows across the catchment from 414 to 140. Volume has also been reduced by 95 per cent, bringing Llanelli into compliance with the National Environment Programme targets. The live link of three assets alone has led to an estimated saving of £8.5m. Overall, the project has made use of 50,000m<sup>3</sup> previously unused storage capacity with 'optimisation' schemes making use of existing storage at one third the cost per m<sup>3</sup> compared to constructing new storage tanks, with significant carbon and land area savings.



## JURONG LAKE DISTRICT SINGAPORE

By Peter Stones

A 'City of Gardens and Waterways' will be created by bringing together the natural environment with existing and proposed multi-million dollar developments alongside the Jurong Lake in Singapore, following Arup's input into a new city masterplan.

Following our involvement in all five shortlisted competition entries to the Singapore Urban Redevelopment Authority for the creation of the masterplan, and the successful KCAP team, focus is on creating a Central Business District with greater open spaces and connection to the lakefront and integrating water throughout.

A new mixed-use business area will be built around the future Kuala Lumpur-Singapore High-Speed Rail (SHSR) terminus, with the proposals opening up a huge area for redevelopment, providing a great opportunity to redesign the area and reconnect with the Jurong Lake.

Arup's commitment to developing blue-green cities, has been at the core of the project. This will recreate naturally oriented water cycles while contributing to the amenity of the city by bringing water management and green infrastructure together. These plans focus on making the most of the riverside position.

Residential developments have been focussed around the water front along with more parklands and open civic spaces, whilst commercial developments have been placed more centrally around the SHSR.

With the region prone to short and intense periods of heavy rainfall, parks will act as sacrificial zones and areas of natural drainage. Where terraced streams can fill with water in the event of heavy rainfall, warning systems are in place to warn residents.

Plans also include measures to ensure maximum water management efficiency, with the fixtures and fittings meeting the highest levels of performance, and drainage systems designed to cope with a 1/100 year flood event (factoring in Climate Change).

The opportunity to tap into a national water network at site means the district will also benefit from the national water recycling system both for toilet flushing, district cooling and irrigation.

The result has been a plan which fits perfectly in the Active, Beautiful, Clean Waters Programme, and has been approved by the Urban Redevelopment Authority.



“Done well, green infrastructure reduces flooding, improves water quality and replenishes groundwater. The protection of water resources from urban runoff and associated pollutants like sediment, nutrients, metals, pathogens, trash, and hydrocarbons is a constantly growing challenge.”

Vincent Lee



# Sustainable development goals

By Thomas Sagris, Senior Water Engineer, UKIMEA



The Sustainable Development Goals (SDGs) were born at the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012, replacing the Millennium Development Goals (MDGs), which started a global effort in 2000 to tackle the indignity of poverty.

The purpose of the SDGs was to produce a set of universal goals that address the urgent environmental, political and economic challenges facing our world. All 17 SDGs interconnect and, therefore, progress in one goal can affect other outcomes.

The core focus of SDG 6 is to ensure availability and sustainable management of water for all. In a world where pressure on water resources is rising due to growing populations, water intensive patterns of growth, climate change and pollution, coordinated action is required by the governments, the private sector and society to tackle the water challenges.

Effective action requires a change in the way the world thinks about water.

Water should be everyone's responsibility; governments need appropriate regulatory environments and policies to better manage water and deliver water and sanitation services using integrated water management approaches.

As major water users, citizens, farmers and the private sector should assume responsibility to use water efficiently, minimise pollution and engage in water stewardship initiatives. Water stewardship, in particular, could play a key role in achieving outcomes at a lower cost, eliminating possible investment gaps and promoting cooperation and partnerships in the water sector.

Finally, users should pay the right value for water; a price that does not just reflect the cost of physical supply but also its social, economic and environmental value.

Solutions to water issues have direct links and contribute to the achievement of the other SDGs that rely on the development and effective management of water resources. Water has a wider, key role in assisting sustainable development at local, national, transboundary and global level.

Achieving the SDG targets and outcomes could create several opportunities for economic growth due to water sector contributions:

- Protecting and restoring water-related ecosystems not only improves quality of life, but
- could also enhance economic prosperity through the provision of ecosystem services
- Wastewater and waste by-products could be seen as an important element of the water cycle enabling circular economy business models
- Health improvements could reduce the ever increasing cost of healthcare provision
- Investments could be unlocked due to increased social value

As this annual report illustrates, our global reach and the diversity of our skills enables us to contribute to meeting the SDGs in different ways depending on the nature and location of our projects; from engineering input on infrastructure projects in developed countries to providing long-term strategic advice to emerging regions and cities.

LINKAGE OF WATER TO OTHER SDG TARGETS  
Source: Katinka Weinberger, UN ESCAP, 2015



“At Arup, the sustainable development goals inspire us to act for the long-term and consider how we collaborate with our clients to drive positive change.”

Thomas Sagris

## ARUP GLOBAL CHALLENGE

By Steve Johnson

Through the Community Engagement Global Challenge Fund, Arup has committed £5 Million over five years to projects which contribute towards achievement of the UN Sustainable Development Goals. Global Challenge was conceived following a company wide consultation into how Arup's Community Engagement activities could contribute to the UN Sustainable Development Goals (SDGs).

Global Challenge was launched in 2017 and supports engagement with communities and partner organisations to understand the problems they've identified and collaboratively design, develop and deliver solutions. Global Challenge aims to positively impact communities and ensure solutions are viable. We have focused on SDGs where we can deliver the greatest impact, based on our skills and experience, in partnership with others.

The first three projects awarded funding via Global Challenge aim to deliver tangible benefits to communities and contribute to progress towards the targets for water sustainability.

The projects are:

### WASH Basins, India

In partnership with FRANK Water, who work with communities in India and Nepal to develop their own solutions to securing safe, clean, drinking water and sanitation. As part of the WASH Basins project, we are working with FRANK Water and their local partners to develop an integrated water resource management (IWRM) toolkit for use by communities and district-level governments. This includes gathering best practice for how local communities manage their water resources using existing power structures in Chhattisgarh and Madhya Pradesh. The final toolkit will help promote a more consistent approach to water resource management at a river basin level, that meets the needs of some of India's poorest and most vulnerable communities, whilst aligning with national reporting of IWRM implementation for the Sustainable Development Goals.



### Handwashing in Emergencies

Handwashing during disasters is critical to reducing disease and saving lives. There is a significant challenge as, by the end of 2016, the UN Refugee Agency found that 65.6 million people were forcibly displaced worldwide, with a high proportion of them living in temporary camps. People living in these environments often face poor sanitation and an increase in the risk of disease.

This project brings together the diverse expertise of the British Red Cross, the London School of Hygiene and Tropical Medicine, Butyl and Arup.

Together we aim to co-design and distribute a novel handwashing product that will allow equitable access to effective hand washing, with soap and water, in emergency situations. By making handwashing facilities more universally accessible and easier to use we hope to facilitate handwashing behavior change.

The simple act of handwashing with soap has the potential to make a huge difference in emergencies since it is estimated that approximately 40% of all deaths in the wake of a humanitarian crisis are due to diarrhoeal diseases.



Handwashing has the potential to halve these mortality rates. The co-creation process involves developing a deep understanding of humanitarian contexts, (including the varied environments in which displacement camps are located), potential stakeholders and its numerous cultural factors, ages and disabilities, and current handwashing needs and behaviour.

We will draw on the latest evidence about behavior change in order to create a product that crisis-affected populations will find intuitive and desirable while also considering the practicalities of product distribution within the humanitarian system (i.e. developing something that is light and compactable).

Also to be taken into account is that the final product needs to be a solution which can be manufactured around the world and transported quickly, without being too costly.

### Vanuatu WASH Centre

A project in partnership with Live & Learn International, which works with communities throughout Asia and the Pacific to design, implement and learn from community-based development projects, with Water, Sanitation and Hygiene a key area of focus.

This project aims to directly benefit 40,000 people through developing a culture of WaSH entrepreneurship on the pacific islands of Vanuatu, which was ranked 134th out of 188 countries in the 2014 Human Development Index. It will support capacity building for community based social enterprises as well as designing a 'WaSH centre of excellence', which will enable the enterprises to showcase their products as well as deliver WaSH training.

It is hoped that over the next 12 months a new community sanitation enterprise can be established in Luganville the second largest city in Vanuatu, alongside those existing in Port Vila. Key to all projects under Arup's Global Challenge is developing models that can be shared and replicated elsewhere in the world.



# Climate finance – money well spent?

By Jason Fairbairn, Hydrogeologist and Water Resources Specialist, UKIMEA



In December 2015 the countries of the world that are signatory's to the United Nations Framework Convention on Climate Change (UNFCCC) met in Paris and reached an historic agreement to strengthen the global response to the threat of climate change. The 'Paris Agreement' aims to keep global temperature rise this century well below 2°C above pre-industrial levels. Additionally, the agreement aimed to strengthen the ability of countries to deal with the impacts of climate change, particularly on developing nations, through financial, technology and capacity building frameworks.

It is recognised that one of the main ways for the impact of climate change to affect people, ecosystems and economies is through changes to the water cycle. Drought, floods, unpredictable rainfall and other extreme weather conditions are likely to increase in frequency and severity. Water management systems and infrastructure that are able to cope with and proactively prepare for more extreme and unpredictable weather patterns is a necessary investment for a sustainable future.

But how do we move to these more resilient solutions. The UNFCCC recognises that the implementation of the Paris Agreement includes critical links between water and the climate adaptation, mitigation and finance agendas, as well as knowledge and capacity development.

The UNFCCC called for USD100 billion for climate finance by 2020 to support the environmental and climate change solutions needed to help achieve the aims of the Paris Agreement. Traditional sources of capital for infrastructure development such as government and bank finance will also require growth in financing to respond to this challenge. Building resilience to droughts, floods, water supply quality and yield pressures and long-term climate shifts will require significant investment.

One area of growth in climate finance options are green or climate bonds tailored to projects and portfolios that deliver climate change mitigation and adaptation outcomes. The green and climate bond market is young, beginning in 2007 the European Investment Bank (EIB) and the World Bank began issuing green bonds as a loan mechanism to show the use of proceeds applied to environment-positive projects. The reputations of these institutions gave the financial markets confidence as to the suitable and effective use of proceeds to support these environmental objectives.

However, with the significant growth now required in climate finance and the large number of investments that will be required, how do investors and other stakeholders maintain confidence that the investments 'do what they say on the tin'?

How do you measure and report the environmental claims of these bonds, to achieve confidence that the proceeds are allocated to assets that have real and clear environmental value.

To address this challenge and to introduce a level of standardisation and assessment of these green and climate bonds. The Climate Bonds Initiative has established a Climate Bond Standard and Certification Scheme. These aim to provide assurance and transparent common benchmarks for the green and climate bond market. These include Climate Bonds Standard Water Criteria, which define low carbon and climate-resilient water infrastructure by evaluating the impact of water related investments on climate mitigation and climate adaptation. The criteria provide guidance on the types of water projects that should be included in green/climate bonds, including infrastructure for water capture and collection, water storage, water treatment, flood and drought defence, stormwater management and ecological restoration and management. The criteria also include both built and nature based-water infrastructure, such as rivers, lakes and aquifers. The Standards provide a framework for assessing the climate mitigation, adaptation and resilience performance of the investments and include for independent verification and reporting that the use of the proceeds are compliant with the Water Criteria of the Climate Bonds Standard.



**“The Intergovernmental Panel on Climate Change (IPCC) identify that substantial climate mitigation and adaptation infrastructure will be required to ensure future clean and secure water supplies.”**

Jason Fairbairn

# Collaboratively tackling flooding risks

By Will McBain, UKIMEA Flood Risk Management Leader



Communities themselves may not have influenced the planning process, even when the issue directly affected their lives. In more recent times however, there has been a recognition of the need for a shift in approach, putting collaboration with communities at the heart of long-term plans to improve capacity to cope with, and rapidly recover from, the impacts of flooding.

In essence, the focus has become much more about the need to engage communities and to give all who are affected by proposals a voice in the future management of flood risks to their village, town or city – and a role in making it happen.

The towns, cities and communities now coming together with clear, agreed long-term strategic plans should be better able to secure funding support from the government's £3 billion flood and coastal erosion risk management capital investment programme.

The better investments will be those aligned with wider proposals to regenerate the economy, improve the environment, mitigate carbon emissions and address



**“Flood-risk management has historically been viewed by many as the sole responsibility and concern of major organisations such as the Environment Agency and local authorities.”**

Will McBain

social problems, such as a lack of access to the natural world. But are we sufficiently joined up?

The reality is that catchment-wide, nature-based solutions to flooding problems can be challenging to realise for a variety of reasons. Aligning flood risk management investments with wider proposals for environmental, economic and social regeneration is not perhaps as straightforward as it sounds.

Communities affected by flood-risk can see this and many are frustrated as a result. There is still much to do in making our policies and practices more joined up; to empower communities and provide the evidence required to support investment decision-making.

#### Learning from other communities

High Water Common Ground is an independent film that showcases what some innovative communities across the UK have done to tackle flooding and captures the story of how they explore opportunities for natural flood-risk management. The nature-based solutions covered in the film provide an anecdotal toolkit for communities with innovative insights into how we can take care of ourselves, our land and our water.

#### Scope for optimism

Earlier this year we saw the welcomed announcement by UK prime minister Theresa May of plans to plant 50 million trees between Liverpool and Hull. The Northern Forest is a key part of the government's 25-year plan extending between these two cities to improve the environment and help prevent 190,000 homes from flooding.

The Department for the Environment, Food and Rural Affairs (DEFRA) has pledged an initial £5.7 million to launch the scheme and is expected to cost £500 million in total. It is a fine example of using our land and natural environment to tackle a range of issues, but is not something that is easy to deliver.

#### The search for evidence

Providing firm scientific evidence regarding how landscape restoration and management techniques, can significantly reduce the peak flows associated with major floods is a clear priority. Farmers and land managers need to make a living, so evidence of the benefits to society of managing our landscapes differently are invaluable in helping them to make this transition.

The Natural Environment Research Council is developing a national programme of scientific research in this area. Initiatives such as the Yorkshire Integrated Catchment Solutions Programme aim to improve responses and long-term resilience to floods and droughts and advance understanding of dynamics and interactions in river catchments. If successful, national-scale sharing of these stories is critical to help educate and influence others to change how they manage their own land.

#### The challenge for engagement

Working in true partnership with communities requires a strong focus on consultation. Major cities that have flooding issues should engage local communities in the debate, to create a collaborative and catchment-based solution. Holding public consultations about the programme can help illustrate the plans, provide realistic expectations for how effective each of the interventions will be, but also gain insight into what stakeholders support, and have concerns about.

Well-designed infrastructure schemes have significant scope to boost regeneration and economic growth and can be developed in tandem with complementary nature-based solutions.

#### The need for exemplars

Raising awareness of successful examples of how risk-management authorities can truly engage local communities to develop more sustainable long-term solutions are vital.

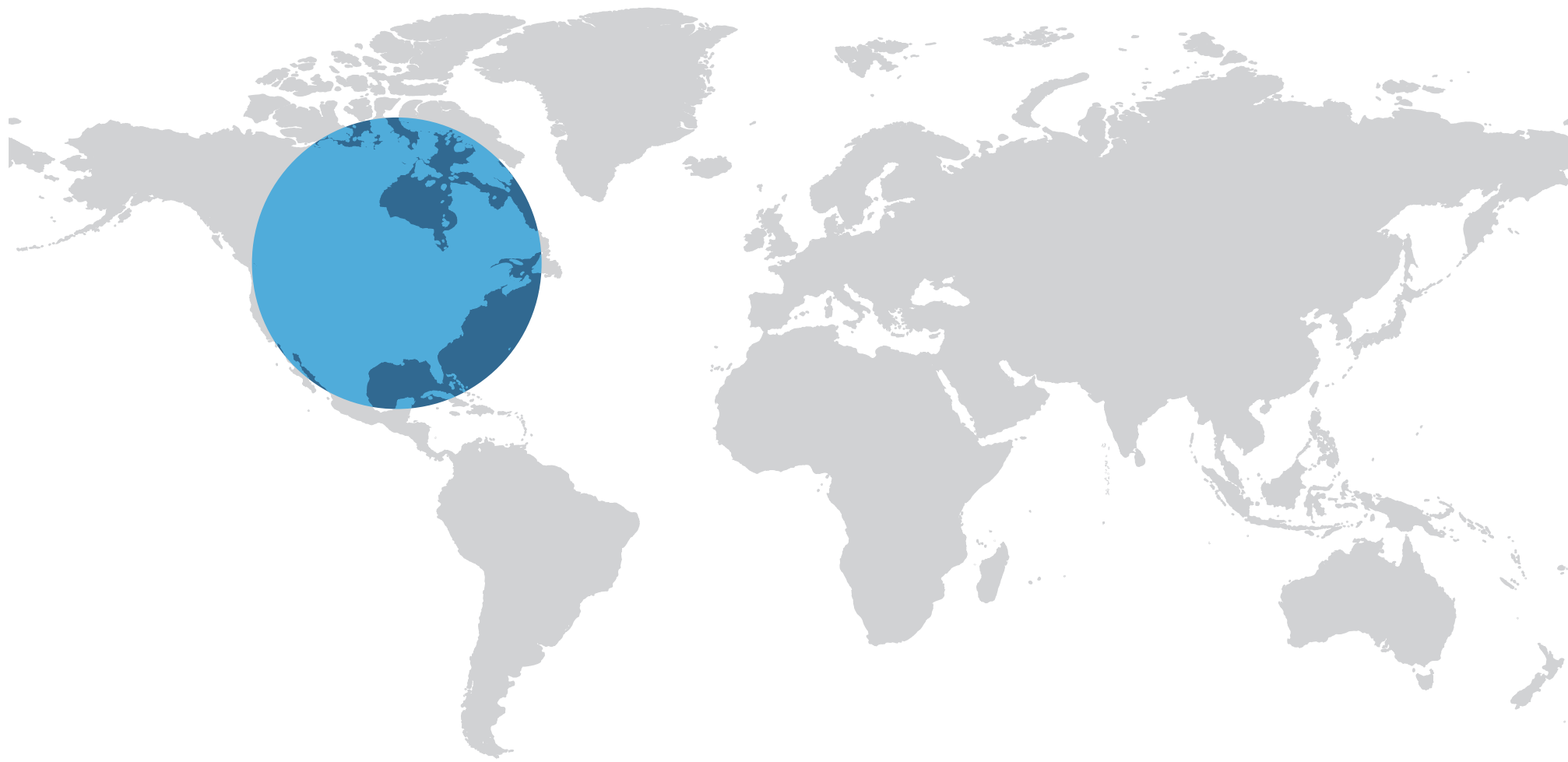
The first phase of Leeds Flood Alleviation Scheme, is one of the largest river-flood schemes recently completed in the UK. The project team explored options that were compatible with the views of those working and living in the city, and established a steering group to meet on a regular basis which included Leeds City Council, the Environment Agency, Yorkshire Water Services, Network Rail and the Canal and River Trust.



Phase one of the scheme included an innovative, engineering-based solution, using movable weirs to reduce river levels at times of dangerously high water. Alongside landscaped flood defences and the modification of existing buildings, a good standard of flood protection was achieved to protect the character of the city waterfront for both wildlife and the public, without affecting city views.

Flood protection is more effective when those affected are empowered to be fully involved. Collaboration of all those with a vested interest can create a social contract between communities and government to best serve the long-term interests of the places they live, work and spend their leisure time.





**REGIONAL ROUNDUP:**  
**Americas**

“Extreme weather events continue to challenge our clients limited resources while they try to maintain a state of good repair, be in compliance with regulatory requirements, and ensure system reliability. Arup have utilised our breadth of regional and global resources to address the challenges our clients face every day.”

Janine Witko

The Americas Region continues to provide a broad range of consulting services to our increasingly diverse client base; our clients include municipal and private utilities, developers, and municipal agencies from the northern reaches of Canada, to the East and West coast of America, and down into Central and South America. Around the region, we have assisted our clients in resiliency planning and design, wastewater re-use and development of sustainable water solutions, water tunnel planning and design, and hydraulic/hydrological analyses.

The digital tools we use to support our clients’ needs are increasingly expansive, and range from the use of WaND (Water Neutral Design tool developed by Arup)

and Weathershift, to enabling our clients to use 3D and BIM design tools in progressing their work in a collaborative and integrated environment.

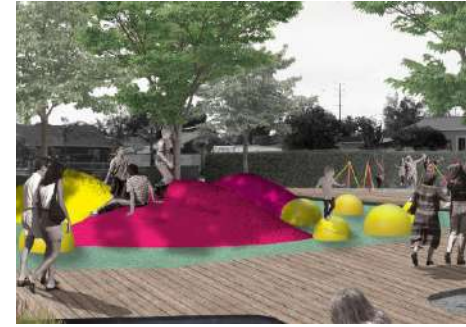
We anticipate the “Digital Tide” will be increasingly important as we support our clients’ needs in providing data analytics and developing and applying automation tools.

We envision that these digital tools will also provide our clients with a better foundation for asset management which is being increasingly driven by financial pressures, desire to maintain a state of good repair and address new regulatory requirements.



Our clients and projects have been recognized through receipt of awards such as the NYS ACEC Gold award for the Norris Cut Design Build project for Miami Dade Water and Sewer Department and the Platinum award for the MTA NYCT Pumping Capacity Improvement Project. Industry organisations have invited several of our team to present on our projects, citing the value added attributes.

Our team participated in the P3 Water Summit in San Diego, and regularly presents at local and national WEF, ULI and ESRI LID conferences. Arup continues to challenge and develop our team by providing training in new analytical and design tools, and encourages the development of new tools in house.



**BRADLEY GREEN ALLEY**

By Anthony Kirby

From Alleyways to Pocket Parks – transforming urban areas in LA

‘Pocket parks’ and the transformation of urban areas such as alleyways into natural green spaces could be the future in Los Angeles following a pilot project in which Arup has proposed a new way of thinking to tackle storm water run-off and pollution.

Working with landscape architect Rios Clementi Hale Studios, Arup is the lead designer on a pilot project for The Trust for Public and community organisation Pacoima Beautiful, looking to bring improvements to the management of storm-water run-off, which currently contributes to overflowing storm drains and causing diffuse pollution. The project will be transformative for the community and serve to replenish groundwater resources in the San Fernand Valley region of Los Angeles.

Proposals include the removal of concrete pavements and walkways to be replaced with green landscaping, taking full advantage of the highly permeable soils which are currently under concrete to better treat stormwater.

Plans to place screens and create areas of shade for art and creative projects, raised planters, seating and a vine trellis “bird cage” have also been proposed in the concept stage to provide better shade and a true green infrastructure.

A rigorous community outreach process, conducted through Pacoima Beautiful, will now take place to ensure that the community is engaged in the early design process and feels fully included.

The project is in an underprivileged community and the alley has perceived safety issues, especially at night, so developing a trusting relationship with the community, engaging them in the design process, and helping them to understand how it can help improve the management of run-off water, create a better environment and community and help reduce crime, will be the benchmark for a successful project

Arup is providing civil engineering and lighting design services for this pilot project, which when complete, will be the first shared traffic and pedestrian street in Los Angeles and will be a catalyst to reconnect the community it serves.



**GREEN INFRASTRUCTURE IN PUBLIC SPACE**

By Nancy Choi

Using public rights of way to better protect our water supplies

Our team continues to work alongside the New York City Economic Development Corporation and the New York City Department of Environmental Protection on two contracts to deliver green infrastructure on public properties in the Bronx and in Brooklyn. Previously on these contracts, we designed 143 Right-Of-Way Bioswales (ROWBs) that have since been constructed in the Newtown Creek drainage area in Brooklyn and have designed 30 ROWBs that will go into construction this year in the Westchester Creek drainage area in the Bronx.

Tasked with reducing the amount of storm-water run-off into the Newtown and Westchester Creeks, which have issues with run-off and sewer overflows, we have used our civil engineering, geographical information systems, geotechnical and water engineering expertise to design green infrastructure storm-water management solutions into huge areas of public rights of way, effectively looking to mimic a natural water cycle environment in built-up areas.

In this new phase of work Arup is designing green infrastructure and stormwater best management practices to manage the first 1.25 inches of rain that falls on impervious areas at various public properties within the Newtown Creek and Westchester Creek drainage areas.

We are looking at four parks and recreation sites, one public housing authority site and one school site within the Newtown Creek area and two parks and recreations sites and one public housing authority site within the Westchester Creek area. Solutions have included rain gardens, turf fields, permeable pavements, and underground detention and retention.

Arup is managing the design team and leads the civil engineering work on tributary drainage analysis, site selection, construction drawings, and construction administration support. Throughout the design process we have and will continue to work with multiple agencies to consider available space, programming and maintenance needs.



**WATER ENERGY TOOL (WET) MASSACHUSETTS UNIVERSITY TRIAL PROJECTS**

By Derek Anderson

With water in short supply in many areas of the world, the desire to make better use of rainfall is ever increasing – but is it always the most energy efficient solution?

Our teams in Massachusetts have actually proven not, employing a sophisticated Water Energy Tool (WET) developed through Invest in Arup R&D funding on two university projects in Massachusetts to calculate and predict the amount of energy needed to collect, treat and reuse rain water and grey water (water you’ve used in your sinks, showers and baths), compared to traditional water systems already used.

“There is a real desire to minimise water consumption regardless of energy costs, particularly in areas of the world with low water supply, with a focus on recycling and reuse of rainwater and the recycling of grey water,” said senior engineer Derek Anderson, “We worked with two local universities, using the tool to first optimize both water and energy consumption and then to assess the overall impact of their proposed rainwater harvesting systems on the environment compared to drawing water from municipal water supply. This allowed us to engage our clients in an informed discussion about the holistic value of rainwater harvesting: Is the actual energy footprint more than using traditional water supply systems, and therefore having a net negative environmental impact? If so, is reducing water consumption more important than reducing greenhouse gas emissions?”

The system uses calculations based around the typical efficiencies of local municipal water and electricity supplies, taking into account the particular characteristics of the water and energy sources, treatment systems, and water distribution and transmission losses to the site, using this as a basis to compare the energy costs against building an efficient recycling system.

The two trial projects had differing results. One found that by optimizing collection and recycling of rainfall both water and energy use could be reduced, whilst in another area, the local municipal water supply was sufficiently energy-efficient that rainwater harvesting could not compete in terms of energy cost and greenhouse gas emissions,” added Mr Anderson. “We’ve found it’s not a one size fits all solution,” “You can’t just look at rainwater recycling in isolation. This tool allows people to calculate the impact first and discover whether, in their location, it is actually an energy efficient option.”



**NYC DEPARTMENT OF ENVIRONMENTAL PROTECTION KENSICO EASTVIEW CONNECTING TUNNEL**

By Janine Witko

Arup is the prime consultant for the design augmentation project for the development of the new Kensico Eastview Connecting Tunnel for New York City Environmental Protection (NYCDEP).

Currently, the hydraulic grade line of the Catskill Aqueduct is insufficient to provide water to the UV treatment facility it supplies, resulting in reduced operational flexibility, loss of system redundancy and increased vulnerability of the overall water supply system which transports and treats drinking water for between seven and eight million people in the city of New York.

Our work started in August 2017, with integrated design carried out with the in house design department of the NYCDEP.

The new facility will provide redundancy to aqueducts and allow for operational shutdowns when needed.

It is paramount that the solution is able to meet expected future demand for water and the 27ft diameter deep rock tunnel, located approximately 500 feet below the surface, will have a 2645 MGD capacity.

A large screen chamber facility is also a major component of the ongoing design effort

Computational fluid dynamics (CFD) modeling is playing a key part in the design of the screen chamber and tunnel, which will provide a new link between the Kensico Reservoir to the recently-completed ultraviolet filtration facility in Eastview.

Our team is currently working on a 30% design to create a development plan to a level of sufficient detail to enable the client to evaluate major design features prior to advancing to the final design and build phase.





REGIONAL ROUNDUP:

# Australasia

“We have continued to develop our reputation as both thought leaders and high-quality designers in the water industry in Australasia.”

Daniel Lambert



As thought leaders we have given strategic advice to water authorities and private sector clients in both urban and rural areas. The breadth of Arup’s advice and capability has been highlighted by engagements focussing on the consumer (Arup led the inaugural New Zealand National Customer Survey) to urban water reform (Arup in partnership with Frontier Economics advised Infrastructure Australia on Urban Water Reform) to long term scenario planning for water in South East Queensland.

Other key services delivered include asset management, demand management, business case analysis, integrated water management, liveability, privatisation and implementing new technologies.

We can provide this strategic advice to both the public and private sector because it’s underpinned by our strong design capability in water supply, wastewater, dams and water resource management. Over the last twelve months we have designed water and wastewater pipelines, major tunnels, irrigation schemes, dam upgrades, feasibility studies for pumped hydro power stations and innovative solutions for water and wastewater treatment.

Thank-you to our partners and collaborators for partnering with us to deliver industry leading advice and design for the water sector over the last 12 months.



## MELBOURNE WATER PANEL ASSET MANAGEMENT

By Rhys Anderson

Arup’s technical expertise in Australia has continued to provide vital detailed assessments of key assets for Melbourne Water – identifying risks to asset life and areas in need of remedial work.

As part of a five year contract in which Arup provides partnership technical services on a consultant panel, the condition and material structure of more than 10 major assets – including sewage treatment tanks, sewers and drains - have been assessed over the past four years, with two of the biggest focused upon over the past 12 months.

It has included assessment and remediation advice for the Western Trunk Sewer, a very large 4.5m diameter sewer conveying approximately 55 per cent of the city’s sewage. The first such detailed survey of the site for 10 years, Arup’s commitment to quality and excellence in undertaking the inspections was able to identify potential risks due to the life of the asset. This commitment included detailed internal inspections of key sections of the sewer and major manholes.

Similar surveys of aeration tanks have been conducted at the Eastern Treatment Plant, which treats around 40 per cent of Melbourne’s waste water, on which Arup provided integrated technical support in both the materials and structural review of the asset.

Across these projects we have been able to utilize innovative technology to identify cracks, gather data on the chemical and physical properties, sample concrete depth and corrosion levels to assess the remaining lifespan of the facility – providing key data for the client in terms of the future of its key assets and in being able to gain a clear indication of the lifespan they have remaining.



## ASPLEY RESERVOIR WATER QUALITY MANAGEMENT FACILITY, BRISBANE

By Cameron McDonald

A cost-effective solution was developed for one of Australia’s latest bulk water businesses by Arup’s process and mechanical experts, as part of a new Water Quality Management Facility at Aspley Reservoir.

It has seen a new approach taken to boost the disinfection of treated water by chloramination at a secondary disinfection dosing facility, making it better able to respond during times of extreme weather, as well as enabling the Mt Crosby water treatment plant to deliver its treated water further north of the Brisbane bulk water network.

The use of monochloramine, rather than chlorine allows the disinfectant residual to stay longer in the treated water, ensuring safe level of drinking water are maintained throughout the long distribution network.

Given Arup’s teams were drafted in when the design parameters of the project was largely endorsed, challenges were faced when it came to finding a suitable, cost-effective solution, with notable constraints with the operations and maintenance of a proposed 6m long stainless steel, removable injection quill housed in a 7m deep buried chamber. This created particular issues regarding maintenance of the quill seals in a confined space, and a very risky construction methodology.

Using 3D modelling, supported by Computational Fluid Dynamics (CFD) Arup’s design team was able to demonstrate how the injection of monochloramine - through a six-metre long injection tube - into the water flow would ensure homogenous mixing of the disinfectant reagent at various flows and provide a longer-lasting disinfection as water moves through the bulk water network to consumers and residents in the northern suburbs of Brisbane.

Importantly, the 3D model also assisted the design phase by providing a three dimensional perspective for risk identification and mitigation during installation and maintenance phases.



## PORT MORESBY OCEAN OUTFALL

By Jaco Wagenaar

Port Moresby, The National Capital District (NCD), recorded an average population growth of 2.7% per annum between 1990 and 2000. The city further recorded a population growth of 2.1% per annum between 2000 and 2009. Port Moresby’s coastal areas discharge raw sewerage into the ocean. Port Moresby’s coastal areas population is expected to grow from 53,377 (2011) to 126,392 (2042). This project is one of many components of the overall program of works to collect, treat and discharge treated effluent into the ocean. Funding was set aside by the Japanese Government (Japan International Cooperation Agency) and Independent State of Papua New Guinea to find the ideal ocean outfall solution and contracted the engaged Pacific Marine Group (PMG) for the Design and Build project. Arup’s Maritime and Water teams completed the detailed design services.

The proposed and accepted project was for approximately 1km long ocean outfall, to enable discharge of treated effluent at 23 metres depth into the ocean.

Key to the project completion was Arup’s ability to understand the site specific requirements considering the challenging construction environment and a collaborative team with PMG.

Using the latest 3D modelling tools, which gave the contractors clear visualisation of how a 200m sections of polyethylene pipelines and anchor blocks weighing three tones each assembly could be assembled on land, welded, launched and then positioned either in trenches or on the seabed.

Jaco Wagenaar, pipeline lead for Arup on the project, said: “The project delivered great value to the contractor in that our diffuser design was easier to construct and installed at 23 metres depth while still meeting the design intent, this was a great win for Pacific Marine Group as the revised design was accepted by the end client.”

“We had to convince the end client that our standards (Australian Standards) was equal to, if not better, than the American Standard they had worked to previously, and we were able to demonstrate that, and the excellent value of our proposals.

The result of the work of Arup’s specialists in Brisbane, Perth and Sydney will provide a 50-year asset for Port Moresby, discharging treated effluent into the sea from a diffuser with 22 outlets.



## SUSTAINABLE WATER AND WASTEWATER MANAGEMENT PLAN FOR THE TORRES STRAIT ISLANDS

By Samuel Koci

Water and wastewater service provision in the Torres Straits is complex. The sheer remoteness and vast geographical spread of the island communities, limited freshwater resources, significant climate change related risks, and a diversity of other factors complicate service delivery and increase capital, operational and maintenance costs for all aspects of service provision. As a result, the 15 island communities regularly face severe water shortages and in many cases rely on costly mobile desalination plants to maintain water supplies throughout the dry season. The inability of the communities to access clean drinking water 24/7 throughout these drought periods also has significant implications for their health and wellbeing.

Arup is working with the local authority to support the development of a ‘Sustainable Water and Wastewater Management Plan’ that will guide the long-term transformation of TSIRC’s water and wastewater business over the next 25 years, facilitating more sustainable, cost-effective and resilient water and wastewater service provision, and deliver improved health, economic and social outcomes for the people of the 15 Torres Strait Island communities. The plan is being developed in close consultation with relevant internal and external stakeholders to ensure all solutions developed are practical and satisfy both short and long term regulatory and customer requirements, including considering climate change risks to water and interdependent infrastructure, water availability and water demand.

The first stage of the project has involved working collaboratively with the authority and other stakeholders to identify and assess the key risks facing all of the 15 community water supplies under both current and future climatic conditions, as well as a comprehensive suite of opportunities to address those risks. Importantly, the opportunities include a range of infrastructure, institutional and information based approaches to address the unique challenges faced by the communities, that are appropriate to both physical context and the technical, operational and financial capacity of the communities and supporting organisations. We are continuing to work with the client to better define and optimise the priority opportunities, in order to formulate the strategic long-term plan for the Torres Straits.





**REGIONAL ROUNDUP:**  
**East Asia**

**“We continue to diversify our reach and portfolio of water projects in the East Asia Region.”**

Kenneth Kwok



In China, we continue to build our profiles on technical advisory and design role on regional stormwater drainage tunnel and Sponge City consultancies for new developments.

In Hong Kong, we are delivering green infrastructure schemes for major new town developments.

Manila continues to be buoyant with a significant win on Novaliches-Balara Aqueduct 4 Construction Management, Detailed Design Review and Contract Administration Services. We have just won Manila Water’s Consultancy Framework to deliver major water and wastewater projects over the next 5 years. Elsewhere in Asia, we are actively seeking water project opportunities and have had some initial successes.

For example, in Vietnam, we are supporting the Hong River Surface Water Company on a bulk water supply project.

With China’s Belt and Road initiative and the rapid economic growth in the ASEAN countries, which will require significant investment in water and wastewater infrastructure. We look forward to support local practitioners to draw upon our international experience in the delivery of sustainable and resilient water infrastructure.

We are also proud that our Harbour Area Treatment Scheme in Hong Kong was honoured with the 15th Tien-yow Jeme Civil Engineering Prize, which is the top honour for civil engineering and construction in China to commend engineering projects with outstanding achievements in technological innovation and application.



**HANOI BULK WATER SUPPLY PROJECT**

By Paul Taylor

Our team in Hong Kong is working to ensure more than one million people of Hanoi, in Vietnam, have clean drinking water by providing reference design and tender management services for the procurement of a new surface water treatment plant.

One of the largest capital water project undertakings in the city of Hanoi, the contract is with the Hong River Surface Water Joint Stock Company.

We are providing multidisciplinary technical advisory services, tender documentation and tender management for the procurement of an international EPC contractor.

The plant will eventually extract 300,000m<sup>3</sup>/day of raw water from the Hong River, which will be pumped and then treated to potable water standards to replace the existing, over-extracted and increasingly polluted groundwater sources that have provided water to Hanoi residents in the past.

The project consists of a 300MLD Water Treatment Plant, a raw water intake pumping station and over 18km of large diameter transmission mains that will connect to the expanding city-wide potable water distribution network.

The high total suspended solids (TSS) and annual variation in water quality challenged the team’s process designers to create a reference design that can mesh the local dynamics while appealing to international water companies.

The transmission pipelines contain numerous challenges, including crossing flood protection dykes, rivers and irrigation channels and negotiating paddy fields and highways.

Mr Vu Thanh Long, the General Director of Hong River Surface Water Joint Stock Company, said:

“This is the first Water Project in Vietnam that will be designed and constructed to international quality and standards. The project will benefit the ordinary people in Hanoi.

It will ensure that as the population increases, there will be sufficient potable water available, at the correct quality standard, to meet the demand.”



**JIAXING SPONGE CITY PILOT PARK**

By Cici Shao

China recently experienced its worst flooding since 1998 but now has plans to convert many urban areas into ‘Sponge Cities’ by 2030.

Jiaxing was one of 16 cities selected and approved by government as ‘Sponge City’ pilots, with Arup’s team chosen to propose how best to use its natural environment to better protect it from flooding, whilst also better engaging the community.

The aim is to ensure water entering the city is absorbed when there’s an excess, instead of simply meeting water-resistant concrete, through the use of permeable materials and green spaces to soak up rainfall, with rivers and streams interconnected so that water can flow away from flooded areas.

The vision is to create a city which has resilience and can adapt to climate change to avoid and reduce the impact of extreme rainfall – which often occurs between July and September, and has sustainable ecological function. As a river plain city in Yangtze River Delta, Jiaxing has a long history of water carriage and paddy agriculture culture.

Arup suggested a future vision of the place as a destination for civic activities, water culture, and natural education, building a vibrant river bank, forest shore, and water culture ecological corridor.

A focus was placed on improving the ecological value of the river, the reasonable setting up sponge ecological facilities and introducing activities that surrounding residents can be involved, which can create long-term value for the city

As a national pilot project with the objective of becoming an innovative waterfront ecological space, the project faced significant challenges. Given the total area of the project is 1.2 km<sup>2</sup> and the length of the coastline is around 4.3 km, the project is a PPP project and an integrated strategic plan package with many major stakeholders in terms of the landscape, water environment, ecological, infrastructure and architecture being involved.

Coordinating the interests of different stakeholders from concept, planning, plans to operation was a consideration and was a focus for Arup’s multidisciplinary team.



**RELOCATION OF TSUEN WAN SERVICE RESERVOIR TO CAVERN**

By Michelle Shum

With land for residential development at a premium in Hong Kong, there is a drive to relocate some of the suitable infrastructure facilities such as service reservoirs to caverns to enable valuable land to be released for other benefits such as residential developments and community facilities.

As a result, Arup’s resources team is currently carrying out the feasibility for the relocation of the Tsuen Wan Service Reservoir, which has a capacity 34,100m<sup>3</sup> to a cavern site, vacating a key piece of land for residential housing development, which has been outlined as part of the a masterplan for the city. The hilly terrain and strong rocks in Hong Kong make it highly suitable for developing rock caverns.

The Arup team were well placed to lead on this two-year feasibility study with their experience on previous strategic cavern studies for the Government and identified a number of cavern sites for relocation of major infrastructures. This has included services such as geotechnical studies and the preliminary design of the cavern, hydraulic modelling, taking a risk assessment approach to optimise the storage volume and extensive public consultation, given the portal locates in a built-up, residential high-rise area.

The team has faced other significant challenges, in particular the public concern over the portal facing their homes, which the limited data available also proved an obstacle as Arup has had to conduct a full hydraulic modelling process. However, the project has brought opportunities for improvement of skill sets in hydraulic modeling.



**NOVALICHES-BALARA AQUEDUCT 4 (NBAQ4)**

By James Rickard

Ensuring the long term viability of water supply to the East concession of Metro Manila is the focus of one of the largest water supply infrastructure projects undertaken by Manila Water, in which Arup is playing a key role. Our successful project submission provided design, tendering and procurement advice to Manila Water for the development of a fourth aqueduct leading to the awarding of the design and build contract to a joint venture of international and local contractors.

Our teams will now project manage the construction of the Novaliches-Balara Aqueduct 4 (NBAQ4) – running from the La Mesa Reservoir to the Balara Water Treatment Plant.

The work is essential to protect the region’s long term water supply and resilience, as an event such as an earthquake could damage aqueducts, potentially with the loss of a third of the population’s water supply.

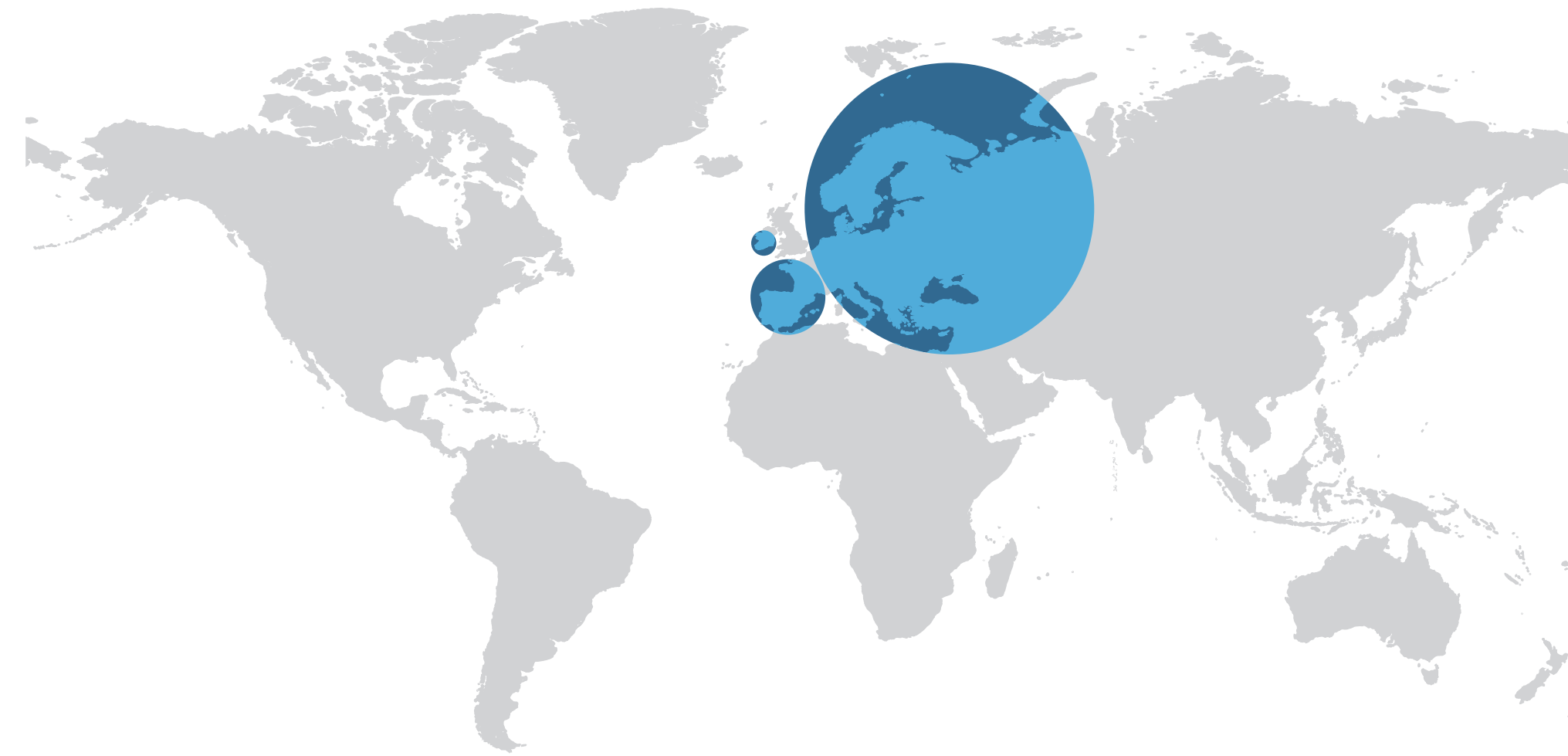
It will be the first tunnel to be constructed with a tunnel boring machine in Metro Manila and is targeted to be completed by 2021.

The new aqueduct will be 7.3km long, 3.1m in diameter and capable of carrying 1000 MLD of raw water.

Added to the project has been the construction of a mini-hydro power plant – for which Arup conducted the feasibility study, which will support 50% of the treatment plant’s power requirements.

The tunnel, once constructed, will be able to handle between 70 to 80 per cent of the water requirements to Manila Water’s treatment plant at Balara, improving the reliability and security of the raw water conveyance system.





REGIONAL ROUNDUP:

# Europe

“In the Europe region, we are focusing on further developing the capability and resilience of the water business.”

Evelyn McAuliffe



The identification of both existing and potential new client relationships and the resulting market requirements is central to our success in these areas. We are currently tracking a number of strategic major opportunities that will be instrumental in us building our brand in the European context.

The European water business is predominately located between Ireland and Poland, but also continues to develop in countries such as Madrid, Turkey and Serbia. The business has a diverse portfolio of work, through current client framework appointments in-home-countries alongside a number of other direct engagements.

Our Water4 provision is a significant portion of our daily operational outputs. We continue to export services in supporting such large projects as design of the Mariholm Connection Project in Sweden and the Cherrywood Site Development Project in Ireland.

We are aligning ourselves with Ireland’s Capital 2040 plan and are actively engaged in some of the tender processes including the second runway at Dublin Airport and the Dublin Metro Project. Our networks team have successfully builds a strong relationship Irish Water, which we have identified as a source of a considerable number of future projects.

Elsewhere in Europe, we are actively seeking water project opportunities particularly in advisory roles and frameworks where our wealth of design expertise can be most beneficial to our client. We are leveraging our network throughout Europe to ensure our tender applications showcase the wealth of knowledge within the team.



## ARKLOW WASTEWATER TREATMENT PLANT

By Neil Reid

The provision of water treatment facilities in the east coastal town of Arklow in County Wicklow, Ireland, is a high priority for Irish Water, who turned to Arup’s expertise to design a proposed solution and see the project through to completion.

The town, which has a population of 13,000 and a commercial community of around 8,000 contributing to its waste water production, has never had treatment facilities, an issue which often leads to untreated wastewater from homes and businesses through the town running into the in River Avoca.

Filling this void has been a priority for Irish Water since taking control of the countries water utilities in 2013, especially with the matter on the Environmental Protection Agency’s (EPA) Remedial Action List – a register of public water supplies with the most serious deficiencies and known to be most at risk, issuing legally binding directions requiring specific work to be carried out to ensure the safety and security of water supplies.

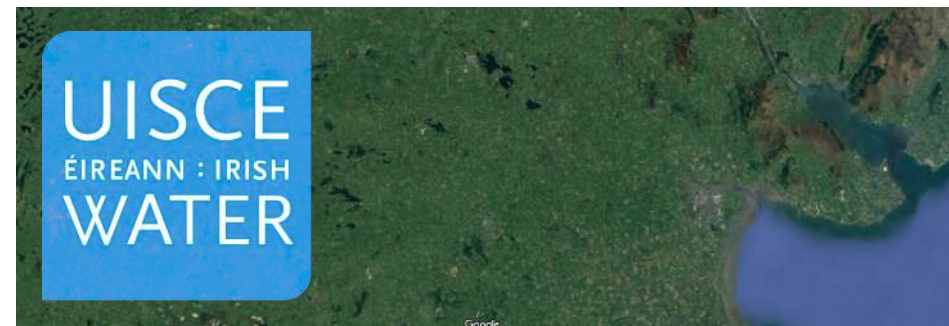
Irish Water intends to fix this problem in partnership with Wicklow County Council.

Arup has designed the proposed solution - a new Wastewater Treatment Plant (WwTP) which will bring benefits in terms of health, integrity of the environment and improved water quality for all and has led the process through planning.

The new wastewater treatment plant which will treat an estimated population equivalent of 36,000, and include associated infrastructure such as pumping stations, interceptor sewer pipelines to bring the untreated wastewater to the WwTP and a marine outfall pipe to safely discharge the treated wastewater effluent to the Irish Sea.

It will require approximately two hectares of land and will meet the current needs of Arklow and allow for any future expansion of the town. We will also oversee tender documents, procurement for design and build, the appointment of the operational contractor and provide construction supervision to project close out.

It is expected that the planning application for the Arklow Wastewater Treatment Plant will be submitted mid-2018.



## DUNDALK / MONAGHAN DRAINAGE AREA PLAN

By Richard Brown

Our water team in Ireland is working on providing the first full drainage area plan for Irish Water covering the Dundalk to Monaghan Drainage Area in the north of the county. Arup was appointed in the summer of 2017 to carry out a full review of the waste water and drainage network. Irish Water has no information from which to make decisions over future investment and remedial work to future proof its assets in the long term. The project was divided into four stages, data collection followed by study and survey scoping, surveys and Hydraulic Model Build and Verification, Risk Assessment and Needs Identification before finally Strategy, Optioneering and Future Solutions Design.

Arup has overseen surveys of the entire network over the past six months, work

which continues to enable computer generated modelling to be used to identify the areas of the network in greatest need of investment and upgrading, and those most susceptible to failure and flooding issues. Scoping, procurement, management and supervision of network surveys including manhole surveys, CCTV surveys, flow and rainfall surveys and other investigative surveys will be completed before computer modelling of the network is tested against live real-time information and performance data, enabling Arup to propose plans for the short and long term maintenance.

Surveying of the entire network of tanks, drains, manholes, pipes and waste treatment plants continues on this project – the first Drainage Area plan Arup has won with Irish Water – with meetings continuing with local authorities and other bodies to gather information. Arup expects to be in a position to provide full findings and recommendations by early 2019.



## POZNAN RAINWATER MANAGEMENT STRATEGY

By Jacek Zalewski

A combination of aging infrastructure and the continued urbanisation of the area has increased pressure on the existing water management facilities in the city of Poznan, resulting in episodes of flooding.

Arup analysed what happened to surface water in the city – looking ahead with a three part plan to creating a new rainwater management strategy – and how that strategy is overseen and managed for the long-term benefits of all. The key was firstly understanding the issues and why they have developed through a technical analysis of condition of assets to understand what is impacting on the water catchment and causing stresses to the systems.

City wide scans and surveys were then conducted to identify areas of underperformance such as overtopping

manholes and drainage system back-ups, and 1D and 2D modelling to gain an understanding of the surface slope run-off across the city.

Hydrological modelling was used to understand the amounts of water flowing through each area of the catchment and identify the impermeable surfaces impacting on performance of the networks.

This research has been used to base recommendations for the best, most cost effective and efficient solutions as part of the three stage plan.

This is an ongoing project with stage one completed by Arup’s teams in the first quarter of 2018 and fed back to the client, with stage two and three due to be communicated in mid-2018.

One consideration going forward will be the possible creation of a municipal entity to oversee and set the goals and strategies for surface water management across the city, which is currently inconsistent.



## BYDGOSZCZ DRAINAGE INTEGRATED MODELING WITH THE CATALOGUE OF GREEN AND BLUE INFRASTRUCTURE

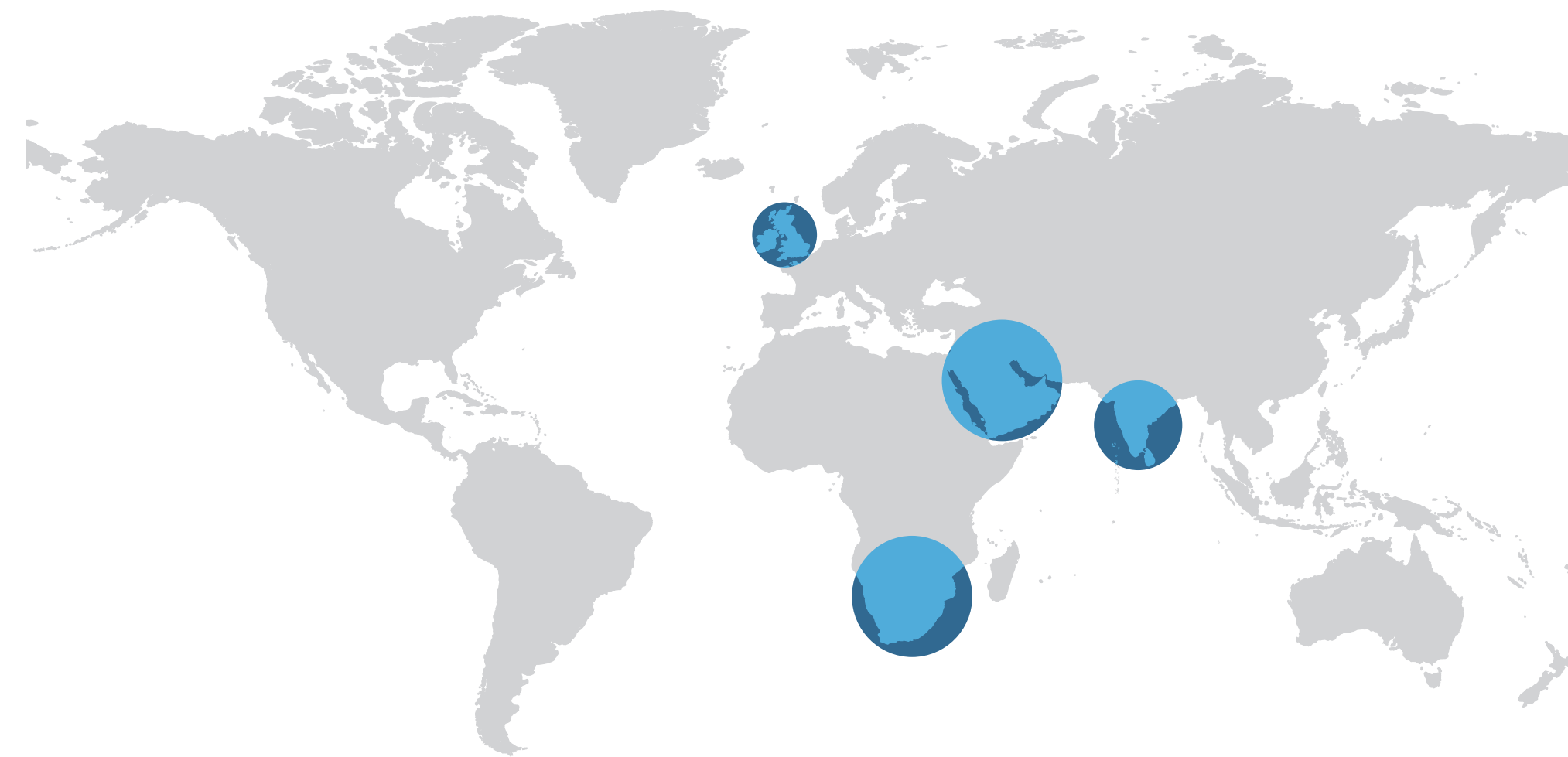
By Tomasz Glixelli

Recent floods in the city of Bydgoszcz (Poland), as a consequence of interconnected factors, such as intense urban sprawl, reduced permeable areas, increased surface water runoff, overloaded sewerage network and watercourses, caused substantial damage to critical infrastructure, which in turn failed to maintain public safety and socioeconomic welfare. Arup Water Team in Krakow has been spearheading a push to transform the city and help it function as a sponge – accumulating water during rainfall events and releasing this precious resource during droughts – supporting Bydgoszcz to work towards its long-term strategy of becoming a more sustainable, water sensitive and resilient city. The aim has been to create and establish a new way of thinking about storm water - not as a problem but as an opportunity and a precious resource, creating a water sensitive city, the city that will withstand rapid changes, with features such as parks, rain gardens and revitalized

watercourses, putting a strong emphasis on both development and improvement of water bodies and green areas within the urban realm, because we believe that coupling traditional gray infrastructure with diversified and decentralised sustainable infrastructure is the future of water management and is corresponding to resiliency challenges encountered in cities.

The project has needed a lot of public relations support, including organising workshops and consultations for citizens of Bydgoszcz, to ensure they fully support the concept. Therefore, the Catalogue of Green-Blue Infrastructure Solutions has been elaborated, triggering significant media interest – considered as unique and pioneering because it was the first of that kind in Poland, guiding urban planners, architects, engineers, water companies and communities towards sustainable storm water management. One of the most interesting inside is the solution No. 20 Biomimicry which explores this interdisciplinary approach towards sustainable design based on emulating nature’s time-tested mechanisms, patterns and strategies, trying to take the most of “3.8 billion years of nature’s R&D”.





**REGIONAL ROUNDUP:**  
**UKIMEA**

“The past year saw Arup once again helping our clients to tackle some of the most challenging water-related issues facing the UKIMEA Region.”

Catherine Wenger



The magnitude of these challenges has driven a need for increasing levels of partnership working and collaboration. Our advisory work for major utility companies, including Severn Trent, Anglian Water, United Utilities and Thames Water has focused on long-term business planning. For example, we have helped the Board at United Utilities to develop a robust understanding of the unique external environmental challenges that affect the sustainable long-term delivery of water and wastewater infrastructure in the north west of England.

Over 600 Arup staff have now been involved in one way or another with helping to develop sustainable solutions to water and wastewater management problems in Wales – with the Arup team in our Alliance with Welsh Water now being named “Team of the Month” on 17 occasions. As part of our ongoing framework with Yorkshire Water we have been involved with developing their sludge strategy, resilience strategy, water resources management plan and in assessing treatment options for unusual compounds.

More challenging project work on this framework includes Huddersfield Complex Wastewater Treatment Rationalisation Scheme and the development of an approach to optimising and measuring the wider social value of water infrastructure.

Arup formed part of the core advisory group that assisted the Environment Agency to scope their new flood and coastal erosion risk management strategy for England. We continue to collaborate on these issues with a range of English core cities, including Leeds, Sheffield, Bristol and Hull. Having worked with the Rockefeller Foundation to develop a water-related city resilience framework, Arup is now working with Yorkshire Water, Hull City Council and risk management authorities to apply this framework to the City of Hull.

This complements our ongoing work helping the Environment Agency to develop a long-term flood risk management strategy for the Humber Estuary as a whole. Leeds Flood Alleviation Scheme Phase 1 was successfully completed and Arup has been collaborating with Leeds City Council and others to develop the outline designs and business case for Phase 2.

Concurrently, we were appointed to develop the detailed design of a major coastal protection scheme at Southsea, Portsmouth and have developed six business cases for similar coastal protection schemes along the Welsh coastline.

Our work in Africa has included working on water supply feasibility in Uganda for the UK Prosperity Fund and providing water resources and wastewater advice for an innovative new institute for teaching and research into sustainable agriculture in Rwanda. Highlights from our work in India have included supporting the Stockholm International Water Institute (SIWI) on a pilot programme looking to improve effluent quality in antibiotics manufacture and, as part of our partnership with UK-based charity Frank Water, undertaking a knowledge-exchange visit to Andhra Pradesh to help inform the development of a sustainability assessment tool for development projects.



**HS2 PHASE 2A EAST MIDLAND TO CREWE**

By Will McBain

Arup’s water teams played a critical role in ensuring that a hybrid Bill containing proposals for a 58km stretch of high speed railway between the West Midlands and Crewe were successfully lodged with the UK Parliament in July 2017. Within an 18 month period our teams’ expertise delivered the preliminary hydraulic designs for the river and watercourse crossings, which includes viaducts, bridges and culverts, and preliminary designs for the sustainable drainage infrastructure along the entire route. The baseline water resources and flood risk environment was defined to ensure that the designs avoided sensitive features where possible and that potential impacts were assessed and mitigation was identified. The proposed scheme passes over dozens of watercourses, including the River Trent at two locations, and numerous aquifers, including

groundwater Source Protection Zones (SPZs) associated with public water supply abstractions.

The results of the assessment were reported in five “community area” environmental assessments, supplemented by detailed water resources assessments, flood risk assessments and hydraulic modelling reports. A detailed route-wide Water Framework Directive compliance assessment was also prepared. The proposals formed part of the Phase 2a hybrid Bill, the principle of which was approved by the House of Commons at its Second Reading in January 2018 with 295 votes for and just 12 against, paving the way for future stages of the Parliamentary process. Members of the water team have now moved on to Phase 2b of the project (Crewe to Manchester and West Midlands to Leeds), some providing an environmental overview role for the water resources and flood risk aspects of the route as a whole and others working on the water aspects of the civils design and environmental services contract for development area 3.



**SKIPTON FLOOD ALLEVIATION SCHEME**

By David Neeve

Arup has overseen the design and construction of a new flood alleviation scheme for the town of Skipton in North Yorkshire.

The town has experienced a significant degree of flooding with major events occurring dating back to 1908, and as recently as 2007, and there are currently 378 residential and 165 non-residential properties identified as being at risk of flooding during a 1 /100 year flood event.

The town is surrounded by steep hills and has a number of interconnecting watercourses passing through it, including Eller Beck, Waller Hill Beck and the Leeds-Liverpool Canal, which makes water management and control complicated. Both Eller Beck and Waller Hill Beck often swell very quickly after heavy rain, causing flooding the town.

Skipton Flood Alleviation Scheme has seen the development of two ‘smart’ storage dams upstream of the town on Eller Beck and Waller Hill Beck which have a combined capacity of 130 million gallons. They have been designed to slow the flow and release water in a controlled manner, preventing the flash flooding Skipton has always been susceptible to. The scheme highlighted the huge importance of effective feasibility studies, planning and community engagement to deliver an asset for which the need is understood and accepted by all stakeholders, as the success of the project required the significant co-operation of Skipton Golf Club.

The club agreed to relocate two of its greens to accommodate the Eller beck dam, and to free up land which can be used to form a lake through the storage of water in times of high rainfall. The scheme will provide a 1 in 100 year standard of protection to the town and is due to be fully operational in spring 2018.



**YORKSHIRE WATER**

By Dom Ainger & Phil Press

Arup continues to support Yorkshire Water with their long term strategy, medium-term planning, planned delivery in the current investment period and urgent response to immediate operational issues, having done so since 1995. Over the past 12 months, key projects have included supporting the development of its PR19 business plan, including Sludge Strategy, Resilience Strategy, Water Resource Management Plan and treatment options for metaldehyde and priority substances.

One of the largest projects currently is the Huddersfield Energy Recycling Facility, where a new regional sludge treatment facility is to be developed to replace the current incinerator which suffered from flooding in 2015, bringing forward the company’s plans to replace it, with demolition now planned for June 2018. Arup has completed the design and tendering stage for the replacement plant, which will have the capacity to handle 30,000 tonnes of sludge a year. It will include new sludge reception facilities for indigenous sludge and the provision of a sludge liquor treatment plant to discharge the treated waste, which is transformed into either sewage gas for power generation or sludge cake to be treated and used in agriculture. The site, which will be constructed by 2020, will generate its own electricity to use on site and to export any excess back to the national grid. We have also been working alongside Hull City Council, East Riding of Yorkshire Council and the Environment Agency on the Hull and Haltemprice Flood Alleviation Study. This is taking a fresh approach to addressing flood risk by looking to develop sustainable solutions that work in harmony with the environment and provide wider benefits to the local community, such as access to green space and improved air quality.

Assessing the risk and impact of saline intrusion on the aquifers around Hull has also been a key project which has moved forward over the past 12 months. With the city’s historic abstraction of groundwater causing an influx of saline water from the Humber Estuary, Yorkshire Water implemented a sustainable public water supply (PWS) abstraction management plan in the 1980s, yet no updated data had been provided since. Working with Yorkshire Water, the Environment Agency and Leeds University, we have the first new data since the late 1980s, and are working towards building and analysing a robust continuous monitoring dataset to provide a sound scientific basis on which to make management decisions regarding sustainable abstraction.

**RESEARCH INTO EXTERNAL FACTORS AFFECTING THE COST OF UK WASTEWATER SERVICES**

By Phillip Songa

This is an independent project sponsored by United Utilities. Working with Vivid Economics, Arup has researched whether or how external factors such as geography, rainfall, demographics, ecology, geology and legacy assets affect the cost to the 10 wastewater companies in England and Wales of delivering wastewater services. The outputs from the work were presented to the Ofwat Cost Assessment Working Group as they were developed and informed PR19 thinking.

Led by the water advisory team in Leeds, the interdisciplinary project utilised staff from our water and wastewater, infrastructure advisory, drainage, GIS, economics, regulation and cost estimation teams. Two reports were published to the industry as a result. They are ‘Understanding the exogenous drivers of wholesale wastewater costs in England & Wales’ and ‘Use of econometric models for cost assessment at PR19’.

The key findings from the study were:

- New data: Improved data collection within the industry can allow greater precision in cost estimation. For some variables, the study recommended collecting comparable sector-wide data. More precise regulatory guidance on how companies should calculate load, in particular, would address concerns on the comparability of reported data: reviews.
- New variables: The inclusion of new drivers accounts for factors for which there is engineering evidence of a relationship with cost. The report identifies several drivers where there is a clear engineering case that they affect costs substantially, but where previous analysis has not adequately accounted for this.
- Econometric modelling practices: Econometric models are used by the economic regulator, Ofwat, to determine funding levels for wastewater company business plans. The study found that benchmarking models should be strictly tailored to engineering narratives and avoid techniques that produce unstable results with small data sets.

This market leading study assembled engineering narratives and modelling evidence, new datasets and econometric analysis in an integrated approach that adds a new and unifying perspective to much of the existing commentary on wastewater cost assessment. Overseen by an internal peer review panel comprising Arup and Vivid Economics directors, the integrity of the research was further strengthened by oversight from a panel of independent external peer reviewers from the University of Leeds, Cranfield University, Imperial College London, Cambridge University and Ricardo Environment.



CELEBRATING OUR SUCCESS

# Industry Awards

## People



**PRIYANI MADAN**  
Young Water Professional of the Year  
Australian Water Association  
2017 Victorian Water Awards



**BETH EMERTON**  
Young Achiever Award  
Institution of Civil Engineers 2017  
West Midlands

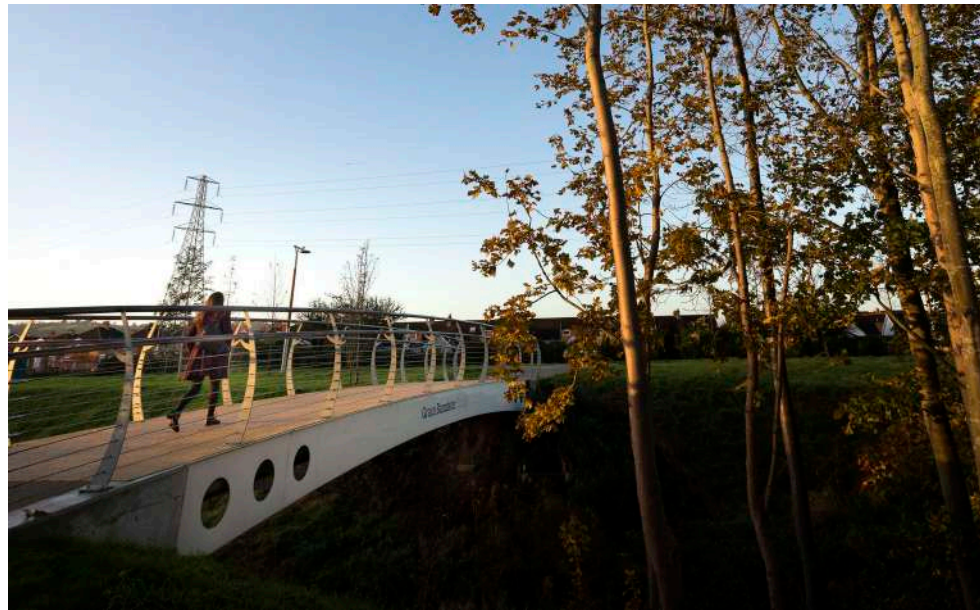


**CONSTANCE PANG**  
Emerging Engineer Award  
Institution of Civil Engineers 2017  
West Midlands



**GABBY BUTERA**  
Research Innovation Award  
Australian Water Association  
2017 Victorian Water Awards

## Projects



### CONNSWATER COMMUNITY GREENWAY, BELFAST, IRELAND

This visionary urban regeneration project is transforming East Belfast by combining improved flood protection alongside the creation of public spaces and pedestrian / cycle routes that connect communities. The £40m project has delivered community cohesion and interactivity, economic development, improvements in public health, cleaner rivers and greater flood resilience.

Sustainable Ireland Environmental Waste Management and Energy magazine 2017  
Environmental Initiative of the Year

Construction Employers Federation 2017  
Construction Excellence Awards - Social/Community Construction Award

Construction Employers Federation 2017  
Construction Excellence Awards - Transport & Utilities Infrastructure Award



### LLANELLI GOWERTON, UK

£100m smart solution for Llanelli to reduce pollution into the Loughor Estuary, a designated Shellfish Waters. Our work negating the need for 50,000m<sup>3</sup> of additional wastewater storage reduced the annual volume of combined sewer overflows by 95%, bringing Llanelli into compliance with the National Environment Programme targets.

Sole UK project shortlisted at the  
Global Water Awards 2018



### WELSH WATER RESILIENCE FRAMEWORK, UK

Pioneering resilience strategy for Welsh Water to anticipate, adapt, respond to and recover from the challenges they know about – as well as the ones they don't – for the next 30 years. Incorporating city, business and asset resilience the project epitomises a new mind-set for tackling both risk management and capital investment.

Management Consultancies Association Awards 2017 |  
Finance and Risk Management Award

New Civil Engineering Awards 2018 | Excellence in Water  
(shortlisted, winner announced 23 May)



### FISHER ISLAND TUNNEL, MIAMI, FLORIDA, USA

Design-build for a new tunnel under the Norris Cut Channel, a location with highly permeable soils and rock. Our technical skills delivered a complex, cost-effective and constructible design for this complex project.

United States American Council of  
Engineering Companies 2018 |  
Gold Award - Waste and Storm Water



### LEEDS FLOOD ALLEVIATION SCHEME, UK

One of the largest river-flood schemes in the UK the innovative solution uses movable weirs to reduce River Aire levels at times of dangerously high water. This solution protects the character of the beautiful city waterfront for both wildlife and the public, without affecting city views.

Constructing Excellence Awards 2017.  
Civil Engineering Project of the Year.

NEC Awards 2017 | Project of the Year.



### GREENER GRANGETOWN WATER SENSITIVE URBAN DESIGN, UK

Working collaboratively we delivered an innovative Water Sensitive Urban Design to a tight budget. The sustainable drainage scheme maximised the use of green infrastructure to future proof the drainage network; providing climate change resilience whilst also delivering enhanced public spaces, promoting sustainable travel and improving ecology.

Water Industry Awards 2018.  
Engineering Project of the Year  
(shortlisted, winner announced 21 May)





This publication has been produced in-house with contributions from the Arup water team globally. Special thanks go to the marketing teams in each region who helped gather information.

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