

ARUP
Global Water
Annual Review
2016/17

Arup carrying out global best-practice baseline geomorphological surveys for SEPA in Scotland using Arup developed apps saving 30% on conventional approaches

Foreword

Sharing the diversity of our work

I am delighted to present our Global Water Review for 2016/17 following my recent trip to Rome and involvement in the WATERSHED initiative. Pope Francis is helping to inspire a global conversation, helping to shift how the world values and understands water – our most precious resource.

This event has rounded off an amazing year where focus on climate change and world water issues has really started to gain momentum. I have been fortunate enough to have participated in a number of events where climate change has been the focus. These include Stockholm World Water Week, the IWA World Water Congress in Brisbane, Australia, COP22 in Marrakesh, Morocco, and Singapore International Water Week in support of the #ClimateIsWater initiative.

Some of the regional projects highlighted in this year's review are showcased in our feature on climate change.

The focus on too much or too little water reflects the way our advisory services and major projects are evolving.

The section on our work specifically covers our integrated approach to water management. It focuses on key service areas as well as including a round-up from each of our five regional water team leaders.

The Arup water team takes social responsibility very seriously and a brief insight into our work with communities shows the positive impact many of our projects have on the people who are most affected. 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.

I am very proud to lead them and have the chance to share our work from across the world.



A handwritten signature in black ink that reads "Mark Fletcher".

Mark Fletcher,
Global Water Leader

Climate change

Water: An essential resource for life

Water is vital to quench people's thirst, and to provide sanitation and hygiene. Yet its importance is much wider. It is also fundamental to food security, human health, energy production, industrial productivity, biodiversity, and virtually every activity that supports prosperity and resilience.

Climate change increases the intensity and frequency of natural disasters and water-related crises – including unpredictable rainfall and



floods, water shortages, cyclones, salinisation and droughts. These events exacerbate existing problems with freshwater quality and quantity (both too much and too little).

Systematically addressing these challenges is key to adapting to climate change and reducing the impact of water-related disasters.

Failure to address the relationship between water and climate will put the planet's future in jeopardy. Two-thirds of the world's population could face water stress by 2025 and the number of people affected by floods could increase three-fold by 2100.

While repercussions will be felt around the world, it's the most vulnerable people – those already exposed to extreme climate phenomena – who will be the worst affected.

These people are also the least able to respond and adapt. Access to food, health and energy is under threat in many parts of the world. Without urgent action, political and social tensions and conflicts are likely to increase.

At Arup, we strive to shape a better world and, as part of this, we seek to educate about climate change and innovate in response to the challenges it poses.

“All people have a right to safe drinking water. This is a basic human right and a central issue in today's world. The right to water is essential for the survival of persons and decisive for the future of humanity.”

[Pope Francis](#)

Climate change

#ClimateIsWater

Supporting the campaign

Climate change poses serious and growing threats to the world's most important resource: water. Access to drinking water, sanitation and hygiene services are all being affected. And water is also fundamental to food security, health, energy production, industrial productivity, biodiversity and virtually every activity that supports global prosperity and resilience.

This is why Arup is supporting the #ClimateIsWater campaign, which aims to place this issue back at the top of the agenda at international climate summits. We are reaching out to the climate community at every level to focus attention on the issues surrounding water provision and to explore potential solutions.

Climate change is a complex issue with many elements, but – as policy responses are discussed, drafted and agreed – it's vital that we highlight water's central importance. Together let's spread the word that #ClimateIsWater.



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“Countries are considered water-stressed if they withdraw more than 25% of their renewable freshwater resources. They approach physical water scarcity when more than 60% is withdrawn, and face severe physical water scarcity when more than 75% is withdrawn.”

[Future of Food and Agriculture Trends and Challenges](#)

This campaign was developed through COP21 in Paris and COP22 in Marrakech where Arup facilitated, presented and championed the #ClimateIsWater message.



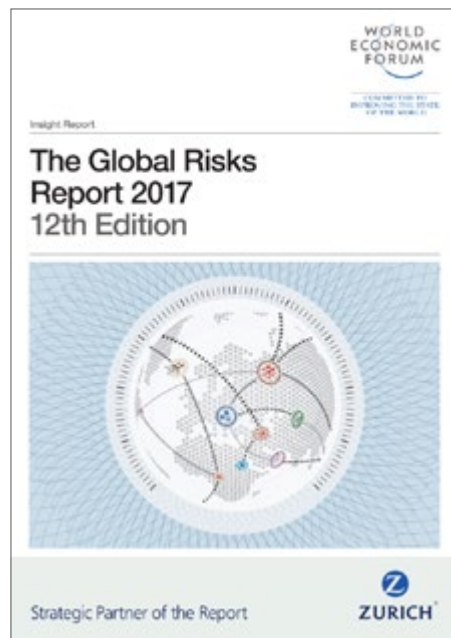
Climate change

Global Risks

Tackling global risks

Global Risk Report 2017

Now in its 12th edition, the World Economic Forum's Global Risks Report 2017 highlights the most significant long-term risks worldwide, drawing on the perspectives of experts and global decision-makers.



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The Global Risks Report 2017 features perspectives from nearly 750 experts on the perceived impact and likelihood of 30 prevalent global risks as well as 13 underlying trends that could amplify them or alter the interconnections between them over a 10-year timeframe.

Climate change and water crises continue to feature prominently in the global risks landscape and are inextricably linked to food security; about 70% of the world's freshwater withdrawals are used for agriculture. This rises to over 90% in many of the least developed countries. At the same time, over a billion people lack access to clean water, 40% of the world's population suffers water shortages for at least a month annually and an estimated four billion people could be living in water-scarce areas by 2050.

Top 10 risks in terms of Likelihood

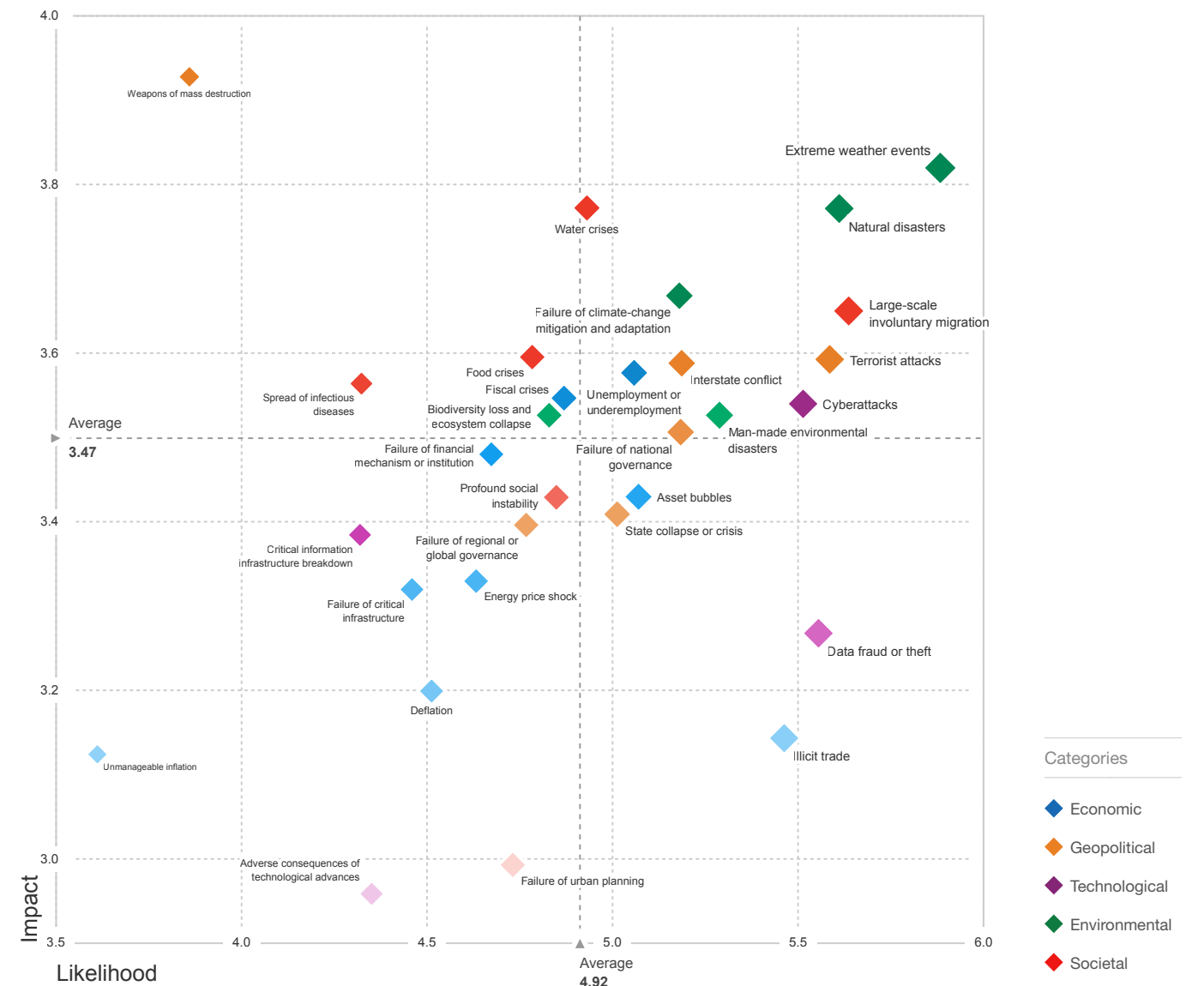
- 1 Extreme weather events
- 2 Large-scale involuntary migration
- 3 Natural catastrophes
- 4 Terrorist Attacks
- 5 Data fraud or theft
- 6 Cyber attacks
- 7 Illicit trade
- 8 Man-made environmental disasters
- 9 Interstate conflict
- 10 Failure of national governance

Top 10 risks in terms of Impact

- 1 Weapons of mass destruction
- 2 Extreme weather events
- 3 Water crises
- 4 Natural catastrophes
- 5 Failure of climate-change mitigation and adaptation
- 6 Large-scale involuntary migration
- 7 Food crises
- 8 Terrorist Attacks
- 9 Interstate conflict
- 10 Unemployment or underemployment

The Global Risks Landscape 2017

What is the impact and likelihood of global risks?



Climate change

Too much water

The posing threat of extreme weather events

With much of the world's increasing urban population concentrated in coastal cities, sea-level rise poses a serious threat to these urban areas.

Flooding can be disastrous – with houses destroyed, lives ruined and wildlife threatened. Flooding and wet weather also affect the global food supply. Arable land must receive enough water to grow crops, but too much rain can severely reduce yields.

Floods that used to take place every 100 years now occur every ten or 20 years, partly as a direct result of climate change. With increasing rainfall, and the continued destruction of the environment exacerbating the problem, catastrophic floods may become regular occurrences.

Our global flood and coastal management experts tackle all aspects of flood alleviation. Their work includes feasibility, modelling, research projects, prevention and long-term, resilient solutions.

Drawing on ideas and projects Arup has used successfully in other regions, we provide sustainable solutions at a local, national or global level.



10 Inches

Sea levels forecast to rise up to 10 inches by 2025 based on a 3 degree Fahrenheit rise in ocean temperatures



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Protecting Sheffield from flooding

In the UK, Sheffield City Council is working with the Environment Agency on an ambitious £83m investment programme to protect the city from flooding. To support this, Arup is developing business cases and project appraisals for flood protection schemes on the Upper Don and Sheaf catchments, as well as preparing high-quality consultation material for the council.

Sheffield sits at the foot of the Pennines and its fast-flowing rivers make it vulnerable to flooding. Options for the flood protection schemes include creating flood storage areas in open spaces such as parks and woodland. Building new flood defences is also under consideration, as is tree planting and moorland restoration to keep rainwater in upland areas and reduce flooding downstream in the city.

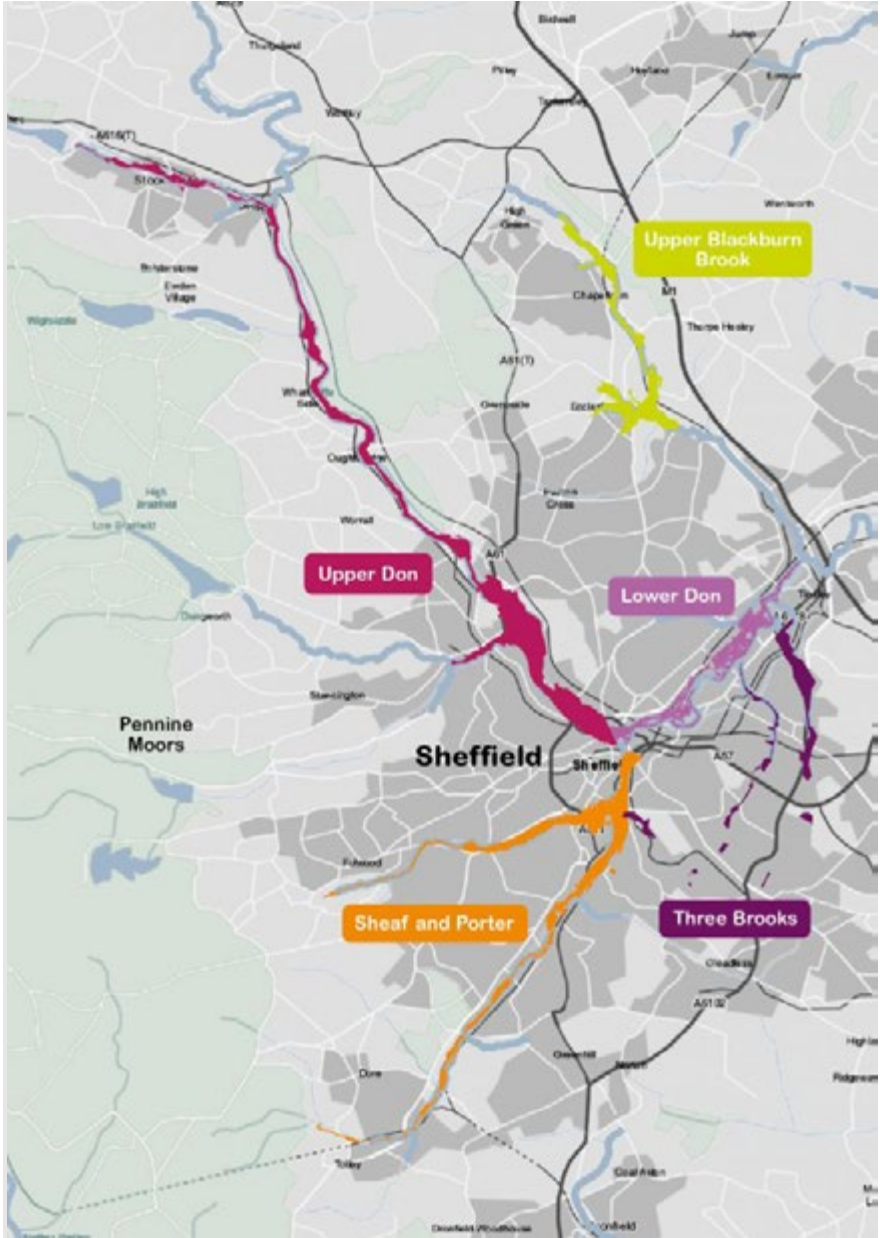
The investment programme aims to protect 6,000 homes and 1,760 businesses, safeguarding 32,700 jobs and, over the lifetime of the programme, preventing £1bn of damage to the city. The programme will also play a key role in enabling growth. It aims to protect 46 hectares of riverside brownfield land for development, creating 15,000 jobs. It will enable 27,000 new homes to be built. And by regenerating 30ha of riverside land it will create new tourism and recreation opportunities – as well as enhancing biodiversity.

 **32,000**
jobs safeguarded

 **1 Billion Pounds**
Preventing £1 billion of damage to the city



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Upgrading the Pacific Highway

In New South Wales, Australia, the Road and Maritime Services have been working to improve transport infrastructure. Our detailed design for the Pacific Highway upgrade between Woolgoolga and Ballina will increase traffic flow, shorten travel times and improve safety. Crucially, we put flood issues at the heart of the design.

Linking Sydney and Brisbane, the Pacific Highway makes a vital contribution to Australia's economy. However, an upgrade is required to overcome problems with access, safety and capacity. In joint venture with Cardno we carried out the detailed design of 34km of the highway upgrade.

Because many areas of the design were in flood plains and areas sensitive to flooding, including sugar cane fields, this was a particularly challenging project. We had to ensure the highway was immune from flooding whilst minimising any flood impacts on sensitive areas as a result of the proposed works.

Using hydraulic modelling software, we assessed flood impacts of the proposed works as well as the detailed design of all cross drainage structures in the project. This was the first time the software had been used for both these tasks.



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Leeds Flood Alleviation Scheme

As a result of our work in the UK city of Leeds, a flood alleviation scheme has, for the first time, examined the impact on the urban sewer system in detail.

Leeds has a flood alleviation scheme defending the city against water escaping the river. Yet within the area protected by the scheme, surface water still flooded from the drainage network when river levels were high. So the council asked us to assess which areas of the sewer network were sensitive to such flooding.

We constructed an integrated hydraulic model combining five watercourses, 40,000 sewers, and a 275km² ground model. This enabled us to carry out a detailed assessment of overland flow paths through the city centre. The model was so detailed that we were even able to predict the impact on individual properties.

Using the results, Leeds City Council has prioritised key risk areas and designed interventions to solve the problems highlighted. The total cost of addressing all the residual surface water risk issues was estimated to be around £1.8m – a cost that would not have typically been accounted for.

Our study has significantly improved the council's understanding of flood risk from all sources within Leeds city centre and provided an invaluable tool for managing the surface water network in the future.



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“In 2015, 52 floods affected 27.5 million people and claimed 3,310 lives. This compares with the 10-year average of 5,938 deaths and 85.1 million people affected.”

[Camel, Food Security and Climate Change Blog](#)



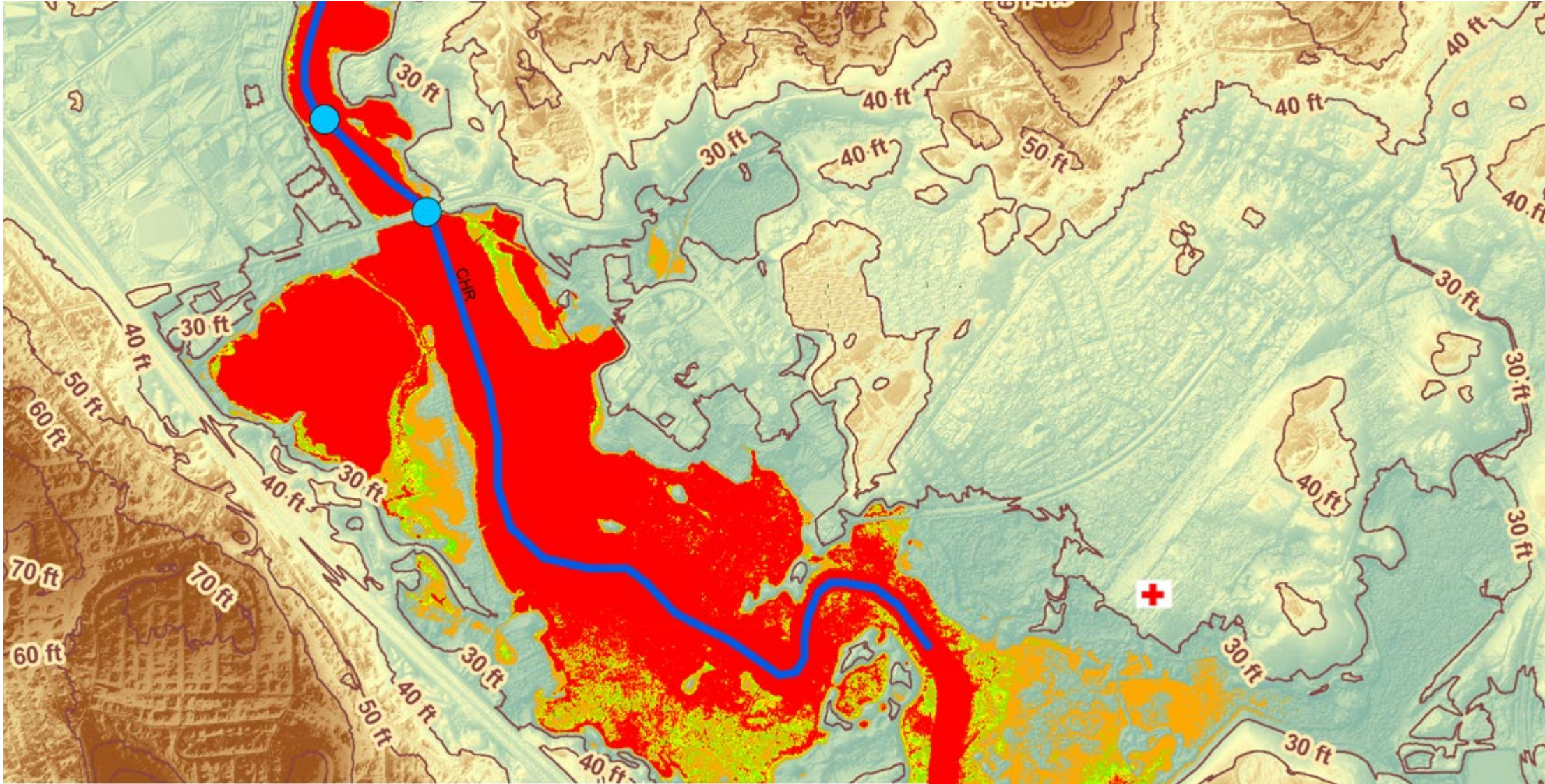
Safeguarding 30 Partners HealthCare facilities

Our innovative flood risk assessment methodology yielded vital information for protecting Partners HealthCare facilities from inland flooding without time-consuming wide-scale flood modelling. This approach enabled Partners HealthCare to efficiently focus resources on identifying, assessing, and mitigating climate change vulnerabilities within its portfolio.

Our vulnerability assessment of climate risk covered 30 Partners HealthCare facilities across Massachusetts, including hospitals, community health centres, clinics and research-based laboratories. For each at-risk facility, we calculated flood elevations and developed updated flood maps for each storm scenario. This assessment was used to understand the risk across the entire Partners system.

Engineers in our Boston and Montreal offices partnered with University of Massachusetts Professor of Climate Adaptation Paul Kirshen to develop a method for rapid flood risk modelling and assessment. For facilities where integrated flood models were not available, this enabled us to quickly define precipitation-based flood risk for future storms based on climate change scenarios.

\$ 2.4 Billion Dollars
The average annual U.S. flood losses in the past 10 years



Protecting properties in Hull

Arup's expertise played a crucial part in securing funding for a project to repair flood defences along the River Hull. The £36.5m scheme is repairing defences along a 4.6-mile (7.5km) stretch of the river, which protect about 63,000 properties in Hull.

We appraised the project and prepared business cases to secure funding for the project, which will reduce flood risk for around 250,000 people living and working in Hull. The repairs will see more than 30,000 residential properties moved to a lower risk band – more than 10% of the government's six-year target to March 2021.

Defences for some 39 riverside locations along the river have been identified as in need of repair. These have aged or deteriorated over time, posing a risk of flooding when river levels are high. As part of the first phase of the project, due to be completed by 2019, the Environment Agency will repair damaged flood walls and other weak spots.

The project will provide a high standard of protection for the city of Hull for the next 100 years, against a backdrop of climate change, increasingly intense rainfall, and rising sea levels.



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 **63,000 Properties**
protected in Hull. High standard
of protection for next 100 years



Climate change

Too little water

More than 740 million people are living without access to clean, safe water

The World Economic Forum says water crises are the biggest risk facing the planet. And, sadly, water scarcity is a problem that threatens to get much worse.

With the global population set to grow to 9 billion by 2050, and also to urbanise, demand for precious water resources will increase dramatically. Unless everyone can learn to cope with less water, more and more communities could find themselves running out.

What can be done to avert a disaster? Our experts believe the world needs a revolution in the way people use water in homes, for industry, for agriculture and to produce energy.



Water scarcity doesn't only affect areas typically associated with droughts, such as East Africa. By 2025, it's estimated that 1.8 billion people will be living in water-scarce regions.

There's no doubt that tackling water scarcity will require radical changes in behaviour. Recognising the social, environmental and economic value of water is an essential first step: at the moment, most people just aren't conscious of the need to use it more efficiently.

With 66% of the global population expected to be living in cities by 2050, it's also vital that urban areas can cope with, and help tackle, water scarcity.

This is what water-sensitive urban design aims to do. It's something we embrace in the approach we call Design with Water, which considers the water cycle as a whole and uses measures such as green spaces to both manage water and provide public amenities.

“2016 is the third year in a row to set a new record for the hottest year since records began.”

[Camel, Food Security and Climate Change Blog](#)



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Informing Queensland's water supply planning

In the Australian state of Queensland, we investigated alternatives to traditional water supply infrastructure.

The water industry in Queensland has undergone significant restructuring in the last decade, as a result of the impact of climate change as well as shifting political and environmental pressures. In the face of climatic extremes and a shift to a low-carbon economy, the focus is now moving towards flexible and smart infrastructure solutions that meet the changing needs of society, the economy and the environment.

We advised the Queensland Department of Energy and Water Supply on available technology and its suitability for use in the state. We reviewed everything from facilitating behavioural change through tools such as smart meters, to the planning and design of dams and reservoirs.

First, we created a library of 60 solutions with information on how each one works, its suitability and examples of how it has been implemented elsewhere. We then shortlisted ten solutions, producing at-a-glance information sheets for each before producing a report of our findings.

We found that water reclamation, desalination, solar power and underground storage are all promising options for Queensland. By structuring the information carefully, we made it straightforward to identify suitable options for different communities – whether, for example, they are located in hot, dry areas or coastal areas that experience more extreme wet and dry ranges.



“Many regions of Australia are still in significant drought.”

Elaine Pang, Senior Water Engineer,
Brisbane



Tackling imbalances in the Pearl River Delta

Arup will investigate the feasibility of building an aqueduct system in Pearl River Delta to tackle the region's east-west imbalance in water resources and consumption.

Water shortages are a major issue for the highly urbanised east side of the Pearl River Delta. Currently, the Nansha area of Guangdong relies solely on the lower stream of the North River for water supply. Meanwhile, Shenzhen and Dongguan draw water from the East River.

A new west-east aqueduct would effectively change the water supply pattern of the region and alleviate water shortages brought about by rapid urbanisation. It will also help to reduce the demand on Dongjiang during the dry seasons and maintain a stable water supply, achieving more sustainable development.

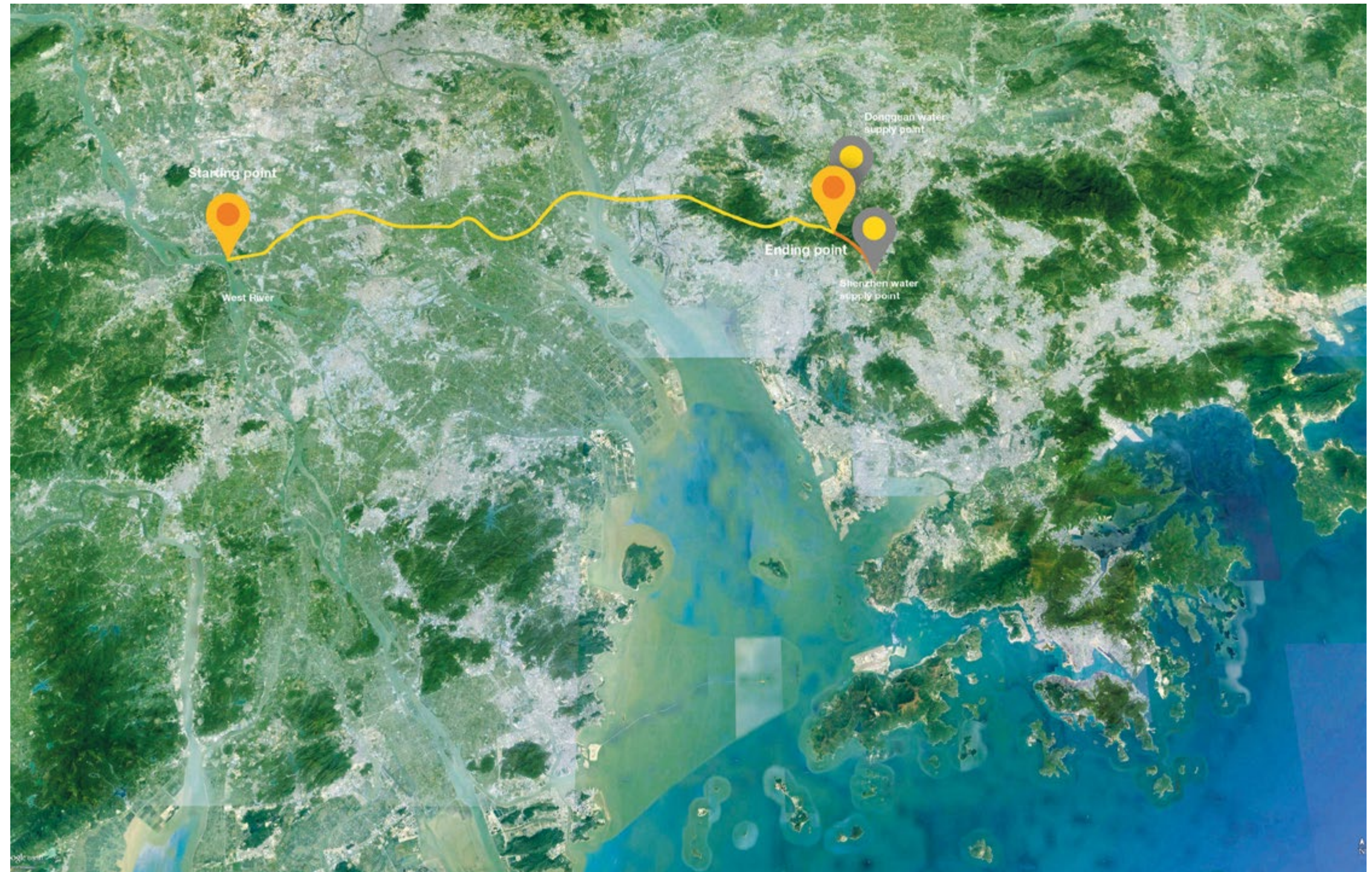
The project is one of the water infrastructure improvement ideas prioritised by the State Council of China. We will optimise the layout of the aqueduct system as well as optimising the design for troubleshooting and maintenance of the deep water supply line.

Following our deep sewage tunnel project in Wuhan, this is the second major water project involving our Shenzhen office.



“This region is often considered an emerging megacity.”

Kenneth Kwok, East Asia Water Leader,
Hong Kong



Reducing water use at Los Angeles International Airport

Since 2012, Arup has provided key engineering staff to Los Angeles World Airports (LAWA) to support its modernisation programme at Los Angeles International Airport and address ongoing maintenance issues across the airport campus.

As part of this, we are helping LAWA design and construct recycled water infrastructure to connect to a new advanced treatment facility at the campus boundary. When it's connected in 2020, this plant will save more than 80 MG (300ML) of potable water annually.

We also created a project definition booklet to gain approval from LAWA's senior executives for the project to move forwards. By carefully coordinating with other capital projects, we have been able to minimise disruption and the cost to our client.

Our work will help LAWA achieve its goal of reducing potable water use by 50% by 2024 – moving towards the Mayor of Los Angeles' goal of Creating a Water Wise City.

“Currently, LAWA irrigates 35 percent of the landscape at LAX with reclaimed water, conserving 123 acre feet (40.2 million gallons) of water annually.”

[LAWA Website](#)



Photo: Michael Urbanek

The view is of the completed Central Utility Plant, Thermal Energy Store (lit) and Cooling Towers (in the background) taken from the north. The plant was constructed in the heart of the LAX Central Terminal Area next to the Air Traffic Control Tower, which can be seen rising up behind the plant.

Climate change

Global Engagement

Raising awareness of water issues

Our water team has once again worked hard to raise awareness of the global water issues caused by climate change. They have attended, participated, presented, exhibited, hosted and debated critical themes at events around the world.

Several of our UK team attended World Water Week in Stockholm, an annual focal point for water issues hosted and organised by Stockholm International Water Institute. And colleagues from around the world gathered for Singapore International Water Week – a global platform to share and co-create innovative water solutions.

In Singapore, the occasion and our purpose-built exhibition booth provided an opportunity for us to showcase our experience of delivering solutions for complex water management, waste and energy issues.

In their presentations, Arup experts from around the world covered hot topics such as the future of urban water, stormwater resilience, designing with water and wastewater management.

At the International Water Association's World Water Congress and Exhibition in Brisbane, Australia, we joined 5,000 water-industry representatives from all over the world. The week centred on "shaping our water future" and the impact digital technology could have on the water industry.

In a busy year, these are just some of the activities it has been our privilege to take part in.



2010

Six of the ten warmest years recorded since 1880 have occurred since 2010



“Water security is one of the most tangible and fastest-growing social, political and economic challenges faced today. We were pleased to support the Singapore International Water Week by contributing to the debate on water management, leveraging our global expertise and breadth of knowledge to give a new perspective on this complex global issue.”

Mark Fletcher, Global Water Business Leader, Arup

Highlighting water issues at COP22

In November 2016 we attended the COP22 United Nations Climate Change Conference in Marrakech, Morocco. This involved over 1,000 national and local government ministers, UN agencies, non-governmental organisations, investors, academic institutions and private-sector organisations. They discussed national climate targets and the innovation needed to achieve the ambitious goals of the Paris Agreement.

Arup's water specialists were among these representatives, exhibiting with our partner organisations. The event provided us with another valuable opportunity to support the Alliance for Global Water Adaptation's #ClimateIsWater initiative. This aims to make water issues a bigger part of the climate change discussions.

Our global water business leader Mark Fletcher also spoke at a session hosted by the Stockholm International Water Institute. This focused on exemplars in water management that lead to business success and resilience.

Mark briefed the session on Arup's work, including enhancing one of Del Monte's wastewater treatment plants by adding an anaerobic reactor. The new plant treats pineapple-processing waste to produce biogas, which is captured and fed to new combined heat and power (CHP) engines to generate electricity.

Mark also described Arup's design of the Yarra Park Water Recycling Facility on behalf of the Melbourne Cricket Club in Australia. This provides a secure, long-term, sustainable water supply to the heritage-listed Yarra Park, Punt Road Oval and the iconic Melbourne Cricket Ground in the aftermath of the country's 'millennium drought'.

“No country, however resourceful or powerful, is immune from the impacts of climate change.”

[Ban Ki Moon, Secretary General of the United Nations](#)



Mark Fletcher, Global Water Leader, welcoming visitors to the #ClimateIsWater stand



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Land Ice
is decreasing by 281bn
tonnes per year

Putting young professionals at the heart of the response to climate change

We are partnering with the Stockholm International Water Institute (SIWI) to develop all the Young Professionals activities for World Water Week. This 5-year collaboration will allow us to develop, implement and improve a strategy for ensuring younger people working in the industry are represented across the wider conference agenda.

As part of the collaboration, Arup and SIWI jointly supported 24 young professionals from underprivileged backgrounds to attend this year's World Water Week in Stockholm. At the conference, a daylong session aimed to create a movement of young professionals. It's hoped they will inspire others across the world, including the next generation of schoolchildren, to become involved in tackling climate change and achieving the sustainable development goals.

The final stream of activity at this year's conference saw us co-host the Young Professionals Booth for the duration of the conference. Each day, the booth was given to a different organisation to showcase its work. This gave the organisations such as Engineers Without Borders UK and the Youth Water Network the chance to reach a wider audience.

“We used to think that energy and water would be the critical issues for the next century. Now we think water will be the critical issue.”

[Mostafa Tolba, former head of the United Nations Environment Programme](#)



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Contributing to an unprecedented dialogue

On World Water Day, March 22, Pope Francis inspired a global conversation. His address from the Vatican helped shift how the world values and understands its single most precious resource: water.

Immediately following the Papal address, 400 thought leaders from around the world began an unprecedented dialogue about the value and values of water. This global convocation of water specialists was drawn together to consider ways to take action for a better world. Those gathered included policymakers and academics, students, artists, business leaders, and men and women from the most at-risk populations.

Mark Fletcher, Global Water Leader for Arup, attended this WATERSHED initiative. Held at the Vatican City, the event was organised by the Pontifical Council for Culture, the Club of Rome, the World Economic Forum Global Future Council on the Environment and Circle of Blue.



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Dr Mark Fletcher, Arup presenting at WATERSHED, Vatican City, Rome



Mark Fletcher with Maggie White , SIWI/AGWA and Diana D'Arras, President IWA/Suez at the Vatican

Climate change

Technology Tackling the effects of climate change

The effects of climate change are one of the greatest threats to this planet. Around the world, technology will play a key role in mitigating and adapting to the negative impacts of extreme weather conditions.

This year, Arup launched Venturi – a digital space that helps bring to market innovative products and services that match the need of the sector. Venturi also aims to accelerate the often-lengthy development process by helping companies to gain important early-stage exposure in the sector.

Technology companies get to showcase cutting-edge solutions with the opportunity to reduce risk during the development process – from inception to commercialisation. Technology buyers and users can access products and services with the potential to solve their most pressing challenges. There is also the option to post these challenges in the hope of influencing technological solutions. Researchers and developers can find support, investment and guidance for pre-market ideas.

The Venturi team travelled the world to raise awareness of our portal and to encourage engagement. This fresh approach has been well received by a global audience.



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Presenters featured are Martin Shouler, Arup Water Leader, London (Far left and third to the right) Dr Mark Fletcher, Global Water leader (far right)



Singapore TechXchange

In July, members of the Venturi team took part in the TechXchange Programme, which ran alongside Singapore International Water Week. The programme connects innovators with partners, buyers and investors to accelerate commercialisation of new water technologies from lab to market.

TechXchange provided the opportunity to introduce Venturi to a global audience and the initiative's leader, Martin Shouler, presented on behalf of the team to over 100 delegates from around the world. During the following days at the main water week event, the team engaged with technology clusters from the country trade delegations – sparking further interest in Venturi.



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The India-UK TECH Summit

Led by the UK's Prime Minister, Right Honourable Theresa May, the India-UK TECH Summit showcased cutting-edge UK technologies whilst promoting the UK as India's partner of choice for innovation. Arup's Martin Shouler attended the Wastewater Trade Mission as a UK expert. Invited to present on water and wastewater technology and innovation, Martin highlighted initiatives such as the Venturi portal. Trade missions to Pune and Mumbai followed the summit, offering an opportunity to network with key decision-makers. Martin also met with leading university research teams from across India, including IIT Delhi and IIT Mumbai, to share new and emerging ideas on water technology.



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British Water International Reception, House of Commons, London

Over 170 representatives from the water industry, government departments and academia gathered at the House of Commons in October for British Water's annual International Reception. In his address, Arup's Martin Shouler spoke about the importance of water to the issues facing the world today – from population growth to climate change. Martin emphasised the growing imperative to innovate and the need to clearly articulate the challenges for the water sector. He spoke about how the Venturi portal provides a way to share the needs of the sector as well as emerging innovative technologies.



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IWA – World Water Congress and Exhibition

In October, the Venturi team travelled to the International Water Association's World Water Congress and Exhibition in Brisbane, Australia.

Attended by over 5,000 water industry representatives from around the world, the event highlighted the potential impact of digital technology on the water industry.

During the week, representatives saw Venturi's potential to accelerate the commercialisation of new technology. It was also evident that the portal could help tackle wider water issues by exposing new technologies to key members of the supply chain.



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Our work

Our Work

Protecting and enhancing the water cycle

Placing water at the heart of sustainable planning, policy and design can address critical issues such as flood risk, climate change and economic growth, and create healthier, more resilient communities.

By aligning with other development needs, actions taken to protect and enhance the water cycle can deliver multiple benefits and support partnership funding and delivery. Water is essential for drinking, agriculture and industry. Rapid population growth, climate change and an increasing demand for water means water suppliers, governments and businesses are rethinking how they can manage water more effectively, to reduce the risks associated with too much or too little water.

We understand the interactions between the water cycle and other systems including industry, ecosystems and cities. Our capability encompasses water in natural catchment systems – including flood-risk management, water treatment and supply, its uses in municipalities and industry, and its treatment, re-use, recycling and return to the environment.

Our global expertise and breadth of knowledge give us a new perspective on water management. Our carbon insight, for instance, tells us that managing water demands an integrated approach to carbon emissions, while low-carbon energy strategies in turn influence the water environment. Our integrated thinking in water, waste and energy delivers more sustainable solutions for our clients.



“Our global expertise and breadth of knowledge give us a new perspective on water management.”

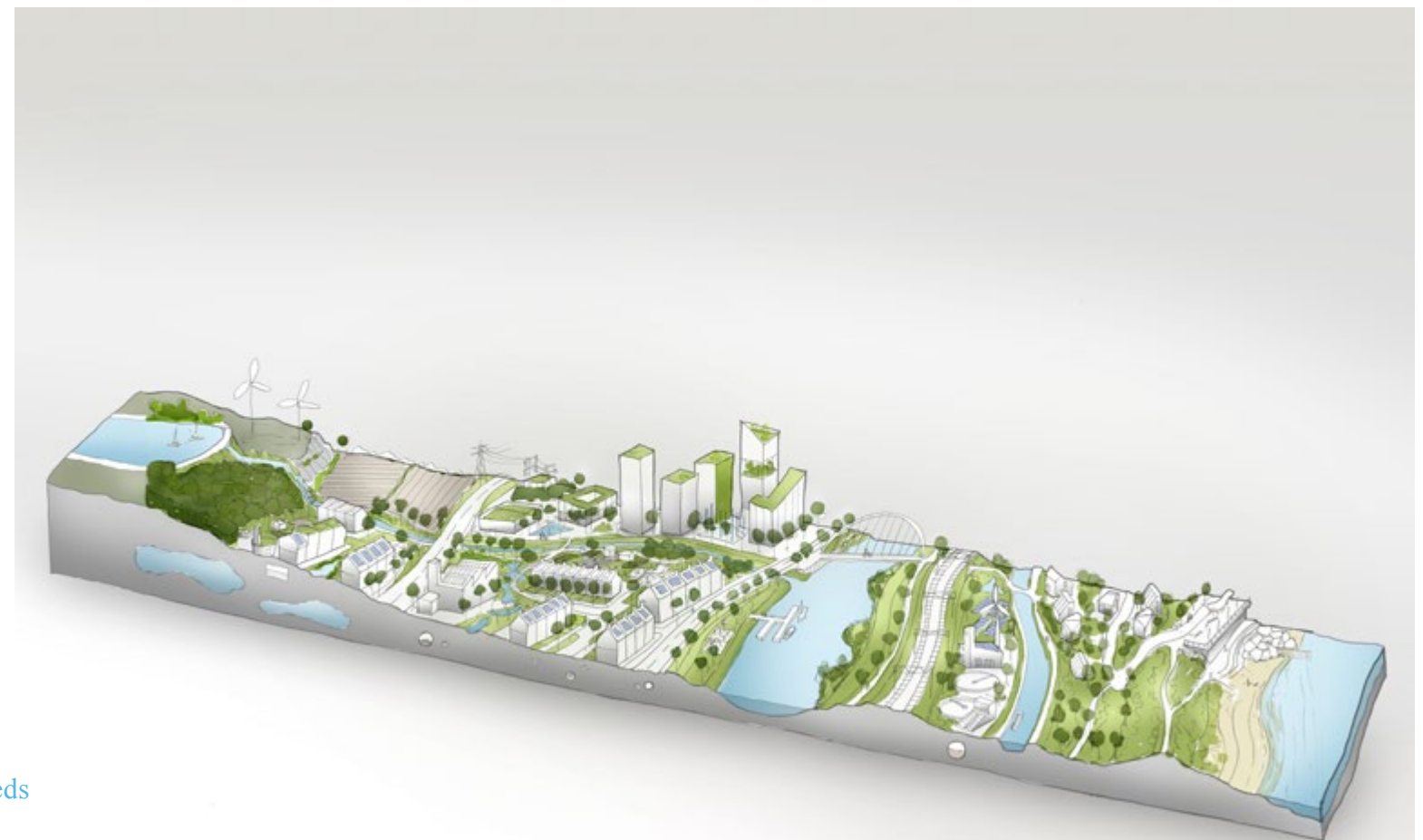
[Justin Abbott, Arup Water Skills Leader, Leeds](#)



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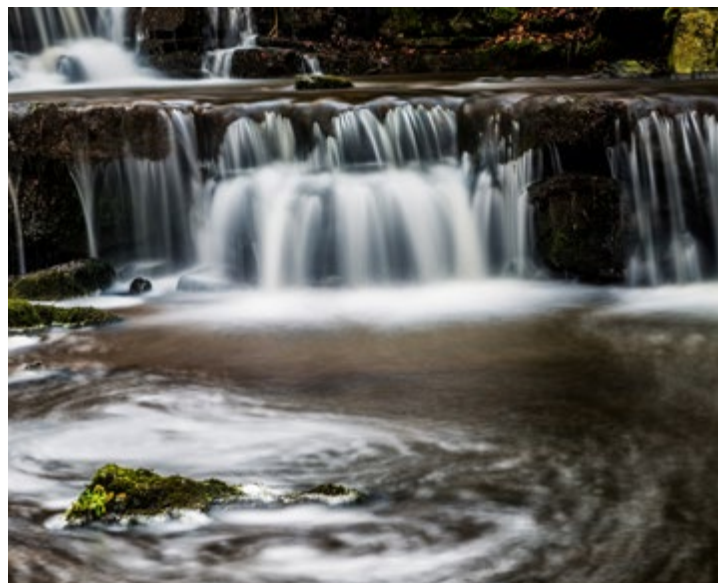
Our work

Clean water Sustaining communities

Without a safe, clean and reliable water supply, people and communities are unable to prosper.

As well as the multidisciplinary engineering expertise needed for water supply projects, we provide skills in areas such as ecology, biodiversity and the environment. This enables us to review options and provide solutions to even the most challenging problems faced on pipeline projects.

We also help to develop water supply projects. Our water resources planning and environmental appraisal skills are regularly deployed in the study and development of regional water supply strategies.



When it comes to inspecting, monitoring and repairing existing pipelines, our in-house expertise enables us to rapidly evaluate and select the right solutions for each client's particular circumstances.

Around the world, water companies, water industry regulators and other private and public organisations benefit from our expertise.

We work closely with clients and key stakeholders to gain an in-depth understanding of the practical, financial and environmental issues, and the legal framework driving water resources management.

“All people have a right to safe drinking water. This is a basic human right and a central issue in today's world.”

[Pope Francis](#)



A robust plan for Welsh Water

In the UK, water companies must produce a water resources management plan every five years. This forecasts demand and available supplies for each water resource zone for the next 25 years – to predict whether zones will have enough water or enter a deficit. Our expertise is helping to ensure Dwr Cymru Welsh Water has a robust plan in place.

We screened a list of over 200 options for addressing any expected deficits to create a shortlist of 35 options to be assessed in more detail. Options include raising a dam, building a desalination plant and using spring water from the Severn Tunnel rail link between England and Wales.

Ten shortlisted schemes are now entering a detailed engineering review undertaken by Arup as sub-consultant to Amec Foster Wheeler.

 **1.4 million**
homes and businesses served

“828 million litres of water
supplied every day.”

[DWRCYMRU website](#)



Investigating ways to remove metaldehyde from drinking water

The pesticide metaldehyde is commonly used in agriculture for the control of slugs and snails. Its presence in drinking water is one of the greatest challenges to the UK water industry this past decade.

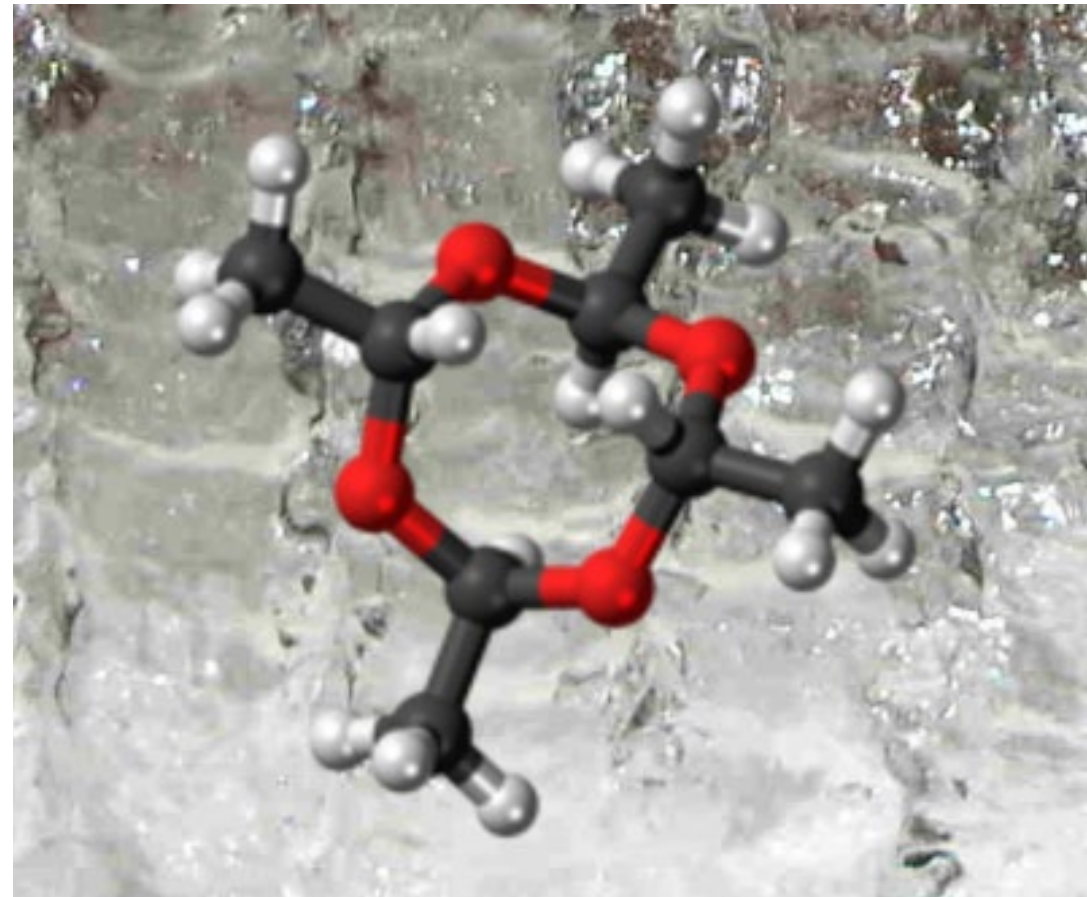
Although of low toxicity, it falls under current blanket EU legislation for regulation of pesticides in drinking water, which will be enforced for metaldehyde in 2020.

For small catchments, it is possible to control the use of metaldehyde or subsidise alternatives. For larger catchments, removal by treatment is the only available alternative to water companies.

The complexity in removing metaldehyde from drinking water has driven considerable investment in innovation, piloting and development of new treatment technologies. This is very much at the leading edge of water treatment technology.

We were commissioned as technical consultants to work with Cranfield University and Yorkshire Water on screening potential treatment technologies, bench scale testing and engineering the integration of the proposed treatment options into five of Yorkshire Waters treatment works. Technologies include advanced oxidation using combinations of ozone, peroxide and high intensity UV light as well as adsorption onto speciality activated carbons.

The output of this work will play an important role in reviewing the impact on the water industry and its consumers of pesticide regulation and control.



“This work will play an important role in the managing of complex drinking water contaminants in the UK.”

[Dr James Bloor, Arup Technical Specialist, Leeds](#)

Developing an integrated approach to managing water at Nine Elms

New mixed-use developments at Nine Elms in London will provide 21,000 homes and create 25,000 new jobs. They will also increase demand on existing water infrastructure by 800%.

Upgrading or reinforcing this infrastructure would be a major undertaking. So the Nine Elms Partnership asked us to review the capacity issues, evaluate future demand projections, and

develop ways to manage water in an integrated way so that existing infrastructure would be sufficient.

The strategy focussed on balancing water supply and demand by using rainwater, stormwater and recycled greywater for non-potable uses, such as toilet flushing, washing machines and landscape irrigation.

We also developed a surface water management strategy. This integrated the current and future sustainable urban drainage (SUDS) strategies with the water reuse and surface water management measures. The result will be reduced potable water demand and better management of rainwater runoff.

So far, the strategy we created has reduced infrastructure reinforcement requirements, made the build-out easier and reduced disruption. It has also cut costs and helped the project achieve higher environmental standards.



“Our region, like much of the South East, is ‘seriously water-stressed’, which means a very high proportion of the water in the environment is already in use.”

[Martin Shouler, Arup Water Leader, London](#)



Our work

Waste water

Meeting higher standards, creating value

The efficient and effective treatment of wastewater is key to maintaining and improving public health. Today, the drivers influencing the management of wastewater include tougher treatment standards, affordability, carbon reduction, resource efficiency, water scarcity and advances in technology.

Our expertise in investigation, feasibility, design, construction supervision, commissioning – and in training staff to operate and maintain new wastewater collection and treatment projects – helps our clients address these drivers. Through technical excellence, efficient management and personal service we enable our clients to meet their business objectives.

Our expertise also covers the inspection, evaluation and design of remedial and improvement works to existing drainage systems and treatment plants. This enables our clients to increase plants' capacity or to improve the quality of the final effluent.

In wastewater and stormwater drainage, we analyse and design conventional sewerage systems as well as advising on trenchless technology and tunnelling construction techniques.

We don't just design wastewater projects, we provide bid management, technical advice, feasibility studies, supervision of surveys and site investigations, environmental assessments, site supervision, assistance with procurement, commissioning, operation, maintenance and training. We also identify and reduce risk associated with wastewater projects.

We successfully employ both traditional and advanced, space and cost-efficient process technologies, including, membrane and tertiary treatment. Our large in-house database, developed to monitor capital and operational costs and plant performance, enables us to rapidly evaluate and select the right solutions for each client's particular circumstances.



“Globally over 80% of the wastewater generated by society flows back into the ecosystem without being treated or reused.”

Vincent Glancy, Arup Global Process Engineering Leader, Leeds

Using smart technology to reduce combined sewer overflow spills in Wales

Using smart technology to reduce combined sewer overflow spills in Wales

In times of wet weather, combined sewer overflow pipes release dilute foul water from the system to avoid it becoming overloaded. Dwr Cymru Welsh Water aims to reduce the frequency of these spills across its network by using smart technology and analysing data trends to optimise its existing infrastructure.

We carried out an initial strategic review for the project, followed by a detailed hydraulic analysis. We then carried out extensive investigations of flows and flow trends under different conditions – such as summer and winter, dry weather and wet weather. Arup, working with Welsh Waters operations and data teams, developed a hierarchy of logic controls which can effectively spread flow around the catchment dependant on the antecedent, current and eventually predicted flow conditions. Finally, we provided the detailed design for solutions.

With around 50% of the solutions installed so far, the volume of combined sewer overflow spills has reduced from two million to 200,000 cubic metres per year – a 90% reduction. The project has made use of 50,000m³ of previously unused storage capacity. It's also reduced expenditure and, by using existing infrastructure, reduced carbon emissions.



“We have been able to make a 90% reduction to sewer overflow spills so far in the project.”

Steve Ollier, Arup Senior Water Engineer, Cardiff



Creating a climate change mitigation and adaptation strategy for South East Water, Victoria

In Australia, we provided South East Water with a roadmap and strategy document to help the company plan how to reduce its carbon emissions and make its business resilient in the face of climate change.

This project built on our previous work with South East Water, which included optimising the company's two largest wastewater treatment plants. Our mitigation strategy cuts greenhouse gas emissions across South East Water's sites, improving the efficiency and resilience of operations in the process.

Working with our client, we identified the major sources of emissions – both now and in the future. We followed this with an initial feasibility and cost analysis of actions to reduce emissions.

The cost analysis was based on our previous studies into efficiency options for South East Water's assets as well as preliminary cost estimates for newly identified actions. By combining this information with emissions reduction calculations, we showed the marginal cost of making reductions – aiding decision-making.

To ensure the initiatives in the strategy are achievable, we worked closely with South East Water staff and stakeholders. For both the climate change mitigation strategy and the climate change adaptation plan, we developed a public-facing summary policy document, detailed reports and a tracking tool to help implement the strategy.



“I feel a sense of pride that we are able to help our clients reduce their carbon-footprint whilst making a positive difference to operational efficiencies.”

Therese Flapper, Arup Water Leader, Canberra



Studying water quality along Welsh coasts

Dwr Cymru Welsh Water (DCWW) appointed its alliance partners – Arup, Mott MacDonald Bentley and Arcadis, supported by Intertek, to undertake an 18-month coastal investigations programme in October 2015. This project studies the impact of wastewater and agriculture on water quality at bathing and shellfish waters along the Welsh coast.

The project has involved extensive field surveys, sewer investigation, river investigations, statistical analysis of rainfall, bathing water compliance assessment and large-scale coastal numerical modelling. Arup led the sewer investigation and the coastal modelling for the southwest region.

This is the largest scientific coastal project that DCWW has ever undertaken. Across 49 sites the investigations identify where, and to what extent, action can be taken to improve the coastal water environment. The results will inform DCWW's business planning and ensure the water company can maintain affordable customer bills while adapting to climate change and growth in demand.

“In 2016, 102 of the 103 designated bathing waters in Wales met the new stricter European classifications for bathing water quality with 84 achieving the higher European classification of excellent.”

Gov.wales



Our work

Stormwater & Drainage

Transforming stormwater from waste to resource

For the last 200 years, the industry has viewed stormwater as a waste product it should get rid of as quickly and easily as possible. But this accelerates the speed of the stormwater through the urbanised catchment, increasing the stress on rivers during heavy rain and resulting in more frequent flooding. Concentrating the flow of stormwater onto hard areas also transports pollution to the watercourses, degrading them and harming natural ecosystems.

What if, instead, stormwater were treated as a valuable natural resource? This is what our stormwater management specialists do. They use advanced integrated modelling to identify and influence the natural flow paths within the urban catchment.

We cannot stop flooding from happening, but we can change where it will happen and, in some instances, when it will happen.

“Did you know that because of impervious surfaces like pavement and rooftops, a typical city block generates more than 5 times more runoff than a woodland area of the same size?”

www.plumboro.com

Instead of continuing to add accelerated stormwater to the already overloaded rivers, we manage the space that stormwater needs.

To do this, we use a variety of techniques including infiltration, retaining water higher up the catchment, slowing flow down across the catchment and diverting flow to areas that can tolerate being inundated for short periods.

Well managed, stormwater becomes a valued friend that feeds a healthier environment, instead of an enemy that devastates homes and destroys ecosystems.



Designing resilient drainage for San Francisco International Airport

The Terminal 1 redevelopment programme at San Francisco International Airport (SFO) is a US \$2.4 billion project to transform one of the airport's oldest terminals into the premier airport terminal in the US.

As part of this programme, Arup is providing airside civil engineering, sustainability, and aviation planning services for the new Boarding Area B (BAB). The BAB reconstruction project will transform the passenger experience, with 24 aircraft gates, new passenger boarding bridges and a two-level terminal building. Due to be completed in 2024, the project will be registered with the US Green Building Council and will target LEED Gold certification.

We hydraulically modelled the stormwater drainage system at Terminal 1 and used our WeatherShift™ tool to calculate the impacts of future changes in the climate. WeatherShift™ uses several published climate models to forecast changes to rainfall intensity at specific locations. We used this to test the robustness of the design for the stormwater system, to adjust it and to make recommendations for increasing the project's resilience to climate change.

 **37% Water Reduction**
with the help of passengers



Integrated catchment modelling for Bydgoszcz

The Polish city of Bydgoszcz is struggling with the results of the intense development that has reduced permeable areas. We identified areas at risk of flooding from the overloaded drainage system.

To achieve this, we developed a complex 1D/2D integrated catchment model of surface water drainage and undertook hydraulic simulations of the 24 critical catchments. We presented the results of these simulations in the form of flood maps. We also conducted economic analysis of the losses caused by potential flood damage.

The green infrastructure guidance we developed presents sustainable drainage solutions that could be implemented in and around Bydgoszcz. These would increase water retention and infiltration, reducing flooding.

Our work is helping Bydgoszcz work towards its long-term strategy of becoming a more sustainable and resilient city.



“Here the climate is cold and temperate. There is significant rainfall throughout the year in Bydgoszcz. Even the driest month still has a lot of rainfall.”

Marta Chudzio, Arup Senior Water Engineer, Krakow



Increasing pumping capacity for subway tunnels in New York

We initially conducted a feasibility study and preliminary design services for pumping capacity improvements at 11 key New York City Transit subway tunnels. The goal being to provide additional pumping capacity as a second line of defence under extreme flooding conditions (SLOSH Category 2 storm event) so that subway operations can be maintained during and shortly after major storm events. Using hydraulic modelling tools we determined the extent, duration and relative elevation of flooding within the complex, impacted tunnel areas. The five hydraulic models we initially developed incorporate tunnel geometry, existing pump facilities, and existing vulnerabilities such as manholes, station entrances and vents. These initial studies helped to determine the most cost-effective way to improve the pumping process during and after entry of floodwaters into the tunnels, assuming a breach of the primary defence mechanisms.

Our scope of work was expanded to include developing models of all subway tunnels impacted by a nor'easter, as well as SLOSH Category 1 and 2 storm events. These models can be used to assess flood impacts under a wider range of conditions, identify alternative remediation measures, and prioritize capital improvements.



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Our work

Energy and resources

Efficient, sustainable and innovative solutions

Global energy demand is expected to double by 2050. In common with other sectors, the water industry must secure affordable, reliable and sustainable sources of energy; tackle climate change through emissions reductions, and improve energy efficiency.

Our specialist teams design and deliver efficient, sustainable and innovative solutions for clients around the world. Based on a combination of technical, financial and commercial expertise, we present clients with a clear path from energy theory to practical application.

With expertise in mechanical and electrical design, instrumentation, and control and automation, we create energy solutions that are efficient, cost-effective, operationally flexible and safe to maintain. We have many years of experience in all aspects of the project life-cycle, from initial feasibility design to asset data management platforms.

We are also leading the way on applying circular economy thinking to the water sector. This approach aims to use natural resources in the way that nature does to avoid depletion – recovering heat to use in homes, for example, or using non-potable water across industrial applications.

Energy, resources and water are inextricably linked and our wide-ranging expertise is tackling issues that span all three.

“The 10 billion people expected to be alive in 2050 will require double the world’s current energy supply. If there is too little, there will be a social and economic crash, if it is the wrong sort of energy there will be climate disaster.”

[WaterWise](#)

“Harnessing the power of water is the cheapest form of energy.”

[National Geographic](#)



Paving the way for a wind turbine at Old Whittington

We delivered vital works that enabled Yorkshire Water to install a 77m wind turbine at its Old Whittington Wastewater Treatment Works in the UK. The turbine will produce 1,300MWh of renewable energy to power the plant. With 40% of the plant's energy needs already met by biogas, this enables the site to offset its energy demands by up to 85%.

Initial wind modelling was carried out to establish the viability of the scheme. Following confirmation that the site had sufficient amounts of wind, planning permission was then sought. We produced an Environmental Statement to support the planning application, this covered Environmental, Visual, Heritage, Ecology, Noise, Transport and Access issues.

We then produced a detailed Works Information package to allow Yorkshire Water to go out to tender, we then assessed the tender returns to allow the most suitable contractor to be selected for the scheme. The works required to build the wind turbine included the construction of the foundations, access track improvements, a crane hard standing and laydown area, a new substation and electricity connection to the wastewater treatment works, and amendments to the site entrance.

We worked on the project from concept design through to completion. This involved project management, design acceptance, site supervision and programme monitoring.

“The site offsets its energy demands by up to 85%. Old Whittington treats and processes sewerage from 100,000 customers.”

[Yorkshire Water](#)



Hong Kong's first waste-to-energy plant

Our award-winning work on upgrading Hong Kong's largest wastewater treatment plant includes creating the territory's first waste-to-energy project.

The Harbour Area Treatment Scheme (HATS) Stage 2A and T•PARK (formerly known as Sludge Treatment Facility) won the Distinction award in the Wastewater Project of the Year category at the prestigious Global Water Awards.

HATS Stage 2A involves upgrading Hong Kong's largest wastewater treatment plant to a capacity of 2.45M m³ per day. The plant is designed to serve an ultimate population of 5.7 million living on both sides of Victoria Harbour (equivalent to 70% of Hong Kong's total population).

As the project consultant, we were responsible for designing and supervising the upgrading works at Stonecutters Island and eight preliminary treatment works on Hong Kong Island.

Sludge generated from the wastewater treatment plant will be delivered to T•PARK using two custom-built sludge container vessels. Up to 2,000 tonnes per day will then be incinerated in Hong Kong's first waste-to-energy plant and used to generate low-carbon energy.

We worked with Veolia-Leighton-John Holland JV on the engineering procurement-construction contract to devise and deliver this green facility.



“Treating up to 2,000 tonnes of sludge daily which is reduced to ash; resulting in a reduction of about 90% by volume.”

Kenneth Kwok
East Asia Water Leader, Hong Kong



Creating a greener Grangetown

Our innovative Water Sensitive Urban Design (WSUD) project is using green infrastructure to future-proof the drainage network in the Grangetown area of Cardiff. The £2m project provides resilience to climate change, whilst also enhancing public spaces, promoting sustainable travel and improving biodiversity.

Using the latest techniques, this scheme will catch, clean and divert over 40,000 cubic metres of rainwater away from the sewer network annually – reducing pumping and treatment costs and creating ‘headroom’ in the system. It does this by planting 131 new trees and creating 1,700 square metres of new green space. Our design forms corridors of green space alongside waterways, improving transport links such as cycle paths. It also protects community assets and creates safe, attractive urban spaces.

The project’s integrated approach to drainage design stems from a unique collaborative funding structure and has continued through community and stakeholder engagement. The City of Cardiff Council, Dŵr Cymru Welsh Water and Natural Resources Wales jointly funded the project, supported by the Landfill Communities Fund. And public consultation involved the residents in the design of their streets, while continued engagement and education is encouraging sustainable living.



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Campaign



Reducing Dŵr Cymru Welsh Water's carbon emissions and costs

In the face of considerable challenges, we helped Dŵr Cymru Welsh Water install two new wind turbines at wastewater treatment works in Nash and Swansea. This will help the company achieve its target of generating 100GWh of renewable energy across its sites by 2020.

We worked on the projects from the feasibility stage to completion, encountering some tough issues on the way. For example, the soft peaty ground at the Swansea site meant that the foundations required very long piles and the crane that lifted the turbine into place needed a specially reinforced pad.

There were multiple constraints on siting the Swansea turbine – including busy roads nearby and the incoming sewer pipes that transfer all Swansea's sewage to the treatment works. Despite this, we ensured the project was completed without interrupting the functioning of the treatment works.

At Nash, even getting the turbine to site was no easy task. After examining the alternatives – including using a helicopter – we decided the best option was delivery by ship to a nearby steelworks. A lorry then carried the turbine along a temporary road to the treatment works.

Finally, we dealt with connecting the turbines to the grid – this proved a fresh challenge when it involved interfacing with switchgear built decades ago. Now both connected, the turbines can make a significant contribution to Dŵr Cymru Welsh Water's renewable energy ambitions.

 **589 households**
Generating enough
electricity to power 589
households a year



Our work

Catchment & Environment Putting the natural world at the heart of design

For rivers damaged by earlier man-made interventions, we propose alternative waterway environments that will offer diverse habitats and encourage a much more natural living system.

For example, implementation of our designs at sewage treatment works along the River Aire in West Yorkshire, UK, along with tighter regulation of industrial waste discharges, has led to a dramatic improvement in water quality. This has resulted in the return of migratory fish and, for the first time in 200 years, otters.

Many Arup flood protection schemes now incorporate natural flood risk management techniques. These include planting more trees, building low, naturalised dams across rivers and other techniques to “slow the flow”.

In urban drainage and design, we treat stormwater runoff as a resource and consider how the excess water could be stored to provide wetland habitats and benefit wildlife or the city landscape.

Arup’s environmental economics team can also help with valuing natural capital and the services provided by natural ecosystems. This helps support business cases to finance new projects.

“Rainfall and temperatures are projected to become more variable with climate change, leading to more droughts. This will have particularly heavy impacts on rain-fed smallholder farming systems in highland areas and in the tropics. These account for 80% of the world’s cropland and produce about 60% of global agricultural output.”

[UN Food and Agriculture Organization \(FAO\)](#)



Addressing safety concerns at the Llyn Brenig reservoir

Using our electrical and mechanical engineering expertise, we were able to clearly define the scope of remedial works to address safety concerns at the Llyn Brenig reservoir.

Llyn Brenig is one of Dŵr Cymru Welsh Water's largest reservoirs by volume and is used to regulate flows in the River Dee. This regulation is important for the many customers of the organisations that abstract from the river: United Utilities, Dee Valley Water, Canals and River Trust and Dŵr Cymru Welsh Water (DCWW).

Following an inspection required by law, two dam safety recommendations were made. The first was to refurbish the scour facilities that can be used to reduce the reservoir water level in an emergency, to make them more reliable, secure and safe to operate. The second recommendation was to modify the valves and electrical system in the draw-off facilities used to deliver water from the reservoir.

DCWW asked us to carry out a feasibility study, including outline design and cost estimates for options to provide facilities that are safe and reliable to operate. Our proposed solution includes a new scour control gate downstream of the existing facilities. This allows routine and emergency operation of the scour facilities without the need to operate the gantry crane, significantly improving reliability and reducing risks to the health and safety of reservoir operators.

As the feasibility study was addressing recommendations made following a statutory inspection under the Reservoirs Act, our feasibility work had to be reviewed by a Qualified Civil Engineer (QCE). One of our All Reservoir Panel Engineers was appointed to carry out this role. This proved valuable to DCWW because he was able to review and provide input to our work throughout the feasibility phase.



Restoring the natural character of the Raba River

By allowing Poland's upper Raba River to follow its natural course, our water specialists found sustainable ways to improve flood management, reverse environmental degradation and restore wildlife to this damaged valley.

The project has improved the quality of water, and our multi-criteria analysis of its sustainability confirmed the validity of the methods used. The positive changes observed in the riverbed over the five years of the project show the potential for increasing the area of protected habitats created by the diverse form of the river.

The initiatives within the project, following our methodology, have saved time and money compared to the traditional methods of river maintenance used in the region. Allowing the river to follow its natural course, and educating designers and staff at different administration levels, has set the standard for innovative, environmentally friendly river maintenance.

We presented our work at an international conference in Krakow in autumn 2016, which focussed on best practice in river restoration and maintenance. The project is now regarded as the model for implementing good practice in river maintenance in Poland.



“Our work on the Raba river is of national importance.”

Tomasz Glixelli, Europe Water Skills Leader, Krakow



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Understanding the impact of outfall discharges in Queensland

To support negotiations with the regulator, Queensland Urban Utilities needed to better understand the environmental impact of its sewage treatment plants and their effluent-release infrastructure.

The results of our study will enable informed decisions to be made on future capital investments. They will also help the company improve operational efficiencies, protect waterways and make local communities more liveable.

The effluent from sewage treatment plants inherently differs based on factors such as influent characteristics and the treatment used. Similarly, the impact on the receiving environment will also differ. This depends on effluent and quantity, the outfall infrastructure and the characteristics of the particular waterway where the treated wastewater is released.

All these factors can have a significant influence on toxicity conditions in the water where discharges occur. So the potential for toxic impact can only be determined by assessing the site-specific conditions at each outfall location.

The report we created provides a summary for each discharge location. This features a description of the location and discharge conditions, followed by results from our mixing zone analysis. These include dilution profiles, mixing zones for contaminants of concern and a summary of compliance and performance.



Managing coastal risk across Wales

We are preparing outline business cases for six coastal risk management schemes across Wales, spanning five local authorities.

The studies consider the risk posed, condition of existing structures and will appraise a long list of options to identify the preferred coastal risk management approach. Options are assessed taking account of coastal processes, environmental and social benefits and impacts, sustainability, and ongoing maintenance. The appraisals will identify wider benefits such as amenity, community regeneration and biodiversity.

As part of this work, we're supporting Neath Port Talbot County Borough Council to develop an outline business case to address the risk of failure of the Aberavon Promenade. Aberavon is one of the most deprived communities in Wales, with tourism providing a vital £15m annually for the local economy. Coastal risk management options will safeguard the seafront and allow further development.

We're also supporting Bridgend County Borough Council to appraise coastal risk management options for Sandy Bay, Porthcawl – a wide amenity beach popular with tourists. Every year Porthcawl attracts around 1.1 million visitors spending £95m and we're examining opportunities to enhance the promenade and beach access.

We identified a phased approach that would safeguard existing properties and future development. Where previous proposals placed a concrete terraced revetment over sand dunes, we have proposed a more cost-effective management and monitoring plan to protect these natural features.



Our work

Advisory

Helping clients tackle major challenges affecting the water sector

Combining business and technical acumen, we provide breakthrough solutions to water challenges. Shaped by our engineering heritage, our management consulting insights help clients achieve durable, adaptable and inspiring outcomes that also support longer-term business goals and meet customer needs. Always guided by Arup's commitment to sustainability and shaping a better world, we create business solutions that are good for the world at large, as well as the bottom line.


This year we have delivered one of the world's most innovative pieces of water customer engagement, analysing Australian opinion from the perspective of customers and citizens. We also drew on our asset management and digital capabilities to deliver practical insights such as investment decision tools and process improvements to reduce the cost and risk of operations.

With Dŵr Cymru Welsh Water, we have adapted our world-leading insights in city resilience to enhance water resilience by integrating city, asset and business resilience. We have worked alongside UK regulated companies to demonstrate that delivering blue and green approaches with stakeholders across the water cycle can deliver lower-cost and more sustainable solutions.

In addition, we have provided both financial and technical advice to vendors and investors around the world on strategic investments in water projects. These include the disposal of Macquarie's stake in Thames Water and investment in a portfolio of water assets in China.

Outcomes we deliver for our clients:

- Increasing efficiency by procuring, financing and delivering projects, programmes and operations at significantly lower cost
- Improving operational performance to benefit a business and its customers
- Delivering business transformation by identifying and implementing opportunities for sustained improvements
- Exploiting digital technology to create competitive advantage and improve customer service
- Enhancing resilience by providing the adaptability to predict, manage and respond to threats, shocks and stresses
- Being a responsible business by making a positive impact across economic, environmental and social goals.

 **40%** of the world's rural population lives in river basins that are classified as water scarce



Conducting due diligence of Willunga Basin Water Co and Lightsview reWater

Colonial First State Infrastructure Holdings Limited and Global Diversified Fund are together seeking to buy all of Water Utilities Australia's Willunga Basin Water Company and Lightsview reWater assets. They asked us to carry out due diligence in just two weeks.

Willunga Basin Water Company generates contracted revenue through contracts supplying treated wastewater. Lightsview reWater is a regulated network supplying non-potable recycled water to the Lightsview housing development and surrounding parks and reserves in Port Adelaide Enfield.

In the very tight 2-week timeframe, we reviewed existing information relating to the nature and condition of the assets – focussing on our client's biggest risks. We looked at whether the future growth opportunities were realistic and achievable in the stated timeframes, and what capital infrastructure was required to facilitate that growth. And we examined whether the current infrastructure was capable of cost-effectively supplying the existing customer base under a range of scenarios.

We delivered a report of our findings, and participated in presentations to management and meetings with insurers.

“South Australia has a long history of using reclaimed water and is the national leader in water reuse.”

[Willunga Basin Water website](#)



Rapid due diligence for 20 treatment plants in China

An international infrastructure investment company appointed Arup to carry out technical and health and safety due diligence reviews for 20 water and wastewater treatment assets in China.

Our client approached us for a rapid and independent third-party review of their potential investment portfolio. To complete this in a tight timeframe, we drew on the combined skills of our resources group in Hong Kong and our water team in China.

The reviews focussed on the suitability of the treatment plants' process designs. We assessed these against the raw water parameters, operation and maintenance performance, the condition of electrical and mechanical plant, costs, safety, water concessions and agreements.

At three of the plants we also conducted independent inspections. These established whether the due diligence reports presented a reasonable representation of the plant's operation and performance, and independently assessed health and safety conditions.

These studies also provided commentary on reported capital and operational expenditure as well chemical and power use. We assessed future works, identified risk areas not included in the due diligence reports, and provided a summary report to the client – all within just four weeks.

“China's wastewater volume is comparable to the Yellow River's annual flow.”

chinawaterrisk.org



Investigating influences on the cost of wastewater services

During the most recent UK water industry price review, PR14, United Utilities put forward a case for 'special factors' funding of just over £1bn. However, the regulator, Ofwat, did not agree that the costs put forward were efficient.

The problem stemmed from a lack of credible data, which resulted in a perceived lack of fairness when Ofwat stipulated how much money each company was allowed to spend in its business plan. Ahead of the next price review, PR19, United Utilities' wholesale business commissioned Arup, supported by Vivid Economics, to carry out an independent study. This investigated whether external factors such as demographics, ecology, climate, geography and asset legacy issues have a quantifiable impact on the cost of delivering wholesale wastewater services in England and Wales.

The work has brought together engineering and econometric evidence to identify and value the drivers of variation in costs between companies. The project assembled narratives on the causal factors that affect efficient costs, data on how these factors vary between regions, and statistical evidence on the relationships between different factors and efficient costs.

This integrated approach to wastewater cost assessment adds a new and unifying perspective to existing commentary on the topic. The project has recommended changes to modelling practices and data collection that can improve on cost assessment at PR19. The project has also recommended that new drivers are included in the econometric models. These account for features of companies' operating environments where there is convincing engineering justification.

The outcomes will improve Ofwat's assessment of company business plans at PR19, and provide better outcomes for our client and the industry.



Creating a resilience framework for Dwr Cymru Welsh Water

In response to global mega-trends such as climate and demographic changes, governments and regulators are challenging water companies to become more resilient.

At the same time, customers have an expectation that water companies will mitigate shock events that affect their service, such as floods and droughts generated by climate change.

Welsh Water recognises that improving their understanding of the challenges they face and becoming more resilient to these challenges is crucial to meeting the needs of their customers in the long term.

Based on global best practice, the resilience framework we developed will help Dwr Cymru Welsh Water to create a business strategy for the next 30 years that mitigates the risks posed by shocks and stresses both old and new.

Informed by a comprehensive review of best practice, client workshops and collaboration with Cardiff University, the framework includes a resilience lens and qualities to ensure that a holistic approach is taken to incorporate resilience into all aspects of WW's business for its customers. The shortlisted actions for improving resilience derived from the framework will form part of the company's strategy for the next 30 years.

This is one of the first projects to build resilience to a wide range of shocks and stresses in all aspects of a water business. It provides 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.



Our work

Research Insight for innovation

Today, competitive advantage is about developing insights that can drive valuable innovation. To achieve this, Arup invests in research that leads to better, more sustainable solutions to the issues our clients face.

Our water research tackles issues including city resilience, river basin management, circular economy initiatives, the digital agenda and climate change. Research is fundamental to our pursuit of technical excellence and integral to the way we do business. It helps us to respond to the changing needs of our clients and the communities we serve.

Arup Inspire is a browser-based collection of emerging built-environment ideas, case studies and concepts from across the globe. It captures the state-of-the-art, the possible, and the surprising. It can be used as a source of inspiration for corporate foresight, strategy, risk or innovation processes.

Drivers of Change communicates research, trends and questions about the future. Conceived by Arup in the early 2000s, it continually explores the changing contexts of the world, and embodies a global and multidisciplinary perspective. The Drivers of Change app features over 250 emerging trends, innovations and questions that are shaping the future: from climate change and urbanisation to water, energy and food.



Identifying new technologies for treating and removing waterborne pollutants

There's growing evidence around the world that emerging, previously unregulated, pollutants are being discharged into the environment, and that this has chronic effects on ecosystems and humans. These pollutants, typically present at low levels, close to limits of detection, will challenge current treatment processes and new technologies will be required to remove them from water discharges.

Our materials, process and water specialists are collaborating to address this important global environmental issue. We are undertaking collaborative research to explore innovative technologies and new materials that could open up new methods of treatment. The outputs from this review will be shared on our website and our Venturi innovation portal.

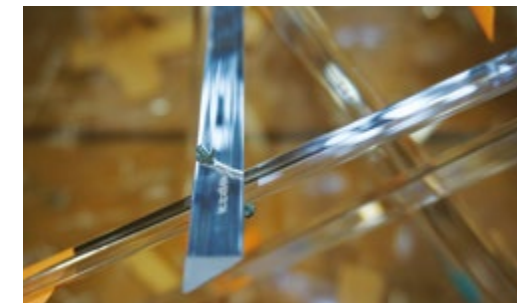


Understanding the vulnerability of Pacific Island Nations to rising sea levels

Just how vulnerable are the Pacific Island Nations to rises in sea level? In advance of the COP22 climate talks, we wanted to help answer this question by identifying gaps in the current understanding of the islands' vulnerability.

What's clear is that the very existence of entire nations is under threat. Recent research by the Australian Bureau of Meteorology estimates sea levels could rise as much as 87cm by 2090. If this happens, Kiribati, Tokelau and Tuvalu would be among the first nations to be fully submerged.

We applied the toolkit developed for our Cities and Sea Level Rise global project, providing headlines, initial conclusions and suggested areas for further research. Our work has also opened up the possibility of developing a sea level rise vulnerability index for Pacific Island Nations.



Researching innovative materials and their potential to solve challenges

This study built upon Arup's expertise in building materials to research innovative materials and their potential to solve challenges throughout the water cycle. The research looked at new and emerging materials technologies with a 5-year horizon and developed an information pack that could be shared with clients and colleagues.

We focussed on materials that could help with measurement and sensors, treatment, fluid resistance, durability and lifetime as well as energy. This meant drawing on our expertise in areas such as using algal building facades to generate biomass and heat.

As well as using the expertise in our Water Skills Network, we spoke to key water clients and reviewed existing literature. Where possible, we acquired samples of the different materials to add to our own materials library, helping to inform future work in this area.



Investigating the contribution of glaciers to flood hazard in mountainous regions

In a warming world, what contribution do glaciers make to flood hazards in mountainous regions? Understanding the answer to this question enhances the knowledge and expertise we can provide to clients and complements our existing natural-hazard and risk capabilities.

Climate change is expected to increase the frequency and severity of natural disasters associated with hydro-meteorological conditions in mountainous regions. And increasing urbanisation downstream makes many of these mountainous regions some of the most climate-vulnerable areas on Earth.

Our research reviewed existing hydrological models to understand the contribution that additional run-off from snowmelt and glacier-melt makes to river flows, and the effects that this has on flood hazard. We then evaluated the effects that climate change will have on the frequency and severity of these floods.

Our work

Service Summary

What we can offer

We are the creative force behind many of the world's most prominent projects in the built environment and across the industry. In 92 offices across 40 countries, our 12,000 designers, engineers, scientists, planners and business consultants deliver innovative projects with creativity and passion.



Advisory services

- Ensuring health, safety, wellbeing
- Strategic business planning
- Digital analysis & insight
- Managing programme risk
- Operational improvement
- Blue green infrastructure
- Knowledge management
- Asset performance
- Resilience
- Corporate risk
- Security and cyber risk
- Flood risk management
- Major planning consents
- Regulatory economics advice
- Technology innovation
- Developer offerings
- Strategic procurement advice
- Investor advice
- Masterplanning & urban design
- Customer Engagement

Technical services

- Water resource planning
- Dam engineering & planning
- Hydropower
- Water supply and treatment
- Desalination
- Water distribution networks
- Water efficiency
- Smart water management
- Flood risk management
- Natural flood management
- River engineering and management
- Green infrastructure & stormwater
- Water re-use networks
- Wastewater treatment
- Sludge management
- Coastal management
- Tidal power
- Renewable energy
- Ecology and ecosystems services
- EIA and sustainability assessment
- Catchment science
- Feasibility studies
- Anaerobic digestion
- Hydroecological assessment
- Integrated drainage modelling
- Water quality assessment
- Hydrodynamic modelling
- Climate change studies
- Community and stakeholder engagement
- Mechanical, electrical and ICA design (MEICA)
- Construction supervision
- Health, Safety and Welfare management
- Design management
- Commissioning
- Post-project appraisal
- Resource efficiency and waste management

Our regions

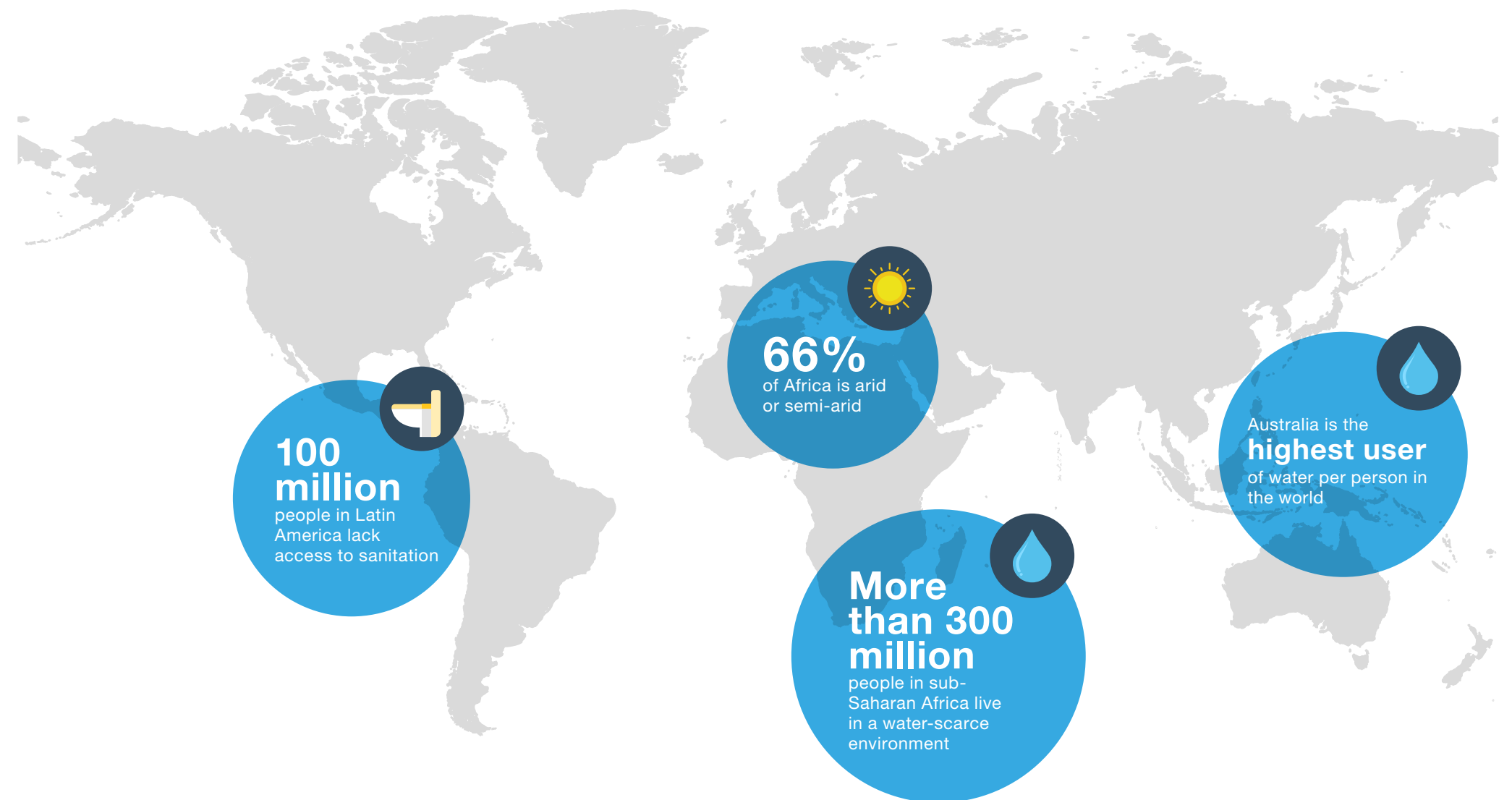
Overview

A snapshot of our impact around the world

Arup employs more than 13,000 people in 92 offices across 40 countries. Our skills community supports 1,500 of those people who have an interest in water.

We work extensively across the Americas, Australasia, East Asia, Europe and UKMEA, and many of our current water projects involve a collaborative approach with no global boundaries. We share our expertise for the benefits of our clients wherever they are, although our project leader is usually based at a local office.

In this section, the water leaders in each of our regions has provided an overview of just some of the projects they have helped to deliver.



70%
predicted food demand will impact on water demand



2-3 billion
global population growth over the next 40 years



85%
of the world population lives in the driest half of the planet



Water availability
is expected to decrease in many regions

Our regions

Americas

Growing our team to meet evolving needs

In the Americas, ageing infrastructure, storm resiliency, persistent drought, funding gaps and regulatory changes are expanding and diversifying the challenges in water. Our water team, our expertise and our resources continue to grow to meet our clients' needs.

The need for resilient infrastructure has resulted in expanding water projects in the US, including water and wastewater conveyance, non-revenue water assessments, and improved stormwater collection and conveyance systems. Our award-winning green infrastructure work on hundreds of sites in New York is helping the city reduce combined sewer overflows.

We have developed new tools such as WeatherShift™ uses future climate data for design and which we employed at San Francisco International Airport.

Our hydraulic modelling work will help the MTA NYC Transit to evaluate the impact of flooding from a variety of storm events, and to prioritise its capital spending.

And to enhance resilience in communities, we continue designing infrastructure and waterfront improvements.

While the drought in the western US was somewhat relieved this year, we continue to support our clients to manage their water resources. We are providing water reuse opportunities for clients such as LA World Airports.

Sharing knowledge remains important to us and we have presented at several conferences, some of which are featured in this review.

On a personal note, I was delighted to again be a contributing author on the newly released American Water Works Association Manual of Water Supply Practices, Water Resources Planning (M50), third edition



148 trillion gallons
of fresh water used in
the US each year



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Using green infrastructure to improve water quality in New York's waterways

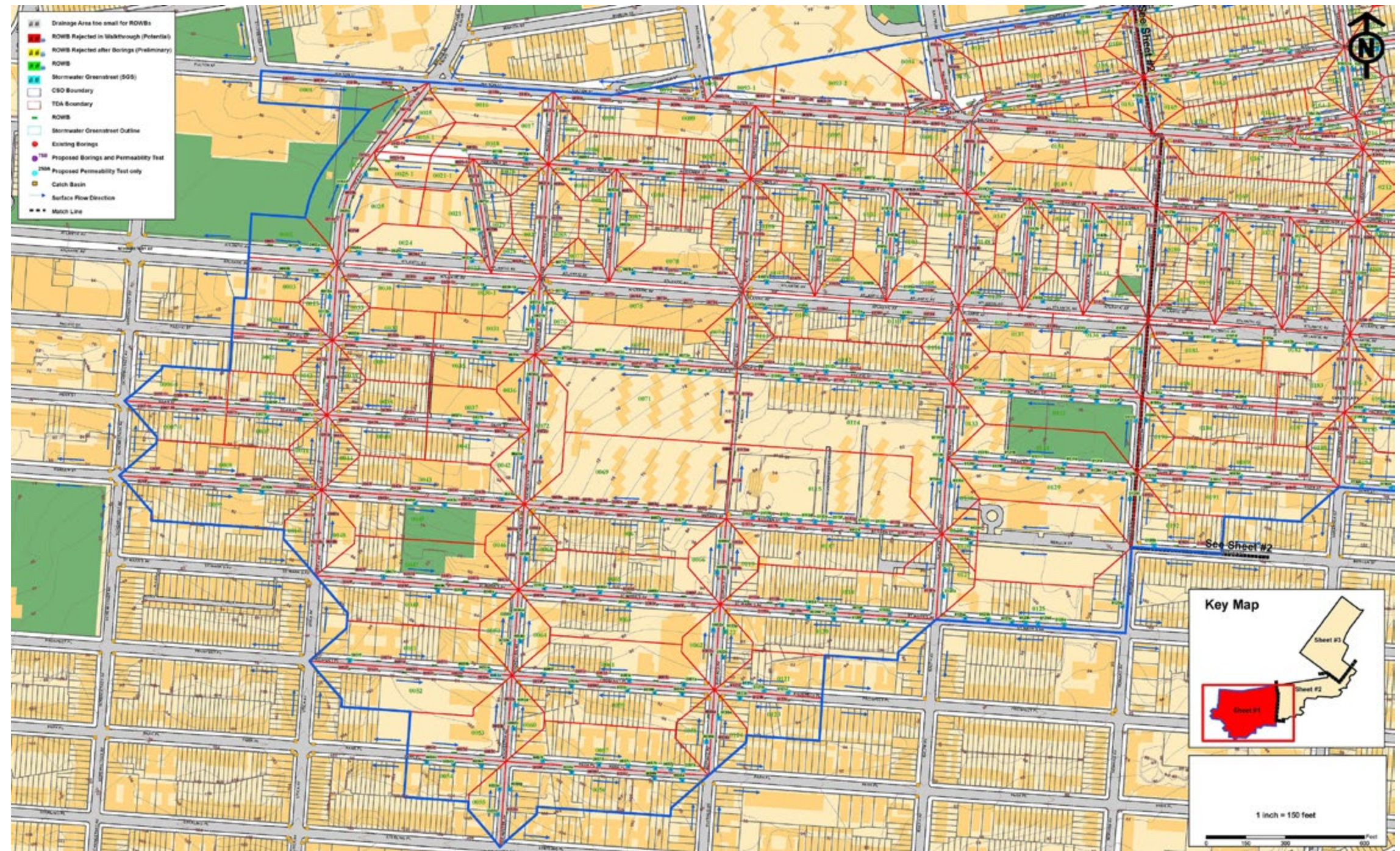
Combined sewer systems carry both stormwater and wastewater. During heavy rainfall, these systems can overflow into waterways, impairing the health of waterways.

New York City is required by law to reduce these combined sewer overflows. The reduction has historically been achieved using traditional grey infrastructure such as storage tunnels and wastewater treatment plants. Using green infrastructure instead reduces rainfall runoff at the source using natural systems – can be designed to absorb 90% of frequent rainfall events or the first inch (2.5cm) of any rain.

We are helping the city install as many bioswales as possible on its streets in three areas: Newtown Creek in Brooklyn, Westchester Creek in the Bronx and Bowery Bay in Queens. The bioswales range in size, with the largest being five feet wide and 20ft long, and generally feature street trees, landscaping and gravel.

Bioswales are relatively cost-effective and help 'green' a local area; they can reduce the heat island effect and absorb carbon emissions. Other on-street green infrastructure options like narrower greenstrips and permeable pavement are also being considered.

We are responsible for site analysis, hydrologic analysis, geotechnical engineering, civil engineering design and construction administration for the bioswales. We are also analysing and designing other green infrastructure interventions – including rain gardens and permeable pavement – within seven city parks, three public housing campuses and a public school.



Creating a catalyst for change in Honolulu

A proposed linear park along the Kapālama Canal in Honolulu, Hawaii, USA, is designed to kick-start further development.

The City of Honolulu commissioned the Kapālama Canal Catalytic Project as part of a transport-oriented development associated with a new light rail system. The canal lies close to a proposed station near the Honolulu Community College and the project will catalyse broader neighbourhood improvements and new mixed-use development in the area around the canal.

The proposed improvements are underscored by green infrastructure, waterway and bank modifications, erosion control, and dredging. These will improve the canal's water quality and create attractive parkland.

We were included in a team led by architects WCIT to assess existing conditions as well as advising on green infrastructure, hydrology and channel hydraulics. Our scope is now being extended to include a canal dredging study, hydraulic modelling and a geotechnical investigation.

We also contributed to the community outreach process by running a masterplanning workshop for students at the local high school.



Helping UC Merced to grow sustainably

Since opening in 2005, UC Merced, the newest campus of the University of California, has continued to grow and strengthen. Due to its success, UC Merced will double the capacity of its campus by 2020 – adopting a compact, high-density development pattern.

Arup is providing full design and construction administration services for the Merced 2020 project. As part of this, we're designing the expansion of the University's water, chilled water, recycled water and sewer distribution systems.

Our water storage calculations proved that the existing firewater storage tank would be sufficient for the campus expansion. This persuaded the University to eliminate a new 250,000 gallon (950,000L) tank from the required programme, saving the project approximately US \$500,000.

Our water system modelling helped to improve the reliability and efficiency of both the domestic water system and the recycled water irrigation system, reducing pipeline construction cost. And our in-house fire consulting capability enabled the university and the design-build contractor to agree quickly on fire hydrant and fire department connection locations.

The sewer design includes a new lift station and force main. Because the lift station wet well was included in an early works package, no separate temporary lift station wet well was needed to serve the contractor's office complex. Savings like this are vital in a project with such a fast-track schedule.

\$500,000 U.S Dollar
project saving



Leveraging design data to save time and create value

Our water team in Canada has been developing new ways of working with data to drive project design.

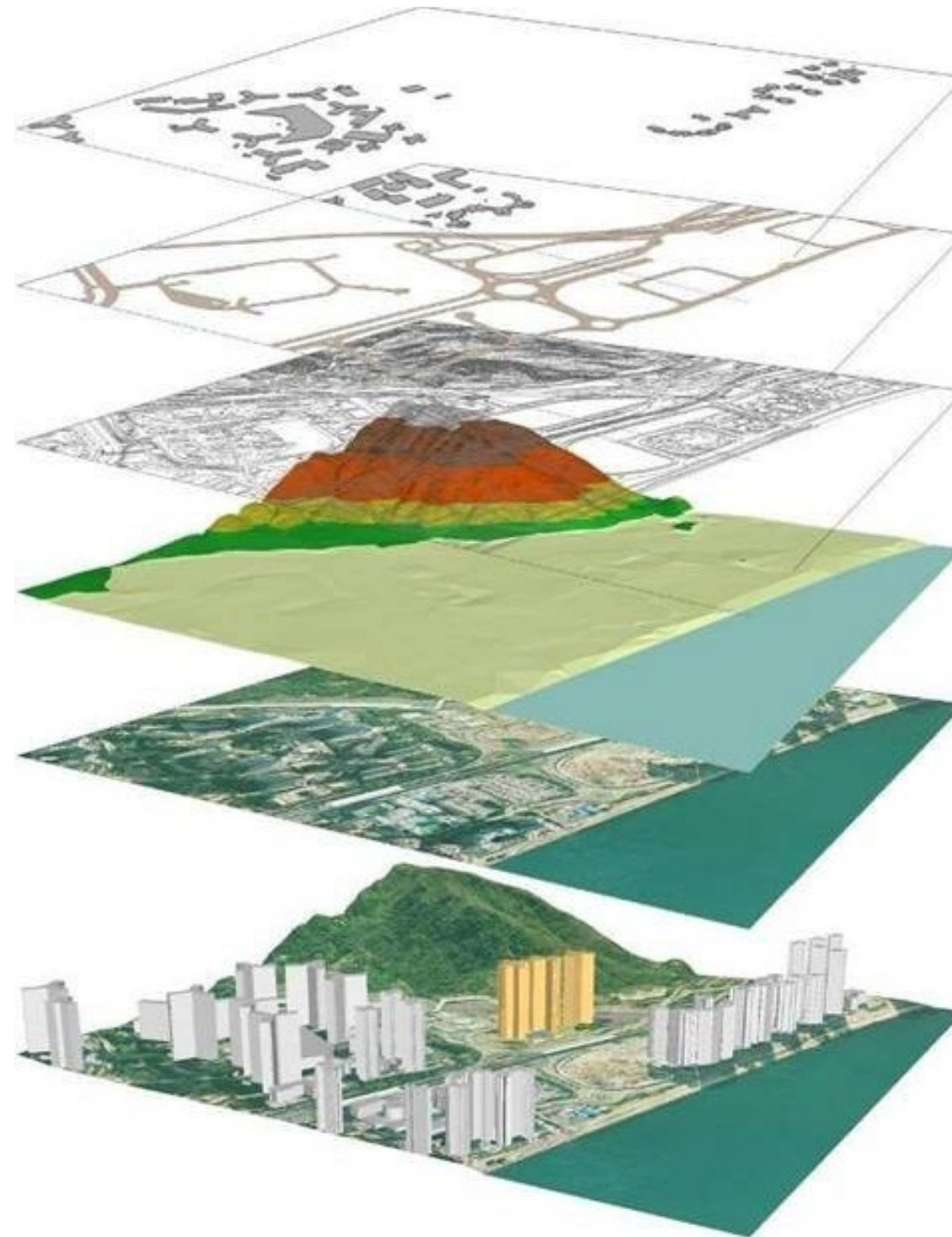
Because we are increasingly working in an environment that is rich with design data, the team believes that changing our behaviour and thinking about how to treat designs as data can unlock huge potential through scripting and design automation.

Based on the team's experience working on large multidisciplinary linear infrastructure projects, we have been able to leverage the wealth of design data to automate many stages of drainage design. The processes we have created have allowed sewerage models and simulations to be controlled by the data itself. This means that if (and when) base information changes, their models can adapt quickly, automatically and without compromising on detail or accuracy. Taking it a step further, the team have explored implementing 'auto-design' processes.

This approach has two benefits. Firstly, our designers and engineers are spending less time working on time-consuming tasks that can be scripted – saving our clients time and money. Secondly, these processes allow our designers to focus on the more challenging elements of the designs and to consider more options. Ultimately, this results in better, higher-value solutions more tailored to our clients' needs.

“Glacier ice over 100 000 years old is found at the base of many Canadian Arctic ice caps.”

Albertawater.com



Our regions

Australasia

Thought leadership and high-quality design

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

As thought leaders we have given strategic advice to water authorities and private sector clients in both urban and rural areas. This advice has ranged from undertaking the industry-leading publication on customer perceptions (the National Water Outlook) through to studies focused on key risks and opportunities for our client's business operations. These 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.

We have also contributed to and sponsored major industry events including the International Water Association World Water Congress in Brisbane, Singapore International Water Week and Ozwater (the Australian Water Association's national water conference).

 **Australia**
is the highest user
of water per person
in the world



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Engaging with stakeholders for South East Water

In Australia, we're providing South East Water with professional engagement services, and an approach that allows community needs and concerns to be understood earlier in the process of engineering design.

The Casey-Clyde area, south-east of Melbourne, has experienced significant local residential growth. Now South East Water is faced with servicing the area locally with a water recycling plant or transferring to a centralised treatment plant.

We have been engaged to undertake the stakeholder engagement for the investigations into a local water recycling plant. The engagement project will improve the company's understanding of stakeholders' needs and concerns and enable it to incorporate these concerns into the plant design.

“Supporting the communities in which we work and helping to protect wildlife and habitats is an important part of our business.”

[South East Water](#)



Expanding an irrigation scheme in South Australia

Arup has worked with Barossa Infrastructure Limited (BIL) in South Australia for 18 years. Our initial role was as owner's engineer, developing an irrigation scheme to supply approximately 7GLpa through 200km of pipeline with four pump stations.

In the years that followed, Arup worked with BIL on minor pipeline extensions, investigations to overcome biological growth, and options to expand the scheme to 10GLpa through PRV and pump station modifications.

We are currently developing designs to allow further expansion to 11GLpa. The scheme is likely to include a 1GL turkey nest storage, an additional pump station, and approximately 6km of interconnecting pipelines.



“The first large-scale irrigation schemes in Australia were introduced during the 1880s, partially in response to drought”

Rhys Anderson, Arup Senior Water Engineer, Melbourne



Understanding the impact of outfall discharges in Queensland

To support negotiations with the regulator, Queensland Urban Utilities needed to better understand the environmental impact of its sewage treatment plants and their effluent-release infrastructure.

The results of our study will enable informed decisions to be made on future capital investments. They will also help the company improve operational efficiencies, protect waterways and make local communities more liveable.

The effluent from sewage treatment plants inherently differs based on factors such as influent characteristics and the treatment used. Similarly, the impact on the receiving environment will also differ. This depends on effluent and quantity, the outfall infrastructure and the characteristics of the particular waterway where the treated wastewater is released.

All these factors can have a significant influence on toxicity conditions in the water where discharges occur. So the potential for toxic impact can only be determined by assessing the site-specific conditions at each outfall location.

The report we created provides a summary for each discharge location. This features a description of the location and discharge conditions, followed by results from our mixing zone analysis. These include dilution profiles, mixing zones for contaminants of concern and a summary of compliance and performance.



Keeping Sydney One safe from flooding

Our innovative flood mitigation strategy enabled the ambitious design for two new buildings in Sydney to meet requirements for flood immunity in extreme storm events despite being in a low-lying area.

To be built in the Circular Quay area of the city, the Sydney One development aims to change the face of Sydney's skyline and also reinvigorate the surrounding public spaces with a network of laneways.

The first building at Sydney One will be a 56-storey residential apartment; the second will be a 35-storey hotel. Due to the location of the development site and the plan for them to share an underground basement, flooding was a vital design consideration.

We updated the flood model for the area to incorporate the effects of the development and came up with an innovative flood mitigation strategy. This proposed using automated flood barriers for building entrances below the flood planning levels.

It was also important to consider future adjoining development, which will share common laneways and public domain. We ensured that the mitigation measures we developed safeguard both developments from flooding.

“Over 1.4 billion litres of drinking water to homes and businesses supplied daily in Sydney area.”

[Sydney Water](#)



Our regions

East Asia

Expanding our reach

We continue to expand our reach across East Asia to deliver sustainable and resilient water infrastructure projects.

For example, we are upgrading the San Wai Sewage Treatment Works in Hong Kong and designing the new Novaliches-Balara Aqueduct No. 4 in Manila. We are also conducting a feasibility study for a raw water transfer project in the Pearl River Delta of China and delivering a new sewage treatment and greywater plant in Vietnam.

We are continuing our strong relationship with the water concessionaries in Manila, winning the title of Best Consultancy Services Provider at Maynilad Water's Top Achievement for Partners Awards. We are also undertaking several sponge cities demonstration projects and watershed improvement projects in various cities of China.

We continue to support our clients in their functions, events and technical forums – including the open day for Drainage Services Department in Hong Kong, Manila Waterlink Forum 2016 and China-UK Urbanisation Roadshow on Smart and Sponge Cities.

We've also been celebrating more award wins. This year, our Harbour Area Treatment Scheme (HATS) Stage 2A project in Hong Kong won Distinction in the Wastewater Project of the Year category at the prestigious Global Water Awards.

“Over 1.7 billion people in Asia and the Pacific continue to live without access to improved sanitation and over 85% of untreated wastewater create the risk of a ‘silent disaster’ from the pollution of surface and ground water resources and coastal ecosystems.”

[UNESCAP, 2010](#)



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Creating Hong Kong's first river park

We are providing consultancy services to design and construct Hong Kong's first river park, which will revitalise the Tung Chung River as part of the Tung Chung West New Town Extension project.

The Tung Chung River is one of the few relatively large rivers in Hong Kong that still retains its natural setting, from its headwater to the estuary although the downstream section of the river has previously been channelized. This project will revitalise the river section to by restoring its natural setting, achieving ecological connectivity for the entire river – from its headwater to the estuary and enhancing ecological connection.

A biodiversity river park will be developed on both sides of the river. Its objective is to enhance the environment, enable active and passive recreational uses and promote a water-friendly culture. The river park will include vegetation, natural materials for landscaping, a walking trail, an elevated boardwalk and river crossings to improve accessibility.

As part of the project we will also analyse the river's hydraulic performance and provide flood control measures to enhance safety and the flood protection standard of the river park. This will feature a 200-year flood protection and be equipped with a robust river flood warning system to provide real-time public alerts during periods of heightened flood risk.

“Tung Chung channels 10 million m³ of water into the reservoir each year – 40% of the reservoir's total capacity.”

greenpower.org.hk



Helping the Yangtze Delta cope with climate hazards

The city cluster in the Yangtze River Delta is one of the most developed and urbanised areas in China, and also one of the region's most vulnerable to climate hazards. In particular, the region faces deteriorating water quality and urban flooding – challenges for future urban development.

China's national Action Plan for Cities' Adaptation to Climate Change was issued in February 2016. In response, the delta's 26 cities need to better understand their climate challenges and improve the way they coordinate their policies. This will help them be better prepared for, and to adapt to, climate hazards. The climate risk assessment tool we're developing will enable the 26 cities to review their climate hazards and assess the likely impact on major infrastructure. Using this they will be able to prioritise areas for action.

Our tool enables users to understand current and future climate hazards, and the trends that will affect a specific city or region. It provides the baseline data to conduct analysis – for example to understand the impact of water shortages or flooding.

The tool enables users to understand which elements of a city's infrastructure are most at risk and what the likely impacts could be. It also helps cities to identify actions they can take to adapt or become more resilient, as well as to prioritise particular areas or infrastructure assets.



“The Yangtze River Delta has over 140 million people in this region.”

[Michael Zhao, Arup Water Leader, China](#)



[Go to Campaign](#)

Developing Hong Kong's wastewater infrastructure

We are carrying out the detailed design for the new San Wai Sewage Treatment Works – Hong Kong's first design-build-operate project.

Located in the northwest of New Territories, the project will replace an aging preliminary treatment works. It will involve constructing new chemically enhanced primary treatment, ultra-violet disinfection and sludge dewatering facilities.

When completed in 2020, the works will treat 494,000m³ of wastewater every day. This will then be transported to T•PARK, the recently opened sludge treatment facility nearby, which we also designed.

The constrained 26,500m² site requires a compact design, which makes integrating numerous buildings and services even more technically challenging. To achieve this, and ensure the administrative building achieves platinum BEAM Plus, we will use building information modelling (BIM) to collaborate on the design.

Our client for this project is the joint venture between ATAL Engineering, Degrémont (now Suez) and China Harbour Engineering. Together we are supporting Hong Kong's development into a more resilient and sustainable city.

 **494,000m³**
of wastewater will be
treated daily



Our regions

Europe

Resilience is a critical factor

European Water Needs are increasingly diverse and continually developing driven by climate change bringing with it issues of increased flooding and areas of growing drought, changes in population and immigration tied to increasing urbanisation and aging infrastructure and the need to comply with extensive European Legislation as well as regulatory changes. Arup's water team, expertise and resources continues to grow to meet our clients' needs in these diverse areas.

The need for resilient infrastructure has resulted in expanding water projects in Europe, including flood reduction and protection works, clean water provision and wastewater treatment as well as water and wastewater conveyance, and improved storm-water collection and conveyance systems. Our Process teams are working on a number of water and wastewater treatment plants helping Irish Water address schemes that are not in compliance with the European Water Directives or are on the Environmental Protection Agencies Remedial Action List.

In our work to enhance community resiliency, we continue designing infrastructure and riverfront improvements, and developing creative approaches to flood resilience linked to the use of SuDS in our urban designs for various Local Authorities and Private Clients around Europe and in a pilot project for the design of a flood warning system linked to individual property protection measures in a rural community for the Office of Public Works in Ireland.

Our storm-water management design capabilities and our technical approaches assist many public and private sector clients in achieving resilient and ecological infrastructure. Over the past 12 months Arup Dublin has developed innovative SuDS features to suit the urban environment. One of the main challenges for SuDS design is integration with the road cross section. Arup have worked with a local council in Dublin to develop details such as bio-retention trees and gully to filter drain connections to marry road design requirements, maintenance requirements and water treatment needs.

Arup Europe continues to share knowledge and present at numerous conferences and other forums including the 3rd European Conference on Flood Risk Management, the River Restoration Conference, and Poland's Water Utility Companies Forum on blue-green infrastructure and rainwater modeling, as well as delivering technical papers to Engineer's Ireland on Energy Efficiency and on Dam Safety.



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“Forty years of investments have improved Europe’s bathing water.”

water.europa.eu

Upgrading the Aran Islands' water supply

For Irish Water, we are upgrading the water supply scheme on two of the Aran Islands. The islands are located around 10km from the western coast of Galway and are accessible only by ferry or by air.

This project presented us with an unusual challenge; there are no surface water features on either island – no streams, no rivers and no lakes. Groundwater tends to be relatively saline and some boreholes, which were previously used as water sources, have been abandoned in recent years. This leaves the islands entirely dependent on rainfall for drinking water and Irish Water is currently shipping treated water from the mainland at high cost.

The islands are also dependent on tourism; it's their main source of income. While there are fewer than 400 permanent residents, during the summer daily visitor numbers can reach 2,000. This puts enormous strain on the existing water supply schemes.

A hydrogeological study carried out in 2015 identified that excess winter rainfall could be captured to alleviate the summer deficit. So our process team is preparing detailed designs for raw water storage tanks and seeking planning permission to construct the tanks in highly scenic areas.

Once delivered, the scheme will provide Irish Water with a resilient water storage system to cope with future water demand on the islands.



“This is a unique and innovative project.”

Neil Reid, Arup Water Associate, Dublin



Go to
Campaign



Upgrading Nenagh and Kenmare wastewater treatment plants

Irish Water has appointed us to deliver upgrade works to the sewerage schemes for two medium-sized towns in central and south-west Ireland. The schemes, while similar in scale, present very different challenges in providing future-proofed and resilient processes for a 30-year design horizon.

Situated on the Ring of Kerry, Kenmare is one of Ireland's most popular tourist towns. Visitor numbers put substantial pressure on the existing plant, which currently discharges into Kenmare Bay. The plant is in the centre of the small town and access is difficult, and sometimes congested. Increasing its capacity will require an impact assessment of traffic from importing and exporting sludge loads and residuals by road. The design challenges for Nenagh relate mainly to protecting the biological system from excess surface water. The excess water comes from stormwater ingress at the head of the works, partly because there aren't enough stormwater management facilities, but also as a result of the increasing flood levels in the receiving water. This means that the outlet pipe from the plant can become submerged during intense rainfall events, inhibiting free discharge and risking a surcharge for the network.

The effects of climate change, including significantly more severe storms, need to be addressed as part of the upgrade works.



“Toilets are the single largest water users. Toilets use over 40% more water than needed! Our team is committed to radically improve this situation.”

[Declan Bowles, Arup Water Leader, Ireland](#)



Go to
Campaign

Analysis of surface flooding problem in the Kabel district of Krakow

In Poland, we worked with the Kraków Water and Sewerage Company to tackle surface flooding in the Kabel district of the city. Modelling 66km of sewers, we found efficient and effective ways to make the stormwater network more resilient.

To find the optimal solutions, we created an integrated model that combines the performance of the stormwater network with surface run-off, based on topography and land coverage. It also included spatial development in the catchment.

We analysed the performance of existing stormwater drainage system and carried out a study of the whole catchment area. We also examined inundation during rainfall events of various probabilities, using advanced GIS tools to create a flood risk map.

Our modelling confirmed that dealing with inundation requires implementing a solution precisely where problems occur. We showed that this would be more effective than focusing solely on retention within the lower, furthest elements of the drainage network.

We developed conceptual solutions and analysed the cost of the proposed, optimised mitigation measures. These included alternatives with various combinations of attenuation facilities, flow diversion or bypass connections.



“Kraków is split by the Vistula (Wisła) River. At 1047 km it is Poland’s longest river. However it is the city drainage system flooding which is for many people a real problem.”

[Jacek Zalewski, Arup Water Leader, Poland](#)



Relieving flooding in Midleton

The Irish town of Midleton is located at the confluence of the Owenacurra and Dungourney Rivers, 24km east of Cork City and within the Cork Harbour and Owenacurra sub-catchments. Midleton has a history of flooding over the past 40 years – with recent instances of fluvial, tidal groundwater and pluvial flooding.

Following the latest flooding, Arup prepared a flood event review for Cork County Council. This highlighted that understanding the hydrogeology of the Midleton area was fundamental to the design of any future flood relief measures.

The council then appointed us to assess, develop and design a viable, cost-effective and sustainable flood relief scheme. This must address all four sources of flood risk and minimise risk to the existing community, social amenity, environment and landscape character.

Work to date has focused on collecting and reviewing data as well as preparing LiDAR, geophysics and hydrometric river surveys. We have also presented an overview of the project to the town council and held a public information day in Midleton where local people were invited to give their opinions, with the majority welcoming the scheme.



“A hallmark of Arup projects is we seek a deep understanding of the needs of our clients and local communities and to build these into sustainable solutions.”

David Wilkes, Global Flood Risk Leader, Leeds



Our regions

UKMEA

Building expertise and influence

The UKMEA region has had a successful year.

The depth and breadth of our work for Dwr Cymru Welsh Water has grown significantly. Detailed design work on the Tideway West tunnel for Thames Tideway is progressing, and we have continued to support Yorkshire Water across projects, including a water-sensitive city strategy for Hull. In Scotland we completed our world-leading geomorphological baseline surveys of 6,000km of rivers.

Our work on flood resilience with the English cities of Leeds, Sheffield and Bristol continues, and we now have a portfolio of projects with the Scottish Environment Protection Agency. In Wales, we are involved with six coastal protection and regeneration projects for local authorities and have ongoing commissions with Natural Resources Wales. We have also built on our expertise in advising urban designers and developers on integrated water management approaches.

Projects include the Nine Elms development in London and the Southern Gateway water-resilient masterplan in Birmingham.

The last year has seen our water advisory activity mature, providing strategic advice to major water companies on resilience, business planning and economic regulation. We have also developed our water and environment offering. We are now leading on the water resources and flood risk aspects of the two largest infrastructure projects in the UK – High Speed 2 Phase 2 and Heathrow. Over the last year, we continued to shape and influence the management of water. We presented to the Welsh Government on resilience and to Parliament on the future of water, as well as sharing links to the sustainable development goals on behalf of British Water. We also took stands, and presented papers, at the British Dam Society conference, Flood and Coast 2017 and the River Restoration Conference, where we again sponsored the River Prize.

“Each Briton uses about 150 litres of tap water a day, but if you include the amount of water embedded within products, our water consumption increases to about 3400 litres a day.”

[UNESCAP, 2010](#)



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Further developing guidance for reservoir risk assessment

The guidance for Risk Assessment for Reservoir Safety (RARS) document provides a framework for assessing the risk posed by a single dam and the consequences of its failure.

We applied the methodology to portfolio risk assessments – including earth embankment dams, concrete and service reservoirs. This has enabled Yorkshire Water and Dwr Cymru Welsh Water to determine the overall risk posed by all their dams and readily identify those where further investigation, or capital expenditure, should be prioritised.

The portfolio risk assessment approach is proving a useful tool to help actively manage a portfolio of assets.

“All the dams in the world together hold nearly 7,000 km³ of water which covers an area of 500,000 km² - which is equivalent to 1/3 of the area of the world’s natural lakes.”

[British Dams](#)

 **100 largest reservoirs**
The 100 largest reservoirs of the world together hold half of all the water held by dams



Exploring the circular economy with Yorkshire Water


In the UK, Yorkshire Water asked us to help explore how it can apply the concept of the circular economy to its operations. This involves identifying key stakeholders, finding a practical demonstration location in the Yorkshire region and developing a high-level business case for a full-scale project.

We undertook a high-level study based upon the principles of the Circular Economy Framework developed by the Ellen MacArthur Foundation. Arup is a knowledge partner to the Foundation, which is working with businesses, governments and academia to build a framework for an economy that is restorative and regenerative by design.

We undertook our analysis of the value creation options for Yorkshire Water using a systems approach and included assets, material flows, and wider economic, social and natural systems.

The project, on which we worked with the University of Bradford, has outlined options for sustainable and resilient offerings. Examples include a vertical farm, a potable water production plant, housing and commercial land development, and an industrial innovation centre.

Yorkshire Water is now considering how to incorporate these into its strategy and future growth plans.

 **14%**
of all energy used
globally comes from
renewable sources



Collaborating as part of the Dŵr Cymru Welsh Water AMP6 framework

Asset Management Programme 6 (AMP6) is an alliance framework for delivering Dŵr Cymru Welsh Water's (DCWW) capital projects collaboratively. In the alliance, Arup is partnered with Morgan Sindall and the other members are Arcadis-Skanska, Mott Macdonald Bentley and DCWW.

The 5-year AMP6 framework projects include infrastructure schemes solving a range of issues on the network – such as reducing flooding, modelling coastal areas and improving assets such as reservoirs and dams.

The alliance provides value for DCWW and its customers by challenging the business case for individual schemes and packaging work together for maximum efficiency. It also explores innovations that improve efficiency – such as no-dig solutions – and optimising the whole-life cost and sustainability of projects.

Alliance working involves dozens of skilled staff collaborating with DCWW and the other alliance partners for the benefit of the water company and its customers. To encourage collaborative working, 30 Arup specialists are based in an office specifically procured to house the alliance partners.

The alliance aims to be an enjoyable, collaborative and inclusive working environment. Arup developed and helped to implement its people plan, which was recognised at the Institute of Water's 2017 Welsh Area Innovation Awards.

Our strategic thinking is also helping DCWW to create its 2050 Vision and prepare for the industry regulator's price review. And we have also developed a unique website to allow the alliance and DCWW to work collaboratively.



Revolutionising field surveys for the Scottish Environmental Protection Agency (SEPA)

We are using state-of-the-art mobile survey techniques that we developed to carry out the largest set of fluvial surveys ever undertaken within one project. This includes urban rivers such as the Clyde and the Almond, as well as watercourses such as the Tweed in the Borders and Allan Water in Stirlingshire.

The data will be used to confirm which ones are failing to meet the requirements of the EU Water Framework Directive. It will also help to identify the reasons for the failure along with the likely mitigation work required – including options such as remeandering, removing embankments and reconnecting floodplains.

Geomorphological surveys require large amounts of detailed information to be collected for vast distances of river channel. They include key datasets on river typology, morphological pressures and riparian vegetation as well as other datasets on factors such as invasive species. This enables SEPA to increase its understanding of the river systems and to improve its tools.

In the past, surveys have been time-consuming and laborious, with data added to paper maps and then digitised back at the office. But our innovation has changed all that. The mobile geographic information systems (GIS) application we developed enables surveys to be collected in the field using handheld devices, with data sent directly to a database on a remote server to be processed and analysed straight away. This saves up to 60% of the cost of traditional data collection and post-survey digitising.



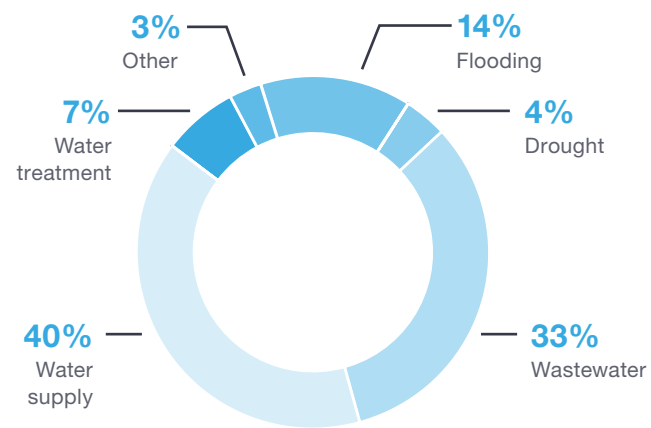
Our communities

Social responsibility Shaping a better world by helping communities

Shaping a better world by helping communities An integral part of our 10-year business plan is to have a positive social impact on 500 million people. This includes, for example, protecting people from flooding or providing access to wastewater treatment. In 2016-17, our project work has benefited 294 million people, bringing us over halfway to our 10-year target just three years after it was set.

Since 2014, we've increased our positive impact significantly. Our UKMEA region made the greatest contribution, followed by East Asia, Australasia, Americas, and Europe. And the benefits are spread across different categories.

On a global scale, water supply is the area in which we help the most people – followed by wastewater. This aligns with Arup's commitment to the UN's Sustainable Development Goals, specifically those on clean water and sanitation.



“We have helped 294m people and are keen to increase that significantly through our water-related work in the coming years.”

Steve Lloyd,
Global Water Advisory Leader



2-3 billion
global population
growth over the
next 40 years

70%
predicted food
demand will impact
on water demand

Our communities

Charitable Partners

Achieving the greatest impact

We aim to deliver a programme of community engagement activities that is inclusive, integrated, inspiring and impactful. Experience tells us that we can have the greatest impact by offering our expertise and skills through pro-bono work with charitable partners, rather than (or in addition to) simply giving cash. This includes work supporting organisations and communities local to our offices across the world and where our skills are particularly relevant. Driven by the local offices, initiatives focus on four key areas: local communities, education and youth outreach, institutional support and building capacity.

So, with our partners, we work to benefit all members of a community. We also provide focussed support for primary and secondary school pupils, tertiary students and young people not in education, employment, or training (NEETs).

A key area for Arup is supporting STEM (science, technology, engineering and mathematics) enrichment activities and inspiring more people to join our industry. We focus particularly on those from disadvantaged and minority backgrounds. These efforts are complemented by institutional support designed to support professional standards and tertiary education. We also provide capacity building to improve the operation and management of not-for-profit organisations. Whatever the challenge, our people willingly give their time to make a positive difference to the work of our charitable partners.

“If everyone everywhere had clean and safe water, the number of diarrhoeal deaths would be cut by 34%.”

[UN Food and Agriculture Organization \(FAO\)](#)



[Go to Campaign](#)

Upgrading the water supply for the Lama Lama people

In Australia, we're providing pro-bono engineering services to design a new water supply intake and treatment system for the Lama Lama people in the remote indigenous community of Port Stewart, Queensland.

The low-cost solution developed by Arup requires minimal operation and maintenance, runs on solar power and requires no treatment chemicals. The robust new system will replace the previous river intake destroyed in a cyclone in 2006, and the unreliable improvised pumping arrangement which the community have relied upon since.

The upgraded water supply system will improve the safety and reliability of the water supply for around 50 residents, reducing health risks associated with contamination and unavailability of clean drinking water. The availability of a reliable water supply will also enable the community to explore and expand tourism opportunities on their land.



“A key challenge on the project was developing an appropriate solution balancing technical requirements and the need for a robust and durable solution, against the limited technical and financial resources available for ongoing operation and maintenance”

[Priyani Madan, Arup Graduate Engineer, Melbourne](#)



Supporting Drop of Life's work in China

This year we continued our partnership with A Drop of Life in Hong Kong, supporting the charity's work to build rain-saving water cellars for arid areas in China.

So far, 30,000 water cellars have been completed in China's dry North West. These have helped more than 150,000 people resolve their water shortage problem. And in total, more than 500,000 people benefit from A Drop of Life's activities, which also include relief efforts for natural disaster victims, education support and poverty relief programmes.

Some 50 staff from our Hong Kong office participated in A Drop of Life's Race for Water event in March 2017 as a way to celebrate the World Water Day and to raise awareness about water scarcity.

By running the arduous trail carrying 4.5 litres of bottled water, participants experienced the hardship of villagers carrying water from source to home in their daily lives.

As the diamond sponsor for this event, we donated a total of HK\$163,850. This will fund the construction of water cellars in Northwest China.

“Across the countries where we work, people have to walk an average of 30 minutes to collect water and return home. In some cases it can be a lot longer.”

[Wateraid](#)



Continuing our partnership with WaterAid

Across America and Australasia, we're continuing our partnership with WaterAid. This international charity transforms lives by improving access to safe water, hygiene and sanitation.

This year, our offices in the US and Canada raised money for WaterAid by selling branded water bottles and holding office fundraising events. The proceeds from these will help to provide water and sanitation facilities for Tranquilino Gutierrez School in eastern Nicaragua, where five teachers and 129 students are without these basic services.

We've also supported WaterAid by providing the charity with facilities free of charge. In New York, we provide ad-hoc conference rooms for WaterAid to use. And our new office in Bogota has offered space as the charity works to establish a presence in Columbia.

In November, our teams in Australasia supported WaterAid's Pay to Pee campaign to raise awareness for World Toilet Day 2016. By inviting people to make a small donation every time they go to the toilet, the campaign draws attention to the fact 2.3 billion people do not have access to sanitation.

In March 2017, Arup teams participated in WaterAid's Walk for Water event to raise awareness of the limited access to clean water in developing countries. And from March to October 2017, staff will be invited to participate in the charity's Water Innovators Challenge. This sees teams from different organisations collaborate to create innovative solutions to real life-water and sanitation issues.



[Go to Webpage](#)



Working with Engineers Without Borders Australia (EWB)



We are using state-of-the-art mobile survey techniques that we developed to carry out the largest set of fluvial surveys ever undertaken within one project. This includes urban rivers such as the Clyde and the Almond, as well as watercourses such as the Tweed in the Borders and Allan Water in Stirlingshire. The data will be used to confirm which ones are failing to meet the requirements of the EU Water Framework Directive. It will also help to identify the reasons for the failure along with the likely mitigation work required – including options such as remeandering, removing embankments and reconnecting floodplains.

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Rallying to support Engineers Without Borders and Dementia UK



“From climate change to resource depletion, urbanisation to population growth, we know that engineering is the solution to the world’s most pressing problems.”

[Engineers without Borders UK](#)

Arup engineer Matthew Sambrook took part in the 6-day Panda Raid Rally to raise money for Engineers Without Borders and Dementia UK.

Matthew drove his 25-year-old Fiat Panda alongside 300 other classic Pandas in the long-distance event. The amateur rally comprises a 3,000km, 6-stage tour to test the physical and mental capacities of the teams. Teams cannot depend on modern technology and are only allowed to use a compass and a roadbook to navigate through each stage.

It’s estimated that the rally will produce approximately 201kg of CO2. Funds equivalent to the offset value of this is being donated to build a new school for zero-carbon technologies in Morocco.

Matthew exceeded his target of raising £500 for his chosen charities, with sponsors pledging over £750.



[Go to
Webpage](#)

Partnering with FRANK to deliver safe water for all

Worldwide, 663 million people still lack access to safe drinking water, and 2.4 billion are without adequate sanitation. FRANK Water's goal is simple: safe water for all. Through partnerships with some of India's best grassroots organisations, FRANK works with marginalised communities to help them understand the issues and develop their own answers to securing safe, clean drinking water and sanitation.

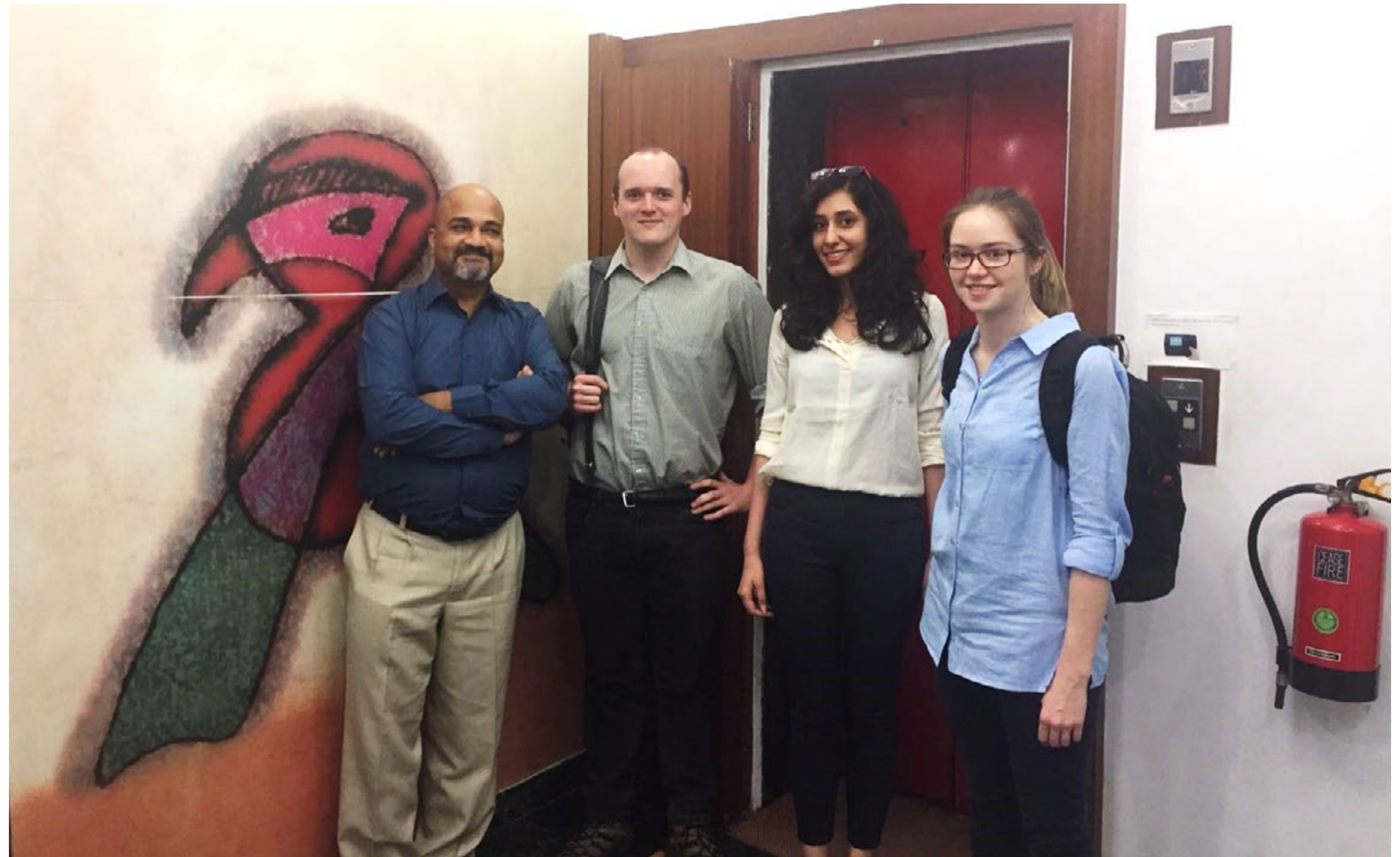
As part of a 3-year partnership, we are helping FRANK's partners to better understand and manage the environmental impact of water, sanitation and hygiene (WASH) projects. We are developing FRANK's community engagement programme in the UK, and improving FreeFill, FRANK Water's most important fundraising initiative.

FRANK Water's India programme combines implementing projects, research and development, and advocacy. Projects tackle the challenges of supplying communities that are the hardest to reach or excluded from mainstream society. Since 2005, they've provided more than 325,000 people in 210 communities with safe water and sanitation. Solutions adopted include gravity-fed and pumped water supply systems, catchment management, water treatment, sanitation infrastructure, and education programmes.

Our expertise and guidance ensure FRANK's activities are sustainable, integrated and resilient to change.



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From left to right Anirudha Deshingkar (Arup Mumbai), Steven Johnson (Arup Cardiff), Aatisha Gupta (Arup Mumbai) and Charlotte Brown (Arup Bristol)

Our communities

Engagement

Forging connections, building understanding

We believe that forging better connections between industry, education, the corporate sector and the public can help tackle some of the most pressing water issues.

As this year's review highlights, we engage with academic institutions to help shape a curriculum that will provide future engineers with knowledge of vital areas. This year, work with McGill University in Canada has led to the civil engineering department introducing a module comparing green and traditional infrastructure.

We are also keen to introduce the industry to promising innovations. Our growing Wet Network events enable water technology companies to share ideas and build business relationships with leading users, entrepreneurs, vendors, advisers and funders. The events regular attract audiences of nearly 400.

Understanding what matters to communities is increasingly important for our corporate clients. We are helping them engage with communities through forums and research such as our pioneering National Water Survey in Australia, which highlighted industry and public concern about water security.

Armed with a deep understanding of community attitudes and expectations, our clients can draw on our expertise to help them create strategies focussed on delivering the best possible outcomes.

“70% of the Earth is covered with water but only about 1% of the world's water is readily available for human use. Nearly 97% is salty or otherwise undrinkable. Another 2% is locked in the ice caps and glaciers. That leaves just 1% for all humanity's needs.”

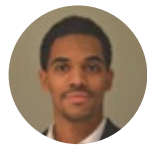
[WATERWISE](#)

Instigating a student mentoring programme

In Canada, Sylvana Hochet Brito, a water resources engineer in our Montreal office, advised a graduate student through a 13-week integrated water resources management internship at McGill University.

As well as leaving the student highly motivated, this collaboration between Arup and McGill has positively influenced the university's curriculum. The overseeing professor in McGill's civil engineering department is planning to introduce a module comparing green and traditional infrastructure in the 400-level BEng hydraulics course.

This is just one tangible example of how we are engaging with the local industry and shaping a better world.



“Arup still follows the business principles our founder, Ove Arup, set out in his Key Speech. Join Arup and you will have the freedom to push boundaries and the space to explore your career as you take responsibility for helping us shape a better world.”

[Chuck Ormsby, Senior Engineer, Montreal](#)



Engaging with communities at home and abroad

This year saw our Ireland teams heavily involved in community engagement. Neil Reid and Aoife Mullally of our Dublin team took part in the A Time to Read initiative, attending a primary school in a disadvantaged area every week to read with 8-year olds.

Our Dublin team is building strong ties with Engineers Without Borders (EWB). Emer Kennedy of the Dublin water team was a judge for the finals of EWB's national competition Where There is No Engineer. This saw nearly 100 students from third-level institutions across the country given the opportunity to design creative solutions to real-life humanitarian problems.

Following the competition, which we sponsored, Arup's Jacek Lakomy, Evelyn McAuliffe and Edit Blennerhassett continued to mentor runner-up teams whose projects showed potential. As a result of this budding relationship with EWB, our Europe region is setting up a strategic partnership with the charity.

We've also been engaging further afield. The summer of 2016 saw Cliodhna Ni Murchu travel to Cambodia to work for two weeks on site with Bridges to Prosperity. Jacek Lakomy and Aine Delany published a tool to assist the charity Splash with the design of water storage tanks for schools in Nepal and Ethiopia.

And Emer Kennedy returned to Nepal in February 2017 with Engineers Without Borders Australia. Emer learnt about design in developing countries and worked with the village of Pitlek on ideas to improve quality of life for the community.



Providing insights into community attitudes to water

In October, the Australian Water Association and Arup released the Australian Water Outlook. This details the results of the Australian Water Survey, which investigates attitudes to water issues in the Australian water industry and the wider community.

The survey, which had two streams of questions – one for consumers and one for people in the water industry, attracted 2,500 responses. These showed water security and governance were areas for serious concern, while there was also an appetite among Australians to make use of alternative sources of water to ensure future supply.

Only 4% of industry and 3% of community respondents were completely confident that Australia currently has sufficient water security to meet social, environmental and economic needs into the future. In fact, more than half of both groups said they were not confident.

The survey results and the insights they provided were released at the IWA World Water Congress in Brisbane. The results will also inform the Association's Water Security Scorecard, which is due for release in May 2017 at Ozwater'17.

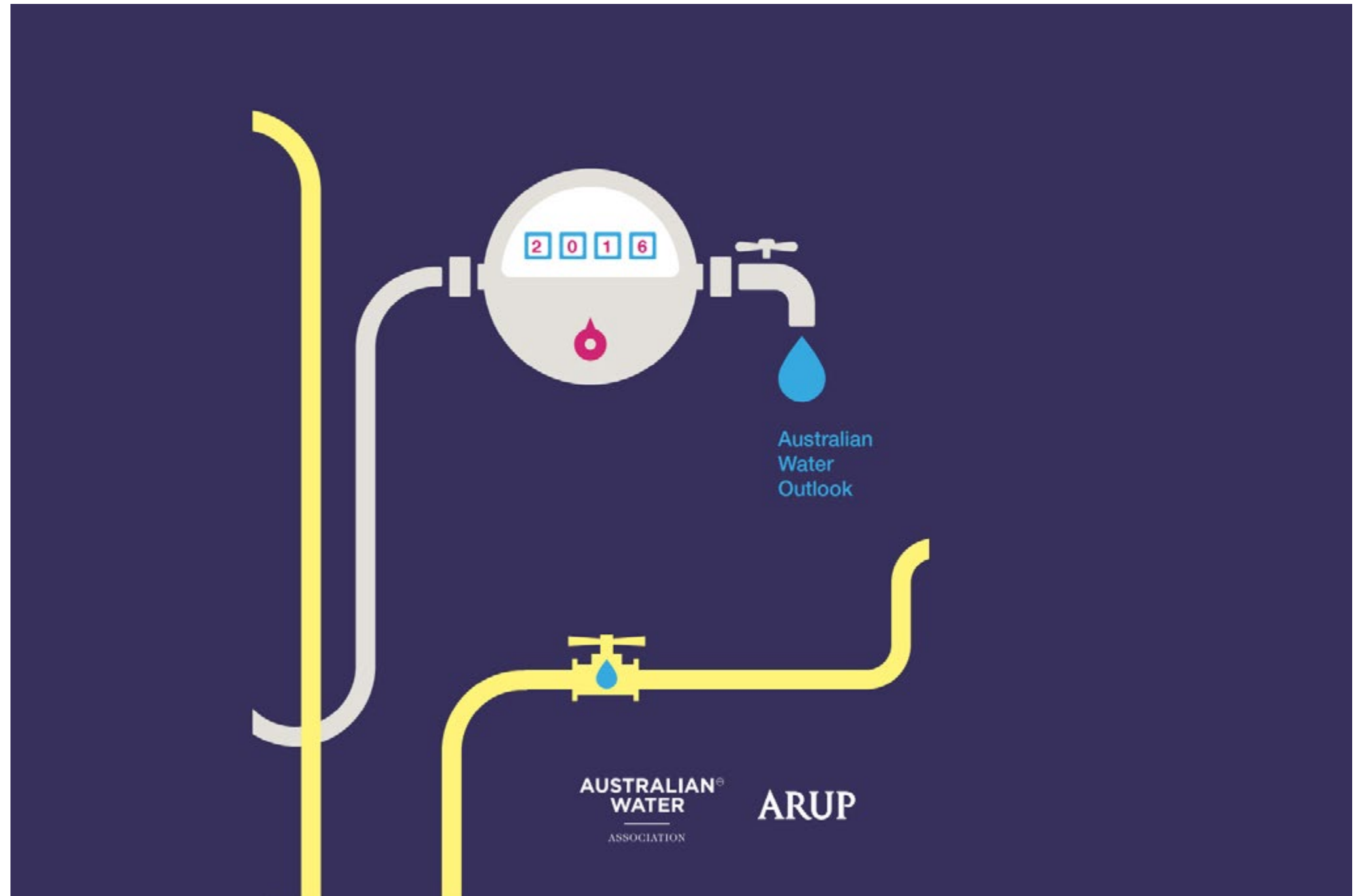


“Our engagement with customers is increasing and we are looking forward to undertaking the first ever national customer survey of New Zealand.”

Daniel Lambert, Australasia Water Leader, Sydney



Download
Publication



Piloting community response to flooding

The towns of Thomastown and Graiguenamanagh in Kilkenny, Ireland, have a long history of flooding. The most recent flood event occurred in December 2015 when both towns suffered severe flooding.

As a result, Kilkenny County Council has retained Arup to provide individual property protection (IPP) measures[PL1] to 150 properties in combination with a flood forecasting system. Typical measures consist of flood doors or slot in barriers, vent and airbrick covers, none return valves and pumps. The Office of Public Works (OPW) is funding the project as a national pilot study to inform decisions on future measures of this type. The main aim of the project is to improve flood resilience for residents at Thomastown and Graiguenamanagh. It also aims to increase community awareness and understanding of flood risk. Work to date has focused on data collection and feasibility assessment. Community engagement during these initial stages of the study showed 90% of respondents welcomed the concept of IPP measures to improve flood resilience. Our survey also showed that a substantial number of residents will require assistance with erecting IPP measures.

We also prepared 150 individual property reports. Each one includes an overview of the detailed building survey and a recommendation of IPP measures. The feasibility assessment for the scheme shows a very healthy cost-benefit ratio (CBR) of 8.7 for Thomastown and a moderately positive CBR of 2.2 for Graiguenamanagh. The project is expected to be approved shortly for detailed design and implementation, which is scheduled for the end of 2017.



“We are proud to be supporting these communities.”

Ken Leahy, Arup Associate Director, Cork



Developing a business ecosystem for innovative water technology

By hosting regular invitation-only events, we are developing a sustainable business ecosystem for water technology. The Wet Network events enable water technology companies to share ideas and build business relationships with leading users, entrepreneurs, vendors, advisers and funders.

The events provide a platform for innovative companies to present their promising technology to potential funders and other interested parties. They also provide senior industry players with a forum for networking and exchanging ideas.

In partnership with the international lawyers, Pinsent Masons, our London event has now been running for over ten years. During this time, over 100 technology companies have had the opportunity to present to water sector audiences. In the last year alone, the regular Wet Network events attracted audiences of nearly 400.

Early in 2017 we staged the first event outside of London. Held in Leeds, England, it was well received with attendees also having the opportunity to tune in to our dedicated Wet Networks event app.

This year we plan to take the Wet Network initiative further afield to reach a global audience.

“In 2016 the London event celebrated its 10th year with 30 events (3 a year) since inception and over 150 technology presenters who have showcased their products and inventions.”

[wetnetworks](#)



Our people

Our people

We want our people to feel valued

Therefore, they need to be treated with dignity and respect.

People should be appreciated as individuals because it's the right thing to do, and because it makes business sense. This is why, at Arup, we take the widest possible view of inclusion and diversity, going beyond abilities, age, ethnicity, religion, sexual orientation, gender identity and expression. Our aim is to create an environment that welcomes and delights in the richness of our differences and in which all can thrive.

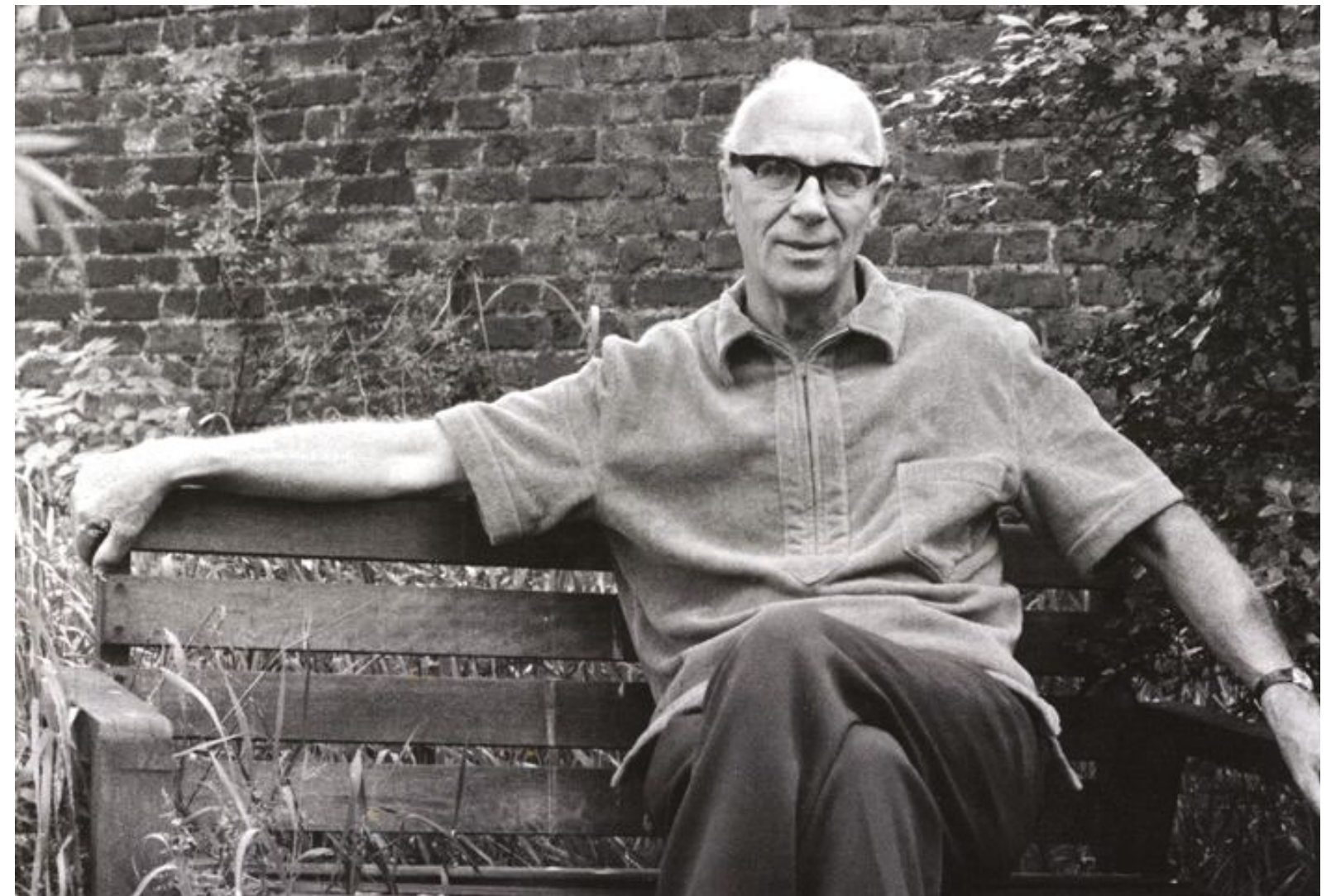
We encourage our people to hone and develop skills that help them to build expertise for the benefit of our clients and give them greater career pathways. We also celebrate in the successes of our teams and the projects they engage with.

Recognising the importance of succession planning, we fully support our 'rising stars' and include them at every stage of projects.

Embracing an inclusive culture that supports diverse talent fosters successful collaboration and enables us to compete effectively – to the benefit of our clients.

“If we can reach a stage where each man or woman is respected for the job they do, and is doing his or her best because the atmosphere is right, because they are proud of what we are and do and share in the general enthusiasm, then we are home.”

[Sir Ove Arup](#)



Our people

Skills

Shared insights, creativity and solutions

Developing, enhancing and sharing our people, their skills and their knowledge lies at the heart of what we do – everything we provide for our clients revolves around shared insights, creativity and solutions.

Our Water Skills Network is central to this process. The network advances skills and knowledge across the firm, oversees our training and development curriculum, facilitates easy access to expertise, experience, and best practice, and promotes consistent technical quality.

The last 12 months has been very busy. We've continued to work closely with Arup University's learning team on training material, and new additions this year include An Introduction to Water Framework Directive Compliance and Embodied Water.

We work hard to bring our practitioners across the world together to share knowledge and to explore future challenges and opportunities. This can be by region, or across particular skill areas. This year we have supported our Americas region's water skills in particular, as well as process skills.

We also continue to grow our water skills community, which supports 1,500 people in Arup around the world who have an interest in water. This active network has regular formal and informal knowledge-sharing events and hosts a global discussion forum. Our current focus is a collaborative redesign of our intranet space to further support the community.



Our people

Reward & Recognition

Celebrating success

In the last year, our people's achievements have been recognised through awards and commendations. We are very proud to share just some of the successes from around the globe.

2016

- International Water Power and Dam Construction Magazine People of the Year:
Ljiljana Spasic- Gril (London)
- Australia's Most Innovative Engineers for 2016
Daniel Lambert (Sydney)
- Institute of Water, Welsh Area Innovation Awards Technological Advances Category - Winner:
AMP6 Framework, Wales
- Institute of Water, Welsh Area Innovation Awards People/Customer Service Category - Winner:
AMP6 Framework, Wales
- United States - American Council of Engineering Companies ACEC:
Lake Mead Intake No 3
- New York - Platinum Award for Engineering Excellence - Water Resources:
Lake Mead Intake No 3
- **David Crooke appointed to All Reservoir Panel by the Institution of Civil Engineers**
- **Tracey Williamson appointed Chair of the British Dam Society**
- **Daniel Lambert appointed as Technical Expert on Australian Water Association's Expert Advisory Committee**



“I find volunteering makes my personal and working lives better. It makes you aware that you can use your skills to change lives and communities, and has made me more inspired to do my job.”

[Priyani Madan, Arup Graduate Engineer, Melbourne](#)

Delivering a keynote on blue-green infrastructure



Vincent Lee, Arup Water Associate
Principal, New York

Arup's Vincent Lee delivered an address on the power of designing with water at last year's Municipal Green Building Conference hosted by the US Green Building Council's Los Angeles Chapter. Vincent explained the design strategy of blue-green infrastructure, which addresses not just water or energy use, but also the inherent connections between two.

The idea, Vincent explained to the audience, is to implement not just green infrastructure and green design, but blue-green infrastructure and blue-green design. Green thinking means designing places with vegetation and thinking about how nature can be a prominent part of your site – not just something that's back of house. Blue thinking means working with the water cycle and designing places that could use water, could store water, or leverage water as an asset and a resource. Blue-green infrastructure and design use both blue and green space, and it serves multiple functions for both of these purposes.

Lee went on to illustrate this idea with examples of Arup projects in Korea, Wales and the US. His concluding message was the importance of cross-collaboration. None of this will happen with just one agency; multiple agencies and multiple design professionals will be needed. Blue-green infrastructure is a true product of multidisciplinary thinking.



Winning silver for our work on New York green infrastructure

Arup won silver in the American Council of Engineering Companies' (ACEC) New York 2017 Engineering Excellence Awards for our Newtown Creek Green Infrastructure project.

The project aimed to improve water quality in the water bodies surrounding the Newtown Creek watershed in Brooklyn, New York, by reducing combined sewer overflows. We coordinated with multiple agencies on the design of 140 bioswales within city streets.

Containing a variety of plants or trees, the bioswales collect the first inch of rain or stormwater and allow it to percolate slowly through the specially engineered soil – essentially diverting it from the combined sewer system. Anything that enters the bioswale is either absorbed directly by the soils and plants, evapotranspirated or at least attenuated, helping to reduce combined sewer overflows into city waterways.

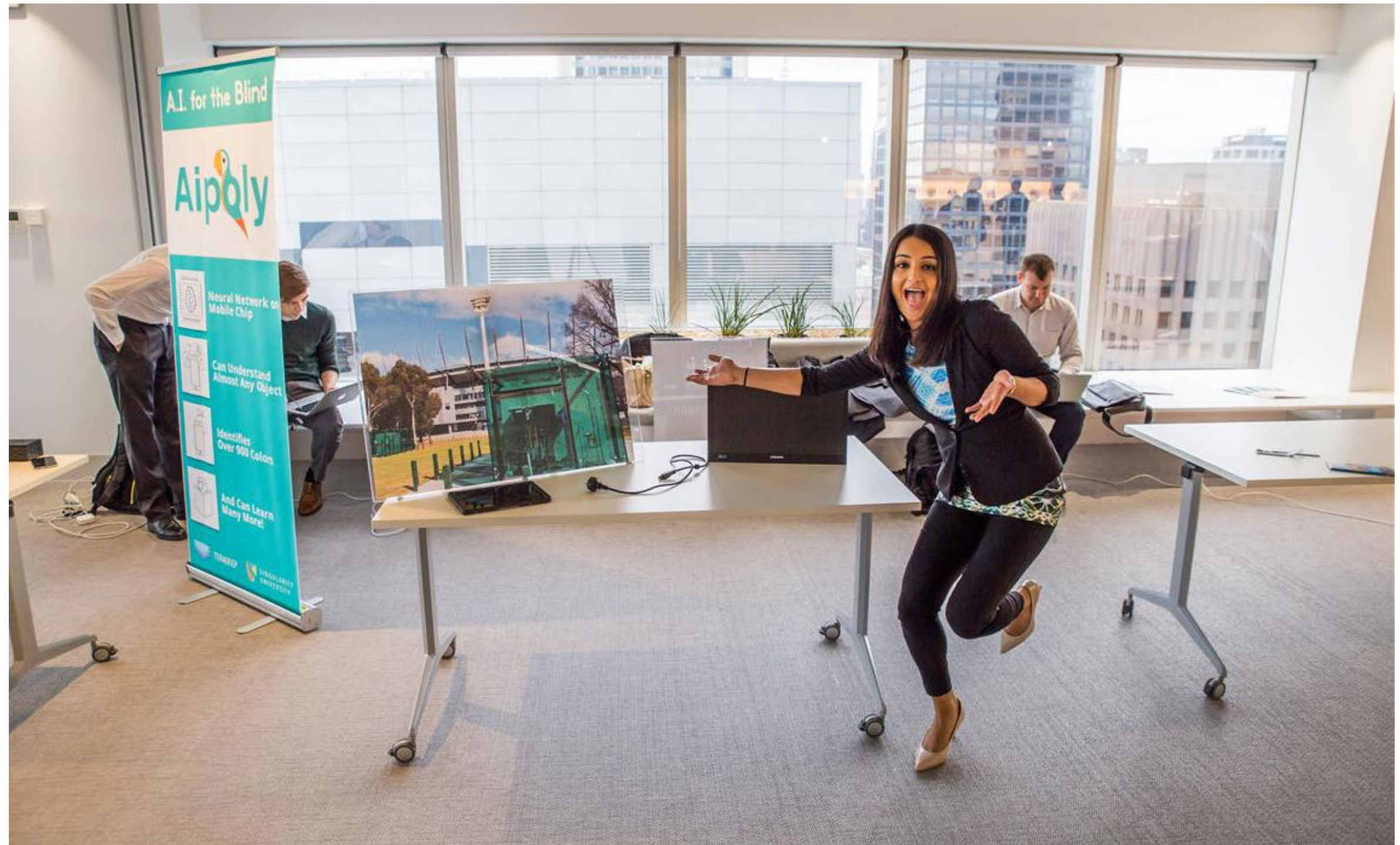


Receiving the Danny Award

In late 2016, Priyani Madan, a civil engineer in our water team in Melbourne, received the Ove Humanitarian Award for Arup Melbourne and the Danny Award from Engineers Without Borders (EWB). The Danny Award is named after EWB's founder Danny Almagor and is presented to inspirational change-makers who embody the organisation's values and leadership.

Priyani originally joined EWB's Melbourne University Chapter and spent a year as an intern with the organisation's head office. She also attended two Dialogues on Development trips (now called Humanitarian Design Summits) – one to the Murray-Darling basin and one to Cambodia.

Priyani now coordinates the EWB/Sudanese Australian Integrated Learning (SAIL) programme partnership in Victoria and Arup's Australasian partnership with EWB. This partnership sees EWB and Arup working towards a future where everyone has access to the engineering knowledge and resources required to lead a life of opportunity, free from poverty.



Celebrating award-winning online collaboration

Katherine Gouws of Arup and the Dŵr Cymru Welsh Water Capital Alliance picked up the Technology Advances Award at this year's annual Institute of Water, Welsh Area Innovation Awards. The prize was awarded for collaborative working using SharePoint.

In 2014, we created a web-based common data environment that now allows over 700 staff across the Dŵr Cymru Welsh Water Capital Alliance to access and update a full suite of data and documents in real time. This 'single source of truth' has transformed the way the six Alliance partners – Dŵr Cymru Welsh Water, Arup, Morgan Sindall, Mott MacDonald and Bentley, Skanska, and Arcadis – manage their work and share knowledge.

Our secure SharePoint site provides one intuitive and searchable location for Alliance staff to find everything they need to work efficiently together. It has established a transparent culture that saves time and reduces the risk of errors and duplication. It also reflects the industry movement towards building information modelling (BIM), BS1192 and collaborative delivery.



Shaping the Institution of Civil Engineers' thinking

Jennifer Laight, who works at our Midlands Campus, and Katie Goode from our Manchester office have been selected to sit on the Institution of Civil Engineers' expert panel for water.

Jennifer and Katie will be helping to shape the ICE's thinking on water issues such as demand management, flood risk and security. The panel will guide policy development and encourage dissemination of knowledge.

As well as being a great personal achievement, Jennifer and Katie's appointment will enable Arup to remain ahead of the curve on emerging water policy.



Jennifer Laight - Senior Civil Engineer



Katie Goode - Civil Engineer

Our people

Young Talent Nurturing the industry's future

Every year Arup provides a global graduate programme to welcome new talent to our organisation – we typically have around 200 graduate positions available. We're also one of the UK's Top 60 Employers of Apprentices, a testament to our commitment to providing the ideal start to an apprentice's development.

We give graduates from diverse backgrounds and disciplines iconic projects to work on, a questioning culture, access to top talent and a carefully designed development programme. Graduates choose their own direction – be that water or another discipline. And for many, that will also mean choosing where they work, taking advantage of our global network to work overseas.

Our apprentices study a wide range of professional disciplines – from civil engineering to accountancy. While acquiring the technical skills and qualifications they need to launch their career, they also build vital workplace knowhow.

We welcome more than just engineers and conventional engineering qualifications. Arup is home to everyone from creative architects, IT experts and transaction advisors, to geographers and economists. We're more interested in how people think than where they're from. We want free-spirited, innovative people of all shapes and sizes. We want independent thinkers.

In this section, we celebrate just some of what these independent thinkers achieved last year.



“You are the author of your own story at Arup. We give graduates from diverse backgrounds and disciplines the iconic projects, the questioning culture, access to top talent and a programme as carefully designed as our projects. You choose the direction.”

[Justin Abbott, Arup Water Skills Leader, Leeds](#)

Presenting on water and low-impact development

Arup's US team had a strong presence at the Environmental & Water Resources Institute's (EWRI) International Low Impact Development Conference from August 29-31 in Portland, Maine.

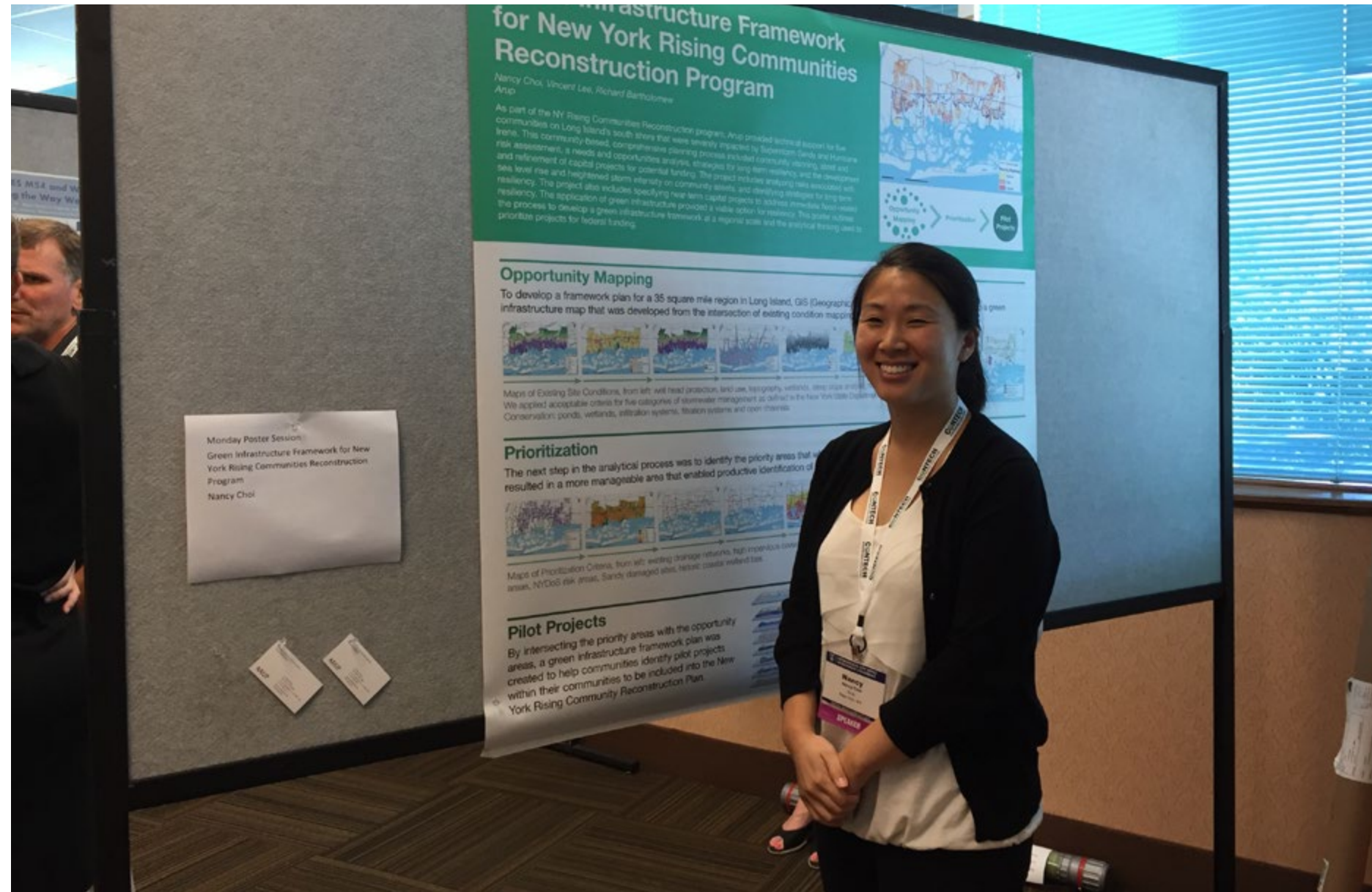
Colleagues from our New York office spoke at the conference, which provides a national forum to present the latest developments, technologies and case studies related to low-impact development and green infrastructure technology.

Monika Marciszewski and Zachary Benedetto presented on mobile geographical information systems (GIS) for green infrastructure. Joseph Kardos and Vincent Lee presented on the use of effective technology, data integration and building information modelling (BIM) in delivering right-of-way green infrastructure design. And Nancy Choi gave a poster presentation on the green infrastructure framework for the New York Rising Communities Reconstruction Program.

The strong presence at this conference is testament to our ongoing commitment to and technical excellence in green infrastructure.

“It is always a great opportunity to share ideas and perspectives with peers in the water sector.”

Nancy Choi,
Arup Senior Water Engineer, New York



Nancy with a poster presentation at the event

This year numerous fantastic graduates joined our team in Australasia.

For example, Gabby Butera joined the water team in Melbourne as a graduate process engineer in September 2016. Since then, Gabby has worked on a number of client projects and is leading internal research into micropollutants and their impact around the world.

Alex Varvaris joined the water team in Canberra as a graduate process engineer in May 2016. Alex has been working with Icon Water on secondment at the Lower Molonglo Water Quality Control Centre as a project engineer.

Priyani Madan is a graduate civil engineer in our water team in Melbourne. Priyani is passionate about helping to shape a better world and is currently leading the design of a water treatment system for a remote Aboriginal community in northern Queensland.



“It is always great to welcome exciting and talented graduates to our growing team. Their positive contribution to projects is very adds value to the solutions that we develop.”

Daniel Lambert,
Australasia Water Leader, Sydney



Examining solutions for green and blue infrastructure in Bydgoszcz



Dastin Adamowski, Arup Assistant Water Engineer, Krakow

In Poland, a young graduate from our Krakow office – Dastin Adamowski – examined green and blue infrastructure solutions from around the world that could be implemented in the city of Bydgoszcz.

In Bydgoszcz, intensive building development has increased surface water runoff. This is overloading the sewerage system and watercourses, causing flooding. The problem is aggravated by more frequent floods and droughts, which cause serious economic losses and sometimes even a threat to the life and health of residents.

With Bydgoszcz's stormwater drainage needing rebuilding to increase its retention capacity, Arup helped to ensure the city can adapt to climate change. The goal is for the city to function as a sponge, accumulating stormwater and using it in times of drought. Key to this aim is blue and green infrastructure – features such as parks, gardens and revitalised watercourses.

Dastin analysed solutions that, if linked with proper spatial planning and an integrated hydrological and hydraulic analysis, allow green areas to combine multiple functions. They can be used for recreation, stormwater management and infiltration, as well as improving the aesthetics of areas undergoing intensive development.

Thanks to Dastin's work we were able to compile a catalogue of potential interventions, analysing how they could be applied in different locations around Bydgoszcz.



Building our business support team for the future

Apprenticeships are not always the technical kind; our team comprises different disciplines and our business admin apprentices make a vital contribution. Often joining us straight from school they have the opportunity to work across a range of business support services.

This is the second year our water team in Leeds, UK, has welcomed a local apprentice and we were delighted when Paige Fisher was awarded a highly commended certificate in Damar's Annual Apprenticeship Awards 2017. This recognition was primarily for the valuable support she has provided to the water marketing team – including her contribution to this review.

The nationally recognised Damar Annual Apprenticeship Award celebrates an apprentice's exceptional achievements. Judges look for apprentices who have demonstrated commitment to their own personal development and progression through learning, as well as making an outstanding contribution to the workplace.



Contact

Get in touch

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, Christopher Sharples in our Visual Communications team who helped pull the whole look and feel together, Paige Fisher who spent hours tirelessly sourcing images and interesting water facts.

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