water

NOVEMBER / DECEMBER 2017 ISSUE 202

2017 Conference Highlights

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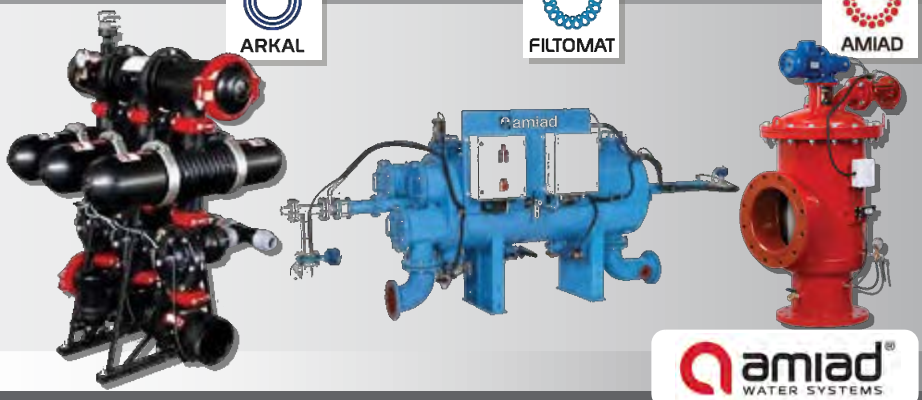
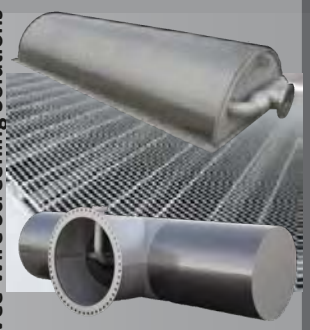


amiad WATER SYSTEMS

Vee Wire Screening Solutions



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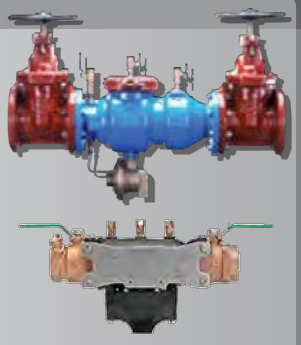

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water

Issue 202 NOVEMBER / DECEMBER 2017

INSIDE

FEATURES

REGULARS

A consistent approach across the 3 waters sector.

The official journal of Water New Zealand – New Zealand's only water environment periodical. Established in 1958, Water New Zealand is a non-profit organisation.

Call for a connected discussion

Kelvin Hill,
Acting president, Water New Zealand

It was a great pleasure to attend yet another highly successful Water New Zealand annual conference in Hamilton this year. Our annual conferences always provide a great opportunity to catch up with members from all over the country and this year was no exception.

Not surprisingly, drinking water was a big theme across the conference and was particularly reflected in the one day Drinking Water Workshop which looked at the lessons of the Havelock North contamination outbreak. It was certainly a bonus to attend the workshop and discuss some of the learnings with world leading experts on water contamination – Dr Steve Hrudey, Dr Paul Byleveld, Jamie Bartram, Prof David Kay, Robert Bos to name a few.

It's safe to say we'll all be interested to see the recommendations from the Havelock North Inquiry when they are released in December. The Inquiry has provided an opportunity to pave a way forward and address the underlying systemic issues that led to the contamination crisis. We're optimistic that we'll see a big improvement in this area.

In listening to the international experts at the workshop, it's clear that we need to do much more to ensure that all New Zealanders have access to safe drinking water and we need to improve our legal and regulatory framework around the delivery of drinking water. It's significant that, as a group, the visiting experts agreed to a number of recommendations around the way we ensure a safe approach to the delivery of drinking water. These recommendations have been put before the new Minister of Health.

Ensuring a more robust and sustainable approach to providing drinking water will be a key platform that the new Government will need to show leadership on.

We've been very aware for many years that meeting minimum drinking water standards can be a challenge for smaller communities. It was concerning that the former subsidy scheme under the Drinking Water Assistance Programme was allowed to expire in 2015.

It is important that smaller communities do receive assistance to help them meet minimum drinking water standards and it's pleasing that Labour's pre-election manifesto stated it will provide that assistance.

Related to the work needed around the drinking water standards is the competence of industry employees in operating drinking water plants around New Zealand. At the Havelock North Inquiry there was considerable concern expressed at the lack of a formalised training and certification regime for water treatment plant operators.

Water New Zealand and the Water Industry Operations Group have a programme of work to develop a certification regime which will establish competency requirements to operate water treatment plants going forward. That work is being complemented by a new approach to training employees who run these plants. It's likely we will see a move away from the focus on just block courses to a more blended learning environment where some of the training is on job and "e-learning".

I hope that despite the dumping of the water royalty for irrigators – a suggested means of funding initiatives to help small communities meet drinking water requirements – the new Government will take steps to ensure that all communities have the means to provide residents with water that meets minimum standards.

However, drinking water will not be the only challenge facing the new Government.

Water quality is something many are now realising we can no longer take for granted.

The technical advisory group set up by the previous government in 2016 to look at freshwater allocation issues was due to report to Cabinet soon after the election. Reportedly, the group was looking at issues of charging and pricing.

Climate change will have a major impact on our three waters infrastructure. Water New Zealand has calculated, in our National Performance Review, that storm and wastewater assets worth a conservative $12 billion will need replacing – many of them sooner than expected because of sea level rise and flooding issues.

The new Government will also face ownership issues and it will be interesting to see how the parties compromise over their differences around any iwi rights.

One thing that is clear is that we will need to do things differently if we want to maintain and improve the performance of our drinking, storm and wastewater management across the country.

This means that the Government will have to play a role in finding a way through what will be a multi-billion-dollar problem across the country as rising sea levels and flooding take their toll on existing infrastructure.

"One thing that is clear is that we will need to do things differently if we want to maintain and improve the performance of our drinking, storm and wastewater management across the country."

It's a problem that cannot be left solely to local communities and councils to sort out at a regional level. We need to see a more connected discussion across the country and we need to ensure that the incoming Government will work with the water sector and local government on a joint collaborative approach to climate change.

Delaying action will only make the choices more painful and expensive down the line. **WNZ**

Customer survey and data tool provides useful regional information

Having a consumer snapshot of Waikato residents' attitudes to volumetric water charging has provided Waikato District Council's General Manager Service Delivery, Tim Harty with a useful benchmark to inform public engagement planning.

The information, contained in the National Water Consumer Survey and data tool, was launched at the Water New Zealand Conference in Hamilton in September.

Tim Harty says the consumer survey provides a range of high level data which gives a good starting point to help define some of the more in-depth and detailed questions that need delving into.

The cost and pricing of water has been a big topic in the Waikato region and he says the survey results have provided useful information.

"This is a big issue in this region because of the perceived availability of water and a poor understanding that water is costly to source, treat, provide and dispose of."

The consumer data tool revealed that in the wider region, 56 percent of people would prefer to pay for water based on volumetric charging rather than as part of their rates bill.

The survey revealed that in the Waikato there is a significant lack of understanding in the community about where drinking water comes from.

In nearby Bay of Plenty, a similar lack of clarity, along with concerns about climate change, are two of the survey and data tool's key findings, according to Tauranga City Water Manager, Steve Burton.

He says these findings will help inform the city's education programme.

The survey also shows that older people in the Bay of Plenty prefer to receive transactional information such as bills and warnings through email but that younger demographics prefer other methods.

"It is very helpful to see the way people prefer to get their information from us and this is definitely something we'll be working on with our comms team in the future," says Steve.

Overall the regional information showed that people in the Bay of Plenty strongly prefer to pay for water on a volumetric basis rather than through fixed charges. The survey revealed that 79 percent of Bay of Plenty residents prefer to keep water charges out of their rates bill.

"This is something that we have been aware of and it's good to see that the survey's strong results back up other information. People understand that this is a fairness and equity issue."

He was also pleased to see a strong finding in the area of confidence in the council.

"It's good to see that people have confidence in us as a supplier but we will certainly be able to use the information to work on areas where people need to understand issues better.

Water New Zealand Chief Executive John Pfahlert says the aim of the survey was to provide information to members across the country so providers can be more effective in their service delivery and communication to customers.

"We've got some quite detailed regional demographic information including gender and age."

The survey report includes analysis of issues across the following key areas: consumer outlook, water use and efficiency, price of water, customer experience, future of water, healthy waterways.

For more information and to see the survey and data tool go to www.waternz.org.nz/watersurvey.

Deep South report on climate preparation

A new report has highlighted the serious risk our infrastructure is facing because of climate change.

The report, by the Deep South National Science Challenge, follows discussions earlier this year with a wide range of water sector organisations and individuals, including Water New Zealand. It outlines current knowledge and priority areas of research needed to enable our stormwater and wastewater systems to be more resilient.

Water New Zealand Chief Executive John Pfahlert says the 'Climate Change and Stormwater and Wastewater Systems' report outlines a very concerning future for our water network.

He says there is a need for a more connected discussion across the country and the new government needs to work with the water sector and local government on a collaborative approach to climate change management.

"Flooding events and sea level rises will have a big impact on water networks and will mean that billions of dollars of underground water assets will need replacing sooner than previously expected.

"This is a huge challenge that cannot be left solely to local communities and regions to grapple with and delaying action will only make the choices more painful and expensive down the line."

The Deep South National Science Challenge intends to do further research to better understand the risks, including cascading indirect effects where failure in one part of the system will have significant impacts elsewhere – many of which we may not yet be aware of.

"This is much-needed learning and will be a great resource for incorporating these aspects within decision-making frameworks. The knowledge should help us to develop the most appropriate and practical adaptation responses to help reduce climate change," says Pfahlert.

Team challenge for clean water across the Pacific

Registrations for Oxfam Trailwalker 2018 are open. Oxfam Trailwalker is the ultimate team challenge and is Oxfam New Zealand's biggest fundraising event.

Teams of four walk either 50 kilometres in 18 hours or 100 kilometres in 36 hours along stunning trails in Whakatane to raise vital funds for Oxfam's poverty-fighting projects in the Pacific.

The distance and commitment may seem daunting for some, but anyone from anywhere with the right attitude qualifies for Oxfam Trailwalker.

"There's such a cool buzz at Trailwalker," say last year's participants Josh Page and Scott Kington.

"It's this real comrade kind of group of people that are all there for the same cause rather than a competition.

"The great thing about it is that it's both a personal thing, it's a motivation for you to get fit, but also it's a good cause at the same time and it's actually quite an enjoyable, fun event."

Bridget Jackicevich belongs to a team called Ich's and Bitches, made up of two couples with names ending with 'ich'.

"Oxfam is specifically involved in tangible projects in the Pacific, so it's our neighbourhood. When you talk about providing water to villages in our neighbourhood, and that you can tangibly see these projects that people are actually working on, it's just a great thing to support."

Beaches, farms, bush tracks, a jet boat ride, laughter, blisters, a great cause, and a whole lot of walking – you don't wanna miss this! Check out

the epic journey here: https://youtu.be/sAptRzw7ERs.

So, join us on 10 – 11 March for New Zealand's 13th annual Oxfam Trailwalker – a global event that has raised $10 million in New Zealand alone.

As a special offer to Water New Zealand magazine subscribers, the promocode WATEROTW18 will give you a $50 discount on your team confirmation fees.

For more information and to register: oxfamtrailwalker.org.nz/enter.

New publication highlights importance of good household wastewater management

The humble septic tank has been part of our small town and rural landscape for many years and most New Zealanders at least at some point have lived in households that rely on this 'do it yourself' method of removing waste.

It's estimated that over 600,000 people still rely on either their decades-old waste tank or what's becoming a much more sophisticated version of the septic tank – the more finely tuned On-site Wastewater Management System (OWMS) – to remove household waste.

Being underground, it's not surprising many people adopt an out-of-sight-out-of-mind approach to their OWMS. Water New Zealand says this attitude has the potential to be dangerous for both householders and the wider community.

That's why it has just published an updated brochure and booklet aimed at giving accurate information to OWMS owners about maintenance and how to ensure they're performing properly.

Water New Zealand technical manager Noel Roberts say an OWMS is definitely not a plug-in-and-forget device.

He says poorly maintained and managed ones can not only become costly to fix but can be a major health risk and seriously contaminate nearby waterways.

Many people don't realise that contamination from poorly operating private systems can lead to events like Havelock North where more than 5000 people became ill after drinking contaminated water.

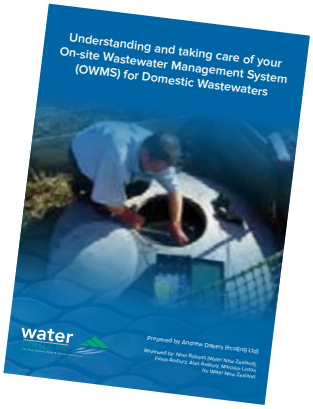
In this country we may not yet have had a major outbreak of illness from an OMWS, but an event in Sweden shows the extent of the risk that a poorly maintained unit can pose.

In 2010, what was regarded as one of the cleanest lakes in Europe, Lake Storsjon, became contaminated by a sewage leakage, probably from just one household, into a creek which flowed into the lake up-current from the drinking waterworks intake. The result was that 27,000 people became infected with Cryptosporidium.

In another case of cross contamination from an OWMS, in the United States up to 5000 people who attended a major Washington county fair developed a gastro illness because an OWMS was located too close to a ground water bore.

Noel says it's important not to underestimate the risk of poorly performing OWMS units.

"It is the responsibility of the homeowner to ensure that their OWMS is working correctly and that it is not a risk to neighbours, animals and the local environment."



He says it's important to look for the warning signs.

These include foul odours, overflowing and ponding, soggy soil around the treatment tank. Other signals include slow running drains, gurgling noises when the bath is emptied and high power consumption.

Property owners should ensure that all maintenance is carried out by a certified contractor and keep records of maintenance carried out for the previous 10 years.

Water New Zealand's new publication outlining key aspects of these systems and how to maintain them is now available on the website:
www.waternz.org.nz/OWMScompleteguide

Robust and fair water policy needed in wake of water tax dumping

Water New Zealand Chief Executive John Pfahlert says he's not surprised that the new government has dropped its controversial water tax on irrigators, but has left a royalty on bottled water for export.

However, he says it's unfortunate that the government has made these policy changes in the absence of a wider, and more important, discussion about water pricing.

"This is clearly a direct response to the public's anger over perceptions that water bottlers are profiting from free access to a public resource.

"But picking off one group of water users, while not addressing the bigger question of water pricing and value, will not result in good policy."

He says we need a sustainable long-term approach to water management.

Prior to the election, Water New Zealand surveyed almost 5000 New Zealanders and the results showed a majority in favour of water pricing.

"While nine out of 10 New Zealanders believed that water bottlers making a profit from taking pristine water should pay a royalty, 77 percent believed that there should be a cost when taking water for agriculture and horticulture despite the outcry from critics during the election campaign.

"It's interesting that more than half – 59 percent – believed that all users should pay for water.

"It's clear that water issues will be a big challenge for the government and I would welcome the opportunity for the water sector to be involved in discussions.

"New Zealanders are increasingly concerned about water quality and the effects of climate change on water and our infrastructure.

"We need a long-term sustainable approach to water."

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Let's Solve Water

Stormwater Kiwis engaging with the world

By Michael Hannah, Stormwater Special Interest Group Chair

Green infrastructure is becoming increasingly vital in the design and implementation of effective stormwater systems and is well on its way to being a major global investment.

Here in New Zealand, we are part of this new and emerging field. So it was very heartening that this year a number of our stormwater group members travelled to different parts of the world to present their work and learn more about the global effort to develop better understanding of the role green infrastructure plays in the management of stormwater systems.

Committee members at the ICED conference – Troy Brockbank, Mike Hannah, and Frances Charters.

CASQA

Allan Leahy of Santec, and Water New Zealand Stormwater Professional of the Year, was one of more than 1000 attendees at the California Stormwater Quality Association's (CASQA) conference in Sacramento. California has the largest state economy in the United States and there is a high level of public awareness and support for stormwater management.

In the US, regulation plays a much higher role in driving better stormwater management. However, even more so than in New Zealand, limited resources means the application and enforcement is often limited though the ability of private citizens to take legal action often sees quasi-enforcement of the legislation,

Green infrastructure (GI) plays a big part in California stormwater efforts and was a big focus of the conference. GI is not only used to treat and reduce stormwater volumes, as in New Zealand, but it is also used to directly recharge the groundwater aquifer, which is under huge pressure from the rapidly growing population.

A large effort has been made to implement GI in the urban environment and to address difficult issues such as safety and litter management, which is now mandated. Allan was particularly impressed with the San Francisco Public Utilities Corporation Green Infrastructure Typical Details which are available on the website bit.ly/SFWater_ GreenInfrastructure.

WEFTEC

Also in the US in September was the Water and Environment Federation's conference, WEFTEC (see story on page 12).

Suman Khareedi, Opus Group Manager Stormwater & Water Sensitive Design, presented the paper *Effective Stormwater Runoff Treatment With Lightweight Media.* It was a great achievement to have a paper accepted at this conference given the high calibre of competition from all over the world. Suman's paper, on suspended rain gardens was presented in a Stormwater innovation stream called *A Long Time Ago in a Galaxy Far, Far Away: Stormwater Design Out of This World.*

Suman was impressed with the way the conference addressed future issues and encouraged innovation, especially in areas of water reuse, decentralised systems and GI for wider environmental benefit.

We could adopt some at our own Stormwater Conference here, such as: A walking tour (focusing on a topic) taking attendees through exhibits that summarise advancements in a particular field – this could be done in conjunction with site tours; a separate section to exhibit water start-ups and new technologies; and hackathon style knowledge development forums.

ICUD

In Europe the 14th International Conference on Urban Drainage (ICUD) was held in September in Prague, Czech Republic.

ICUD is held only once every three years. It presents the latest advances and innovative approaches in fundamental and applied research on urban drainage. With 700 delegates from 44 countries it is like a 'state of play' discussion for global stormwater research. This year there was a small but engaged Kiwi contingency. Their papers are as follows:

- Boyle, K. and Trowsdale, S. (2017) The water sensitive city: disrupting the politics

of experimentation. 14th International Conference on Urban Drainage,

- Charters, F., Cochrane, T.A. and O'Sullivan, A. (2017) Temporal variations in surface-specific Stormwater pollutant loads.
- Cheah, J., Brockbank, T., Simcock, R. and Hannah, M. (2017) New Zealand plant growth trials in rapid biofiltration media.
- Fassman-Beck, E., Afoa, E. and Simcock, R. (2017) Assessing the suitability of models for estimating evapotranspiration for use in an extensive living roof water balance.
- Poudyal, S., Cochrane, T, Bello-Mendoza, R. and Charters, F. (2017) The effect of carpark traffic on pollutants yield from first flush Stormwater runoff.
- Semadeni-Davies, A., King, B., Moores, J. and Gadd, J. (2017) Working together: the Te Awaroa-o-Porirua collaborative modelling project.

Frances Charters of the University of Canterbury, who attended the conference, noted that in Europe much of the research is theoretical whereas in New Zealand we are focused on applied research that links to design and industry decision. In her paper, *Temporal Variations in Surface-specific Stormwater Pollutant Loads*, the audience was surprised by the amount of data that had been gathered to inform her modelling, and was pleased to hear that it had been gathered through projects done with local government (as some of the European researchers commented that they struggled to connect with local government to undertake applied research projects).

Frances also noted that we need to be making the most of the longer-term performance data that is now becoming available for our GI, "as we are coming up to 10, 15, 20 years post-construction for some systems. We need to be making the most of this opportunity to gather performance information and inform future design."

John Cheah, Troy Brockbank and Mike Hannah's Stormwater360 paper on plant trials for rapid biofiltration was one of the 10 papers from the conference to be selected to be published in the *Water Science and Technology Journal*.

Annette Semadeni-Davies from NIWA sits on the Joint Committee on Urban Drainage (JCUD), the organisers of the conference. The JCUD strives to promote effective interaction between experts on the hydraulic and water quality aspects in the field of urban drainage. The JCUD has a number of working groups reporting to it. These include groups for modelling, real time control, water sensitive urban design (WSUD) and urban streams.

The JCUD publishes an annual newsletter that reports on the activities of the committee and working groups as well as announcing conferences on urban drainage and news from around the world. If you would like a copy of the 2017 newsletter or would like to contribute to the 2018 newsletter, please contact Annette at annette.davies@niwa.co.nz.

For more information on JCUD conferences including the next one in 2020 in Melbourne go to the JCUD website: www.jcud.org.

One central theme from all these conferences is that the global stormwater industry is investing in developing and improving our understanding and implementation in green infrastructure. In New Zealand we need to continue to learn from overseas experience.

Key events in 2018 – save these dates

MODELLING GROUP SYMPOSIUM, Christchurch, 14–15 March 2018

The Water New Zealand Modelling Group is pleased to advise the 2018 Modelling Group Symposium will be held in Christchurch next year.

Modelling and data driven decision making is here now and the 2018 symposium aims to bring together those involved.

This symposium is aimed at all hydraulic and hydrological modellers, engineers, environmental practitioners, and stakeholders involved in the collection, management and effective use of information in the fields of stormwater, wastewater and water supply modelling.

We are now calling for abstracts. Please submit a 300-500 word abstract by 15 December for review. You will then be asked to prepare a presentation for the day. A written paper will not be required. For more information go to the Water New Zealand website or contact Vicki McEnaney at Water New Zealand email: vicki.mcenaney@waternz.org.nz.

Modelling Group
WATER NEW ZEALAND

STORMWATER CONFERENCE, Copthorne, Queenstown, 23–25 May 2018

Don't forget this date – come to one of the key events in the stormwater calendar and enjoy the vibe of beautiful Queenstown.

Go to the Water New Zealand website for more details and further updates as they come to hand.

INTERNATIONAL EVENTS

Water Loss 2018 Conference
Cape Town, South Africa, 7–9 May 2018
Registration and Abstract Submission Now Open

The International Water Association Water Loss Specialist Group, together with City of Cape Town, will host the biennial Water Loss Conference and Exhibition from 7 to 9 May 2018 at the Century City Conference Centre and Hotel in Cape Town, South Africa.

The Water Loss Conference and Exhibition 2018 will be one of the world's largest water loss conferences and is expected to attract over 500 participants from more than 50 countries.

For more information go to www.waterloss2018.com

WEFTEC 2017 – from a Kiwi viewpoint

By Garry Macdonald

The New Zealand water sector was well represented at this year's Water Environment Federation's WEFTEC conference in Chicago held between 30 September and 4 October.

Included in the Kiwi-contingent were Water New Zealand Chief Executive, John Pfahlert, our WEF delegate for NZ, a small team from Watercare Services, including the new WE&RF trustee, Shayne Cunis, who attended his first WE&RF Board of Trustees meeting and myself as WEF Program Steering Committee member and WED delegate for New Zealand.

We joined water professionals from around the world to learn about the latest developments, technologies and services for the water sector.

The WEFTEC conferences are massive undertakings on a world scale and this year's event was one of the largest and best attended in the conference's 90-year history.

There were 22,860 registrants and 1011 exhibitors using 305,600 net square feet (that's almost three hectares!) of space.

The core elements of WEFTEC are the technical programme – with two days of workshops in the weekend before three full days of technical paper presentations in up to 20 parallel streams – and the exposition, which is a foot-numbing and leg-weary experience! Wrapped around this core are a wide range of other events, meetings and special functions which capitalise on so many water professionals being in the same place at the same time.

This year's highlights included the installation of an outdoor classroom at Manierre Elementary School during the 10th annual Community Service Project led by the WEF Young Professionals Committee, exciting discussions and knowledge exchange during the Women in Water session and many corporate networking events, the fifth annual Innovation Showcase, the Operator Ingenuity Contest, and the recognition of 25 new Utility of the Future Today recipients for exceptional performance in sustainable water management and operations.

WEFTEC also marked the handing over of the presidential gavel from Rick Warner to Jenny Hartfelder, induction of three new board members and two new officers plus the recognition of 11 new WEF fellows, as well as many WEF industry awards of excellence and service.

"Commemorating 90 years of accomplishments brought a unique energy to WEFTEC 2017," WEF executive director Eileen O'Neill said. "It was especially touching to return to Chicago, the place where it all began, not only to celebrate the tradition, but also the people, ideas and innovations that will continue to move the sector forward."

In addition to this being the 90th WEFTEC, this year also marked the:

- 30th Operations Challenge competition;
- 20th anniversary of the Stockholm Junior Water Prize;
- 15th anniversary of the Student Design Competition;
- 10th annual WEF community service project;
- 5th annual Water Palooza; and
- 5th anniversary of LIFT.

The #mywaterlegacy social media campaign, launched during WEFTEC 2016, entered its second phase, focusing on mentorship and workforce development. These themes were captured in a new video that made its debut during the well-attended opening session. "My water legacy, mentorship, innovation, and workforce development – these are far more than a programme theme or lofty buzz words," 2016-17 WEF president Rick Warner said during the session. "They represent a conscious decision to pursue a life of service and to find pathways to success."

The opening general session also featured a new format, WEFTalks, which included testimonials from four water leaders about their journey into the sector.

Planning for next year's event in New Orleans is already underway. The Call for Abstracts for WEFTEC 2018 is open at www.weftec.org/abstracts/.

Submissions will be accepted through to December 3, 2017.

If any Water New Zealand member is thinking about submitting an abstract or attending the 2018 WEFTEC, feel free to contact John Pfahlert at Water New Zealand or Garry Macdonald at Beca for help and advice.

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Water New Zealand Annual Conference & Expo 2017, 20-22 September, Claudelands, Hamilton.

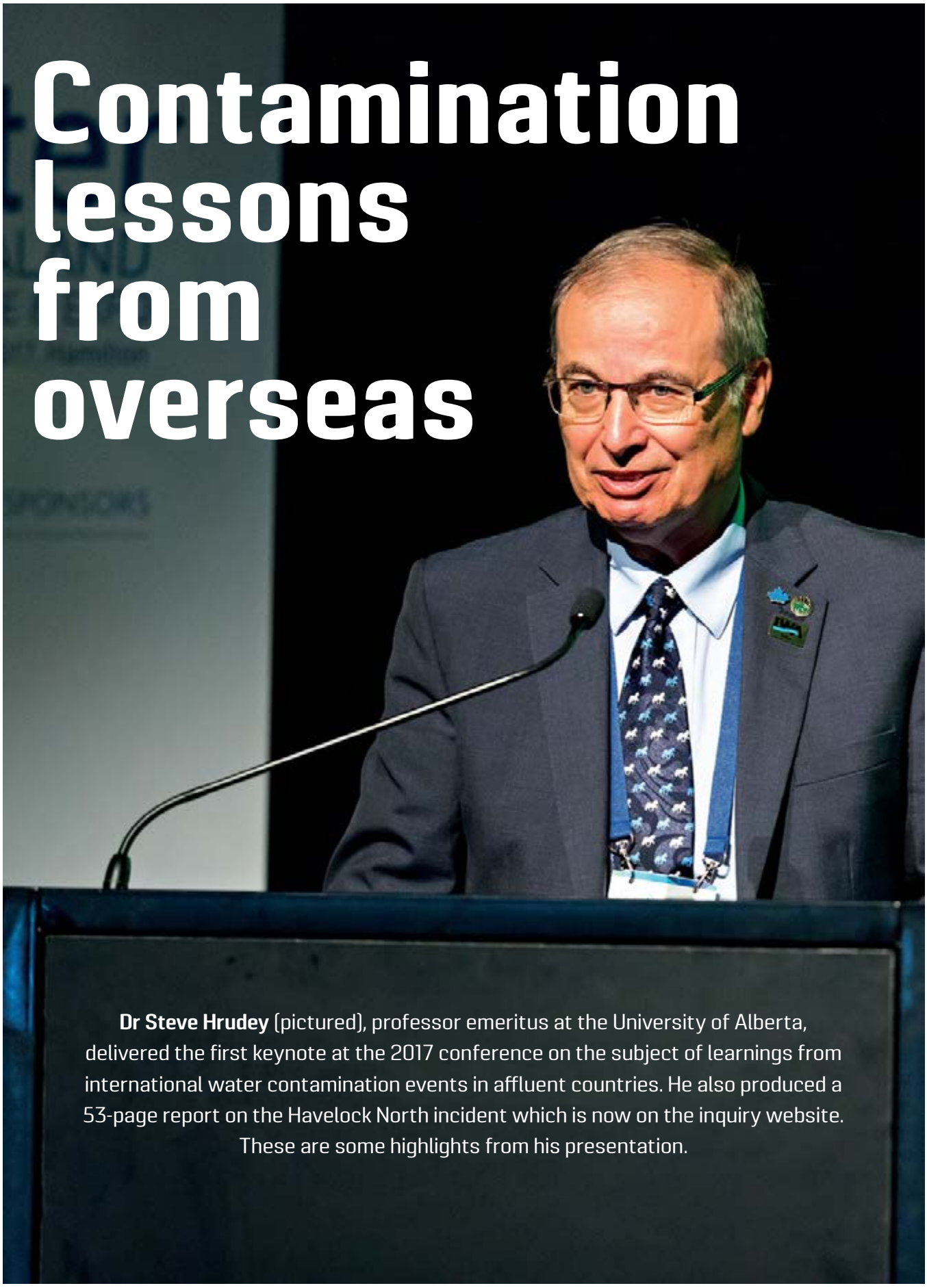
1. Welcoming powhiri.
2. Daniel Lambert presenting angles of the NZ Water Consumer Survey Report.
3. Auction winner Paul Gayford (Horowhenua District Council) with Water New Zealand Chief Executive, John Pfahlert.
4. Te Radar in action.
5. Dr Laurie McNeill (Utah State University).
6. Former All Black Stephen Donald.
7. Neil Summons (Business Development), Assa Abloy.
8. Neal Bowie receiving Gold Shovel award from Jim Bradley.
9. Key sponsor Veolia's stand.


3


6


VEOLIA
9

Contamination lessons from overseas



Dr Steve Hrudey (pictured), professor emeritus at the University of Alberta, delivered the first keynote at the 2017 conference on the subject of learnings from international water contamination events in affluent countries. He also produced a 53-page report on the Havelock North incident which is now on the inquiry website. These are some highlights from his presentation.

Of 38 water contamination outbreaks around the world, nine included fatal outbreaks causing 77 deaths and a total of 460,000 cases of illness, so it's not a trivial subject, he says.

"In order to get something constructive out of it, the message that we learn is that effective water safety plans are essential to provide prevention of these kinds of events."

Steve and his wife Elizabeth Hrudey published their first book with the International Water Association in 2004.

It summarises 73 case studies and outbreaks around the world and then, in 2014, they published a book for frontline water personnel (called *Ensuring Safe Drinking Water: Learning from Frontline Experience with Contamination*) that takes a different approach with its case studies.

"The case studies are written as stories to help frontline personnel identify with what's happened elsewhere and learn from it.

"Essentially our guiding principle is don't learn the hard way. Most frontline personnel are not likely to experience a major disaster in the workplace. That's the good news. But because they don't have that experience they will be unprepared if something does start to go wrong."

The best start, he says, is to have an effective drinking water safety plan that reflects that you, as someone running the water utility, truly know your own system.

"So the case study approach allows you to learn from these things that have happened in other places and the idea is that case studies can make something more real; can be adapted to local realities. The bottom line is I don't believe that operators would ever want to harm their neighbours but if they don't understand the consequences of failing to do the job right, they can. So the idea is personal. If they understand the implications of failure, they will want to do a better job, and will be curious and seek out trouble."

Case studies

The first case study Steve explained to delegates was from Scotland in a small village called Freuchie, which had a water contamination outbreak in 1995. The village is only 50 miles from Edinburgh and has a population of 1100.

"They were supplied by a regional feed water system that used geography to provide the pressure in the system.

"Basically the water was stored at the top of a hill and fed by gravity to the community. This all played out on a Friday which seems to happen sometimes.

"They got a phone call at 9:55 in the morning, somebody complaining about discoloured water and mentioning not feeling well. The first call was followed by three more complaints.

"Any time a running water utility gets a cluster of complaints alarm bells need to be going off. Ultimately, over the course of the day the problem was traced to a cross connection at the vegetable processing plant.

"Prior to 1992 the plant used to draw all water from the

creek and wash vegetables with raw creek water and then use the public mains water for a final wash.

"At that time the sewage treatment plant was located upstream of this location, with its effluent pipe discharging downstream.

"Between 1992 and 1995, the vegetable plant had decided they were paying too much in town water so they drilled a well and went and used the well water for both the first wash and their second wash and they cut off their connections with the main supply.

"Then this is where the weird stuff happens. When they put in the new well they relocated the stream, so that now, the sewage treatment effluent discharged upstream of the washwater intake.

"Their well failed on them in March 1995 so they reconnected to the raw water drawing downstream from the sewage treatment plant with the intent that it would be used for the first wash and they reconnected to the mains water supply for the second wash.

"The problem was they still had this cross connection between the two systems and the one that was contaminated by sewage was at higher pressure. Bottom line is that a major outbreak happened, with 765 people out of 1100 ill.

"This got written up because it was the toxigenic *E. coli* O157 H7 and the first documented case of drinking water spreading this pathogen. This could have had very serious consequences and it did in Walkerton which I'll talk about shortly. The fact that so many people were sick but no one died may have been partially achieved by the fact that the system was chlorinated.

"Next case I want to talk about, which has a lot of similarities with what happened in Havelock North, was in Alamosa, Colorado – a beautiful spot in the shadow of the mountains, a few hours from Denver which is the headquarters of the Water Research Foundation and American Water Works Association.

"This is a town of about 9000 served by seven deep artesian wells, from 150 to 275 metres deep with their producing zones down to 550 metres. Compare that with Havelock North which was 11 metres.

"This was very high-quality groundwater and they had only had detections over the previous decade of total coliform a couple of times in 2002, and one total coliform result in 2006. They were all negative on resampling and total coliforms may not be a great indicator for faecal contamination anyway.

"They were operating under a state granted waiver since 1974 allowing them to distribute that high quality water with no chlorination.

"From March to April 2008 they experienced an outbreak of salmonellosis. Source water was not the cause, coliform was not detected, this was contamination that occurred in the storage and distribution system.

"The water reservoir was constructed in 1979 and last inspected in 1997 – so more than 10 years earlier. The roof and exterior wall were in poor condition, the roof was cracking and it hadn't been drained or cleaned since 1984 – so poor maintenance. So even though they had high quality groundwater coming in, the storage site was grossly inadequate and the best explanation for what happened was that bird waste managed to get into the reservoir and, whether the birds physically got in or whether it was just their faeces that washed off the roof, it was not secure for that purpose.

"They also identified a number of cross connections including three that were funeral homes and one was a meat packing plant.

"Almost every investigation I've seen into outbreaks will uncover cross connections that could be a cause of trouble. But none of them was judged as a cause of this, the most plausible explanation was salmonella from the leakage into the roof and sides of the tank.

"Unfortunately in their attempts to characterise the salmonella in the tank, the samples of salmonella were mishandled and they weren't able to analyse it. Consequently, it was 434 reported cases, 124 confirmed lab confirmed cases of salmonellosis, 20 hospitalisations and one death. Telephone surveys said the total number of cases was 1300, of those with reported diarrhoea illness 29 percent had long term health consequences.

The insurer for the city had to pay $360,000 to residents including [the family of] the 54-year-old male who died, but the city never accepted that they had any role with what went wrong. Cost estimates by residents and local businesses were $1.5 million and the total costs by government and public agencies were $2.5 million."

Pathogen control

"I'll wrap up by saying we can't pretend that we've solved all the problems with ensuring safe drinking water. We clearly have not. Outbreaks like Havelock North wouldn't be happening if we'd solved them.

"The catch, and what's frustrating, is we do know how to prevent them.

"The greatest risks to consumers are pathogenic microorganisms. You need to have this under control, if you can't get your water system under control from pathogens you can't claim it's safe because it's not.

"Drinking water systems need and must have continuous robust multiple barriers. And the operative word there is multiple, and multiple means more than one and there's a reason for that.

"You need to recognise any sudden change in water quality; that these disasters are always preceded by change. And not every change leads to disaster, but if you're not paying attention to the changes you can't detect the disaster.

"System operators need to be able to respond quickly and effectively to adverse monitoring signals – that means you need to understand what you're monitoring, and why you're monitoring, because just writing down numbers alone, is a waste of time.

"System operators, and this includes everybody in the system not just the people turning the valves, have to have a personal sense of responsibility and dedication to providing consumers with safe water.

"As pointed out with the Freuchie example, you don't ever want to ignore customer complaints because a lot of the cases that we have come across have been detected by customers first.

"And you need a sensible risk management approach and you need to be aware that a lot of things are described as risk management which are not truly risk management.

"Good risk management requires a preventive approach."

As to costs, Dr Hrudey observed: "Bottom line, you can have cheap water or you can have safe water but you cannot have cheap, safe water."

Dr Hrudey made reference to guidelines written by a group of international drinking water experts, including New Zealand's Michael Taylor, that he says are as relevant today as they were when developed in 2001.

These are incorporated in the Australian Drinking Water Guidelines, originally in the 2004 edition and still in the current edition: www.nhmrc.gov.au/guidelines-publications/eh52, Chapter 1, page 1. **WNZ**

- The Hrudeys 2014 AWWA book, *Ensuring Safe Drinking Water: Learning from Frontline Experience with Contamination*, is also available. Download a PDF of a free excerpt from the book – www.awwa.org/Portals/0/files/publications/documents/EnsuringSafeDrinkingWaterExcerpt.pdf.

Conference operations challenge

By Brent Manning, Water New Zealand Past President.

This year saw the return of an event that hasn't been run for many years – the Operations Challenge was a new addition to the Water New Zealand Conference & Expo 2017, and was designed to test pre-entered teams of industry professionals in identified relevant activities.

The aims were to promote the water industry in a positive light; promote and encourage teamwork and collaboration between technical professions; and garner further interest and support for future events.

Deliberately billed as an 'Operations' Challenge (rather than solely Operators) the title reflected a desire to showcase teamwork and collaboration as typically utilised in the water sector.

The Challenge itself involved three separate activities conducted over the first day of the Conference. Each activity was judged and scored, with a maximum available to the teams of 50 points per activity, to give a total possible out of 150. Five teams of three fronted up after the Conference Opening & Keynote Address.

We started with a water knowledge quiz of 25 questions.

Then followed a pipe assembly, with sampler installation, requiring a mix of practical and theory. Many thanks to Gary Soper, trade waste officer, with gear kindly made available by his employer New Plymouth District Council.

The final activity of the day was a health and safety challenge – requiring a confined space entry. All of the equipment and judging for this stand was provided by health and safety training company Safety 'n Action – its stand and staff were thoroughly professional and knowledgeable – not surprising given this is their bread and butter.

And the inaugural ultimate winner from the five competing teams was… (Virtual drum roll please) Team "Aces of Assets" from Hamilton City Council, pictured below with a winning score of 132/150.

Hard luck to City Care who were runner-up by one point.

All feedback received regarding the Challenge was very positive – I hope the success of this year means the Challenge will become an annual fixture at the Conference for teams to aspire to win.

My sincere thanks go to all of those who supported and assisted in the preparation of the Operations Challenge (including Water New Zealand, Avenues Event Management, Safety 'n Action, New Plymouth District Council and Veolia Water NZ) but most of all thanks to all of the participants.

Let's aim for 15 teams next year!

Safety 'n Action stand under way with Western Bay Of Plenty District Council team "The A Team" going through their drills.

Richard (Safety 'n Action), Evan Vaughters, Parvati Patel (both of Hamilton City Council), Brent Manning (event co-ordinator), Mark Marr (Hamilton City Council) and representing key activity sponsor Veolia, Keith Martin.

Photograph supplied courtesy of Stephen Barker/Barker Photography.

Conference premium sponsors

Left to right: Peter Harper, City Care; Raymond Lo, Broad Spectrum; Hamish Jones, Hynds; and Suzanne Naylor, Watercare.

Winning Expo Stands

Multi Stand winner – Water Outlook
Runner up – Assa Abloy

Single Stand winner – Stormwater 360
Runner up – Steelpipe

Stormwater 360 general manager, Steve McIntosh.

The way forward after Havelock North

National and international experts gathered in Hamilton at the Water New Zealand Drinking Water Workshop to share their thoughts and ideas on how we can guarantee a safe and healthy drinking water supply in the aftermath of Havelock North. **BY MARY SEARLE BELL.**

There was a sobering and unanimous message from the 12 international and New Zealand experts on water safety who attended the one-day workshop at the 2017 Water New Zealand Conference in Hamilton.

We face a real risk of another major contamination crisis unless radical improvements are made in the way we manage drinking water.

Dr Marion Savill, the New Zealand representative of the International Water Association (IWA), moderated the day-long gathering, along with Dr Robert Bos, senior advisor with IWA, who is based in The Hague.

Both Savill and Bos have significant experience and expertise on waterborne pathogens and public health, and have strong views on what went wrong at Havelock North, and how to mitigate the risk, as did the speakers throughout the day.

Interestingly, their voices were strongly united – the outbreak can and should have been avoided and, without action, we risk a similar disaster somewhere else in the country.

What went wrong?

The town of Havelock North gets its drinking water from an aquifer under the Heretaunga Plains. As this was considered a secure source, the water wasn't chlorinated. However, when heavy rain inundated paddocks adjacent to the Brookfield Road bores, sheep faeces contaminated with campylobacter seeped into the aquifer.

As a result, an estimated 5500 people came down with campylobacteriosis (55 percent of households affected), with some 45 people hospitalised because of the illness. Three deaths have been associated with the outbreak and a number of people continue to suffer ongoing health complications as a result, including increased frailty in the elderly, Guillian-Barré Syndrome, and inflammatory bowel disease.

According to Dr Caroline McElnay, New Zealand director of public health, both the Hastings District Council and the Hawkes Bay Regional Council failed to assess the risks of contamination, and the non-treatment of the water hinged on that assessment.

She also criticised drinking water assessors, saying they were too hands off. Between them, there was a lack of communication.

Regulation failure

Tim Sharp was employed by the Ministry for the Environment at the time of the Havelock North outbreak and represented the ministry at the workshop. He said that the National Environmental Standards for Sources of Human Drinking Water (NES) were brought in to give drinking water suppliers control over the source water they were required to treat. Their primary objective is to reduce the risk of contamination, and therefore source protection is paramount.

Among the issues raised at the Havelock North Inquiry was the failure to embrace NES.

The NES provide the first stage of a multiple barrier approach

to drinking water management by setting requirements for protecting sources of drinking water from contamination.

Sharp said regional councils have specific drinking water catchment obligations under the NES – namely, to ensure that effects of activities on drinking water sources are considered in decisions on resource consents and regional plans – but many are not aware of this.

He said the rule of thumb for resource consents and regional plans is that they must not deteriorate the receiving water quality.

"If an adverse event occurs that could contaminate a drinking water supply, whether that's a chemical spill or heavy rainfall, notification is required as a condition of resource consent," he said.

The difficulty is assessing activities that may have an impact on supply, and that "upstream can be a very long way".

Another problem is that a source protection zone wouldn't have made an impact in the Havelock North case, as sheep grazing is a permitted activity therefore bypassing the resource consent process. Making it a non-permitted activity would have a big impact across the country.

The problem of poo

In his presentation, Professor David Kay of Aberystwyth University in Wales said the microbial indicators were screaming that there was a risk in Havelock North.

He said the Clean Water Act in the USA set out the framework for catchment management – the US EPA publishes data of impaired water every week. Its main concern is pathogens (*E. coli* is an indicator of risk they may be present), and the main source of that is agriculture.

"Sheep have 10 times more *E. coli* than humans, and human waste is treated before discharge," he said.

"We have huge animal-derived microbial loadings – how do we make sure the faecal matter doesn't get into the water supply? How do we minimise the risk?"

Compounding the problem are storm events. These create episodic pollution, which is difficult to manage.

Kay said that an 18-month-long study of water quality monitoring in the UK showed rainfall was the best predictor of water quality. The Drinking Water Inspectorate project looked at seven drinking water supplies, supplying populations similar in size to Havelock North. Three of these had high animal-derived microbial loadings, although they were treated, and stream loadings during episodic events were incredibly high.

"Small supplies have high microbial loadings in every empirical study to date," he said.

"The cause is disproportionate to the burden of disease. Treatment systems need to be more efficacious."

Water treatment for health

Dr Steve Hrudey, professor emeritus at the University of Alberta, Canada, spoke of relevant international experience summarising 38 outbreaks in 13 affluent countries.

He and his wife Elizabeth Hrudey wrote a book on the lessons from recent outbreaks in affluent nations, including the Walkerton *E. coli* outbreak where seven people died and 2300 became ill. They also wrote a subsequent book specifically for frontline personnel.

He said that six guiding principles first developed in 2001 by the World Health Organisation microbial pathogens expert group and the National Health and Medical Research Council of Australia working group on revising the Australian Drinking Water Guidelines are "as relevant now as they were when they were first developed".

The first, and by far the most important, is: "The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised."

Unfortunately, Hrudey said, an initial review of evidence from Part 1 of the Havelock North Inquiry clearly indicated that those responsible for the safety of the drinking water supply had not embraced these principles.

"A multiple barrier approach is needed," he told delegates. Hrudey also touched on the resistance to chlorination in some communities saying there is no evidence to support the view that chlorination in the doses prescribed for drinking water would cause illness.

However, the evidence for pathogen illness via drinking water is overwhelming – from as far back as the 1850s – and pervasive.

He said the Hastings District Council had a clear and demonstrated aversion to chlorination – it clearly didn't understand the risks of not treating the water, describing them as minor. But the risks of chemicals versus that of pathogens are "not even in the same ballpark".

The question was raised of how we educate the population that chlorination is not a baddie. Hrudey said we can't blame the public, as they're inundated with misinformation. The industry experts need to speak up and ensure people are aware that the risk from micro pathogens is much greater than any risk from chemicals.

Multiple barriers a requisite

The reason for multiple barriers stems from the fact that, in many cases, contamination occurs in the reticulation system, not the source. Therefore, relying on just one source of prevention is more vulnerable to failure.

As Hrudey said, "Highly contaminated sources need many barriers, but secure sources need more than one."

Dr Jamie Bartram, director of the Water Institute at the

University of North Carolina, said that all drinking water sources that are not proven to be secure to expert and accredited government assessors must be disinfected to ensure the safety of the public from pollution of the water.

In the panel session at the end of the day, the question was asked, "Is chlorination part of a set of barriers, or a cover up if your water safety has failed?"

To which, Bartram replied, "Chlorine can be misused", citing an example where a representative of a water supplier from the USA said that chlorine had been added to the water to fix a problem. Bartram said to him that the chlorine only masked the problem, it didn't solve it.

The point was also made that water monitoring is not a barrier. Barriers remove contaminants; monitoring validates those barriers.

As Jim Graham, principal scientist at Opus, said in his presentation, *E. coli* monitoring is not a risk management procedure in and of itself, it is an indicator – a verification tool – of whether your risk management is working.

Getting politics out of the water

It is clear there are simply not enough resources being put into establishing safe drinking water supplies. Currently there are not enough assessors, and these people require better training and more funding to ensure they do their job successfully.

Political interference was also raised as a significant obstacle to establishing safe drinking water supplies. Dr Alistair Humphrey, epidemiologist medical officer of health, Canterbury, said politics are influencing the way we regulate – but water regulation must be independent.

"Governance and operations should stay separate," he insisted.

He said the number of political appointments to governance positions has increased, and regulators have lost their independence as ministers have gotten involved in operational issues.

Jim Graham agreed, and said Stage 2 of the Havelock North investigation revealed that the issues that lead to an outbreak go way wider than the water supplier.

"They are issues that are systemic to the whole industry," he said.

The inquiry only makes recommendations, however, Graham questioned how many would be taken up and put into action by the government.

The recommendations include changes to drinking water standards. Changes that are "well overdue", said Graham.

"We need change in the industry. We need leadership," he rallied.

"In the secure groundwater category, the onus for the security of supply should lie with the supplier. These suppliers must be able to demonstrate the safety of their

water source, particularly if they chose not to chlorinate."

These comments are strongly backed by Water New Zealand in its submission to Stage 2 of the inquiry.

Havelock North has highlighted the need for a number of changes including the way water sampling is undertaken along with ensuring adequate training and competency.

Graham said drinking water assessors need empowering. They should be an independent body, able to encourage and enforce compliance. To ensure they can function properly, assessors must be well trained and have the aptitude to do the job well. They also need to be well resourced. Their work should be guided by protocols that provide processes to follow.

Working in parallel with the drinking water assessors, the regulatory body needs enforcement officers that have the authority to prosecute individuals and water suppliers. This will help achieve compliance with the regulations and, thus, the overall goal of safe drinking water for everyone.

The Act itself needs to be updated. Currently it requires "all practicable steps to comply with drinking water standards". This is to be removed – you either comply or you don't.

Halting the decline

The simple facts of increased population, farming intensification, ageing infrastructure, and the under resourcing and under prioritisation of drinking water are all contributing to a sharp decline in the quality of drinking water supplies.

On top of this, increased adverse weather as a result of climate change is likely to exacerbate transmission of pathogens between animals, from animals to humans, as well as humans to humans.

It is obvious that widespread industry reform is called for.

Currently, there are 67 drinking water suppliers throughout the country. Too many, according to Graham, who said the majority of small suppliers don't have the capacity and competence to operate at the level they should.

Ideally, that handful of suppliers would have sufficient resources to ensure the professional delivery of safe water.

He called for change to the regulatory structure – a single drinking water regulator – immune from political interference, "similar to the Civil Aviation Authority", he said.

The very real fear is that without radical improvement in the management of our drinking water supplies, we will relive the Havelock North disaster, sooner or later. **WNZ**

Water New Zealand Conference 2017 Award Winners

Honorary Life Membership
Graeme Mills, featured on page 42.

Hynds Paper of the Year
Operational Use of Rain Radar in Auckland – Luke Sutherland-Stacey, John Nicol, and Geoff Austin, from Weather Radar NZ; Tom Joseph from Mott MacDonald; and Ken Williams and Nick Brown from Auckland Council. Paper precis on page 28.

CH2M Beca Young Water Professional of the Year
Emily Afoa from Morphum, featured on page 32.

ProjectMax Young Author Prize & Hynds Presentation of the Year
Small-scale wastewater treatment technologies for challenging environments – Katrina Bukauskas, Andrew Koolhof, P Kim and M King

Ronald Hicks Memorial Award
Upgrading Waste Stabilisation Ponds: Reviewing the Options – Hugh Ratsey, The Wastewater Specialists

Veolia Health and Safety Innovation Award
Wellington Water for its Safety in Design process – Alex van Paassen

Water New Zealand Project Award
Hunua 4 Watermain Project – Watercare

Opus Trainee of the Year
Daemn Hunter, Watercare Services

Young Water Professionals Conference Attendance Award
Charles Clague

Best Single Stand
Stormwater 360, pictured page 21.

Best Multi Stand
ASSA Abloy, pictured page 21.

Water New Zealand Best Poster Award
How Can Wireline Geophysics Assist The Water Industry – Oliver Gibson, RDCL

Operations Challenge
Aces of Assets, Hamilton City Council

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Operational use of rain radar

This is a précis of the Paper of the Year that was awarded at the 2017 Conference as the best technical paper submitted. The paper was written by Luke Sutherland-Stacey, Geoff Austin, and John Nicol, from Weather Radar; Tom Joseph from Mott MacDonald; and Ken Williams and Nick Brown from the Auckland Council Healthy Waters Department. The full paper can be read on the Water New Zealand's website here: www.waternz.org.nz

Accurate estimation of the spatial and time variation of rainfall across urban catchments is essential for accurate sewer and stormwater modelling and operations activities.

Currently, the Auckland region is served by an extensive rain gauge network operated by Auckland Council Healthy Waters Department.

Sampling the true area rainfall with rain gauges is inherently difficult, because rainfall varies on spatial scales much smaller than the typical separation between gauges and the land area of the Auckland region is some 5000 square kilometres, and experiences highly variable rainfall.

The paper's authors have been working collaboratively towards the use of rain-radar derived accumulations to support decision making in real time during flooding events, immediately post event for reporting to stakeholders and in long-term planning.

To date, they say, use of rain-radar derived quantitative precipitation estimates in the engineering field has been hampered by the large data volumes that need to be handled and the high level of specialised expertise required to quality control and calibrate raw radar observations.

Background

Rain radar is a well-established technology for addressing the spatial sampling problem and has been used in a variety of stormwater runoff and sewer system modelling applications internationally.

This country has been covered by the network of weather radars run by the MetService for many years. However, until recently, there have been only limited attempts to make use of radar data in stormwater and wastewater engineering applications.

This may be attributed to the technical barriers that exist in making use of complex radar data compared to simpler rain gauge measurements. In order to remove at least some of these barriers and foster more widespread use of radar data, the authors have automated data quality control from the Auckland MetService C-band radar, and operationalised real-time calibration of the radar precipitation estimates using the Auckland Council rain gauge network.

The high quality radar-derived accumulations are prepared at spatial and time resolutions suitable for urban hydrology (1 minute time step, 500x500m pixel resolution rasters) and are then fed into a cloud-based GIS platform and can be interacted with by council staff and consultants, for example to extract a catchment averaged accumulation for reporting or a raster stack for model input.

Rain measurements in Auckland

The Auckland region is served by an extensive rainfall observation network made up of telemetered tipping bucket rain gauges run by Auckland Council and now (with Watercare) monitoring local weather radar. This includes vertically pointing radar at Orewa and scanning X-band radar based at Ardmore.

The Auckland Council Research, Investigation and Monitoring Unit (RIMU) runs over 60 permanent telemetered tipping bucket rain gauge sites. The rain gauges are with a few exceptions mounted at ground level or in trenches and equipped with either 0.5 or 0.2mm buckets.

MetService operates a single-polarisation, C-band scanning rain radar located on Mount Tamahunga near Warkworth. The radar performs a scan cycle every 7.5 minutes, measuring radar reflectivity at increasing altitudes and at up to 250 kilometres in range. The radar is well positioned to provide meteorological observations for both Auckland and the Northland regions.

The most southern parts of the Auckland region are up to 100 kilometres away from the C-band radar, so beam spreading and climbing effects mean radar measurements in South Auckland are made between 1.5 and three kilometres above the ground.

To investigate the impact of range limitations on radar-derived accumulations, Weather Radar New Zealand is currently operating an X-band radar out of the University of Auckland Ardmore field site, although data from this radar is not currently part of the operational analysis.

The vertically pointing radar (VPR) at Orewa has been deployed since this year. In comparison to the MetService C-band radar near Warkworth the VPR dish does not move, but rather points directly upwards and continuously measures the vertical Doppler velocity spectra and radar reflectivity in a vertical column directly over the radar site at 100 metre height resolution and at 10-second intervals. The VPR is located about 30 kilometres to the south of the C-band radar site, allowing inter-comparison of the two radar measurements and direct calibration of the C-band radar.

How radar works

Radar is an active sensing technology that illuminates targets with electromagnetic energy and measures the properties of the reflected (or 'back-scattered') radiation in order to elucidate some physical property of the targets.

In the case of meteorological radars, repetitive pulses of electromagnetic energy are focused into the distance by a parabolic dish, by scanning the dish and recording the bearing and time taken for pulses of energy to return, a map of precipitation location and intensity can be constructed.

Radars are typically differentiated according to the operating wavelength and the authors have adopted this approach here – referring to the MetService radars that emit 5.4 centimetre wavelength radiation as "C-band". The principal radar measurement is 'reflectivity', which for meteorological application is the scattering cross section of all the targets in the radar beam at a particular range bin.

Reflectivity is usually expressed in decibel units, and values typically range from 20 dBZ for light rain to 55 dBZ for very heavy rain. Values over 55 dBZ are likely to indicate solid precipitation (hail).

The scattering cross section, and hence reflectivity, depends on the usually unknown raindrop size distribution, and must be converted to rainfall rate to be useful. Other factors influencing the estimation of rainfall are attenuation, ground clutter, beam blocking, uncertainty in the vertical profile of reflectivity, spatial smoothing and time intermittency of the radar measurement.

For hydrological applications, detailed quality control and processing is required to generate useable rainfall estimates.

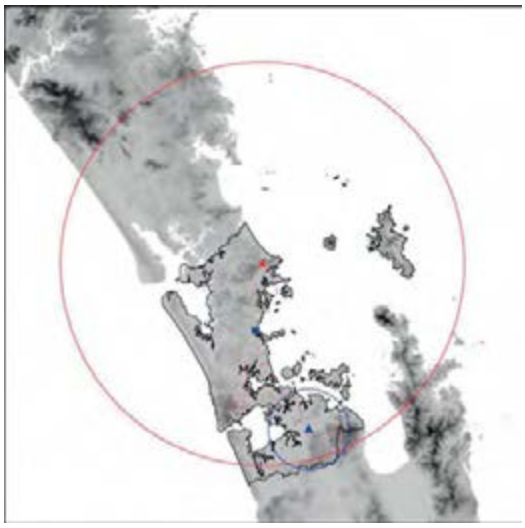
For Auckland Council's requirements, precipitation estimates were required at sub-hourly frequency, sub-kilometre resolution and with minimum systematic bias and error. This level of detail and accuracy was not available from the one-hour accumulation product generated by the C-band radar's bundled software, so raw radar data in polar format (range, bearing and reflectivity) were sourced directly from the C-band radar output files and ingested in the cloud-based GIS system through a customised post processing system.

As a first step, the C-band radar measurements were compared to coincident vertically pointing radar measurements of rain above Orewa to check for any systematic bias.

The much smaller size of the vertically pointing radar affords the luxury of direct end-to-end calibration in a laboratory setting, and it was assumed that any systematic difference in measurements between the radars is due to electrical calibration bias, or un-quantified physical losses in the C-band radar. To exclude differences arising from attenuation, the comparison was only made when there was little precipitation obstructing direct line of sight between the VPR and the C-band radar sites.

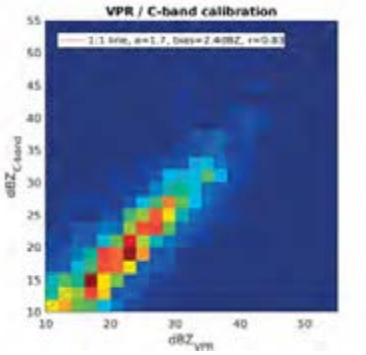
The comparison identified a low bias of approximately 2.4 dBZ in the C-band radar measurements. Because the conversion from reflectivity to rainfall is non-linear, this corresponds to a significant error in rainfall estimates, about 30 percent low bias.

Previously, a low bias had been observed in comparison

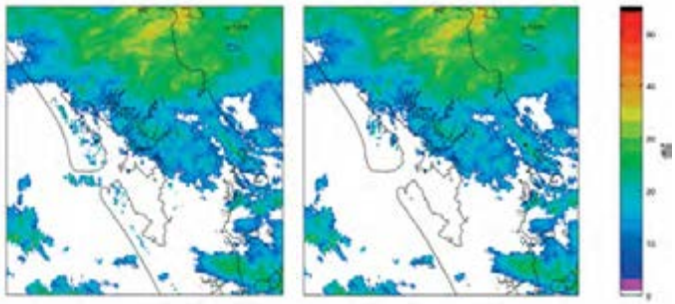


Map of the Auckland Region depicting the location of the MetService C-band weather radar (red triangle and 100 km range circle), tipping bucket rain gauges (red points), vertically pointing radar (blue square) and X-band radar (blue triangle and 20km range circle). The boundaries of the Auckland Region are also indicated with a black outline.

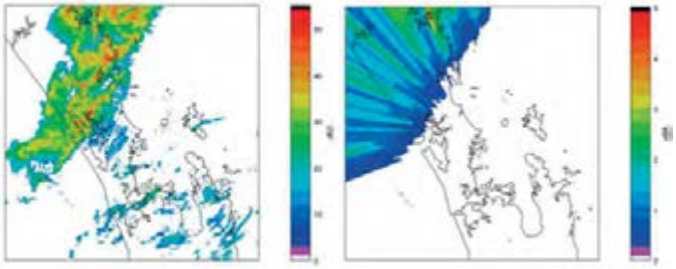
The vertically pointing radar.



Comparison of reflectivity estimates for the C-band nad VPR radars.



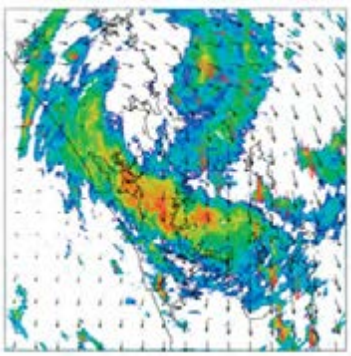
Radar reflectivity map before (left) and after (right) ground clutter suppression. Note the removal of the returns from the ridgelines of North and South head and sea surface at the Kaipara harbour mouth.



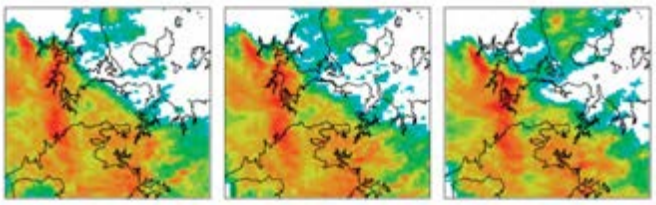
Radar reflectivity map (left) and estimated attenuation (right), 2017/07/22 11:00

C-band radar scan procedure

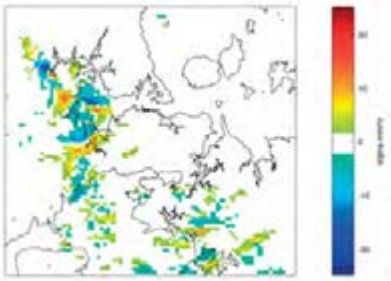
Designation	Dish Elevation (deg)	Range (km)	Doppler Velocity
SURV	0.5,1.0	320	N
VOLA	0.5,0.9,1.4,2,3,4,5,6	250	Y
VOLB	7,8.5,10,12,15,20	125	Y



Radar reflectivity image overlaid with individual precipitation feature echo motion vectors (red arrows) and the overall echo motion field (black arrows) for a cyclonic system 2017/03/12 09:23. The intense convection in the south west quadrant of the cyclone stalled over the suburb of New Lynn, delivering significant precipitation in a short space of time.



Radar images measured 2015/07/15 16:15:00 (left) and 2015/07/15 16:22:30 (right). The centre image is a synthetic image constructed by the advection interpolation scheme, valid at 16:18. Note the subtle movement of the intense precipitation features between frames. Flooding resulting from this short-duration yet intense precipitation resulted in habitable floor flooding in West Auckland.



Difference in average rainfall rate for the 7.5 minute period starting 2015/07/15 when using estimating the accumulation with just the measured frames or including the advection interpolated data.

between C-band rainfall estimates and rain- gauge measurements, so the C-band / VPR comparison helps to identify the cause of the low bias as being a characteristic of the C-band radar calibration, rather than a deficiency in assumptions made in subsequent steps when processing of the radar data itself.

Ground clutter removal

Following correction of the low bias, radar data was treated to identify and suppress ground and sea clutter.

The MetService C-band radar is equipped by the manufacturer with an automatic clutter suppression system that is intended to remove any 'extra' contribution to the reflectivity measurement from targets with zero relative velocity – eg, hills and buildings. In practice, the non-zero dish velocity and random motion from trees and leaves means the filter often only partially suppresses ground clutter.

Suppression of residual clutter is achieved by comparing the reflectivity measurements with a terrain elevation map. In regions where the terrain elevation is flagged as high enough to intersect with the radar beam, the radar data is treated according to a filter that checks for sharp drops in reflectivity in scans of increasing dish angle and low relative wind speed.

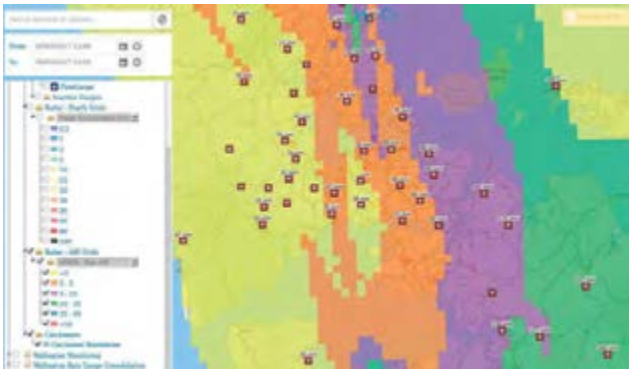
If a large negative gradient (much stronger signal near the ground) is detected it is assumed that the radar signal is due to ground clutter and the measurement is set to zero. Spurious returns from ripples on the sea surface are also suppressed in a similar manner.

Correction for attenuation of the radar signal by rain over the path of the radar beam is applied using coefficient suitable for widespread rain types. Attenuation correction is required to reduce the underestimation of rain at more distant locations from the radar site due to weakening of the radar signal by intervening hydrometeors.

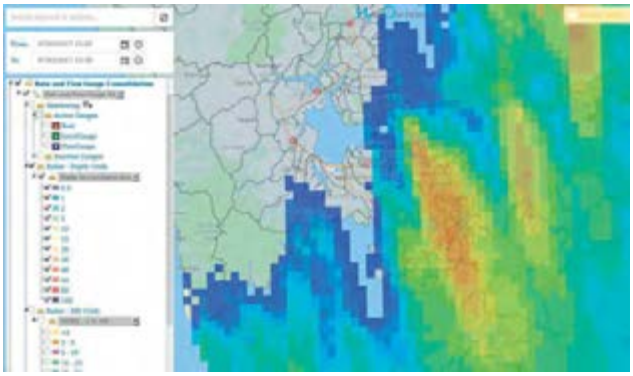
The attenuation correction method is only able to partially correct the underestimation for two reasons.

First, the raindrop size distribution is unknown and therefore so too are the correct coefficients for attenuation correction equation. Therefore, in order to avoid overcorrection a conservative estimate is used.

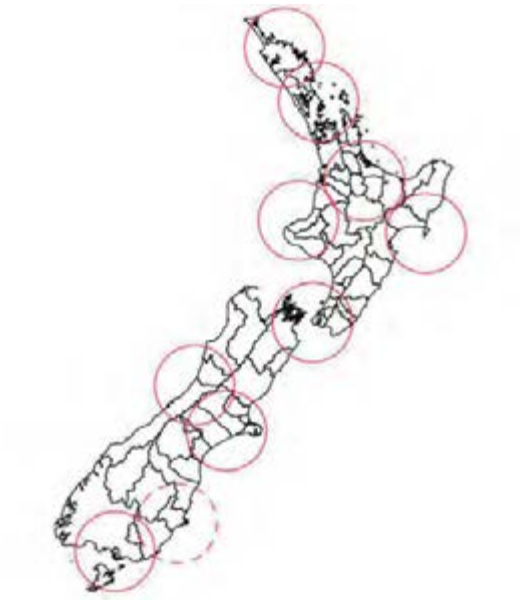
Second, for very strong attenuation, for example due to



Example of automatic generation of a maximum ARI surface from the processed radar data for the flooding event 2017/03/07.



Extraction of radar rainfall accumulation estimates for a sub hourly time period, in this case 2017/03/07 15:00 - 15:30.



Coverage map for the C-band radars which comprise the national radar network. 100km range circles indicated the maximum optimal range of the radars for quantitative precipitation estimation (QPE). The approximate coverage of the planned Dunedin rain radar is also indicated (dashed circle).

blocking by hail, the correction fails completely if the radar signal becomes too weak to correct.

Future work with vertically pointing radars will address the uncertainty in the drop size distribution and deployment of additional small scanning X-band radars has the potential to reduce the impact of attenuation by observing rain from multiple angles.

Conclusions

This project represents the first implementation of a truly GIS compatible and fully automated rain-radar analysis system in this country.

The notable technical improvements over previous efforts, aside from improved quality control, are the facility to access sub-hourly accumulation estimates and a simple web-API interface to retrieve data. Sub-hourly disaggregation of the radar data allows both estimation of short duration ARI statistics and extraction of rainfall estimates at timescales suitable for use directly in sewer and stormwater modelling applications and catchments with short hydrological response times.

This new analysis methodology is suitable not only for the Auckland region, but any area served by a local weather radar and automatic telemetered rain gauges.

Already, the Auckland Council radar processing workflow generates analyses for an area that covers 256x256 kilometres around the Auckland radar site, which includes the southern half of Northland, (including Whangarei and the Coromandel Peninsula).

Modification to the existing system required to provide radar derived rainfall estimates in these regions is limited to establishing data telemetry to the regional rain gauges. Likewise, the equivalent analysis can be extended to other radar locations.

Enabling work is underway to propagate the system to the Wellington region, but equivalently the analysis could be efficiently adapted to include major population centres such as the Bay of Plenty, Waikato and Christchurch, which are well served by the MetService radar network.

The web-based data management system established for the radar accumulations can also be used to handle other spatial data types. A natural extension to the system is ingestion of numerical weather prediction data. Current work is underway to enable ingestion and exposure of MetService forecast products to the same API to allow user interaction via the GIS portal.

Up until now, high technical barriers have prevented uptake of advanced rainfall data for water engineering applications in this country. The work described in this paper is essential for realising the value of the investment in the radar network for urban hydrology.

The authors hope that this new methodology will allow more engineering practitioners to begin to explore the use of radar data in their planning, modelling and operational applications.

They also acknowledge that the bulk of their work has been funded by Auckland Council Healthy Waters Department and C-band radar data was provided by MetService through a data access agreement with Auckland Council. Watercare Services also assisted with a field site and funding of the VPR radar monitoring. **WNZ**

A passion for

environments

Dr Emily Afoa's passion for the water industry was awarded with the Young Water Professional of the Year trophy at this year's Water New Zealand conference. **BY MARY SEARLE BELL.**

Emily grew up in the Bay of Islands where she spent time in the great outdoors, and still does. When it came time to go to university, an environmental engineering degree through Auckland University seemed a good option, and after her first year, she knew she'd made the right choice.

"However, when I finished my degree, most of the jobs available were 'pipe-centric' and not particularly exciting to me," she says.

"I took my job offers to one of my lecturers, Dr Elizabeth Fassman-Beck, to get her advice, and she suggested I do a PhD. She had a project available on water sensitive design – something which was way more appealing, so I stayed on at university to complete my doctorate."

Emily's doctorate research quantified the hydrologic balance for living roofs operating under Auckland climate conditions. Dr Elizabeth Fassman-Beck, along with Dr Robyn Simcock of Landcare Research, were her PhD supervisors, and Emily says they're both very passionate about the industry and have been excellent mentors.

Her research took her to a number of conferences in the USA, where she got to see what they were doing over there, and elsewhere internationally, with regards to environmentally-focussed stormwater solutions.

"It really opened my eyes to the spectrum of where New Zealand could be. Some of them were miles ahead of where we are," she says.

"We have every opportunity to be leading the world on this, or at least be near the head of the pack.

"We face a number of challenges, however, not in the least the resistance to change and the capital costs associated with water sensitive designs.

"So many designers simply focus on flood mitigation, or a single benefit, and don't realise the other benefits that can be achieved through a multifunctional design. A water sensitive design will integrate both water sensitive and standard infrastructure solutions for a better outcome that supports urban liveability – for example, a flood basin that is designed to cope with a one-in-100-year flood (which, by description, is a rare occurrence) but functions as a pleasant open greenspace for the majority of the time."

Emily says the environment is losing out as the different engineering disciplines are quite siloed, and believes the solution lies in a more collaborative approach.

"Drinking water, irrigation, streams, beaches – water management spans so many disciplines. The challenges can't all be solved by engineers – planning, ecology, and other disciplines are an important part of the equation.

"Also, people's mental health and well-being is getting increasing focus, and is now an important part of environmental planning.

"As engineers and designers, we need to always consider how liveability ties into our day-to-day projects.

"We can't protect all water courses in a city, as liveability is a priority which needs to balance many competing factors, such as connectivity and urban design as well as the environment, but what does remain needs to be protected and restored."

Emily is aware that incorporating such things into design usually adds extra costs, something that clients are often reluctant to embrace, but she says it is important to give the client a range of options to choose between, not just the status quo.

"Always include an option that has improved outcomes for the environment to normalise the approach."

Emily is currently employed as the engineering design team leader at Morphum Environmental, a company that very much shares her philosophies.

"After I'd finished my PhD I did some travelling with my husband (who was playing rugby in France), but once I knew we were settling in New Zealand, I approached Morphum for work, as I liked their principles and goals.

"I essentially said, 'I'd like to work here; here's my CV, let's have a coffee. Your company represents everything I stand for'. They didn't have any specific role available, but employed me anyway.

"I'm thrilled to say that Morphum walks the walk on a day-to-day basis. Their philosophies are not just 'speak' on their website."

Emily's job sees her working predominately in the Auckland urban environment, focusing on water quality, quantity, and erosion control. She specialised in stormwater management, including both traditional reticulated systems and water sensitive solutions.

She has designed and assessed a range of stormwater networks, ranging in size from lot scale projects catering for flood plain and overland flow impacts, downstream network limitations or discharge to soakage, through to large public stormwater infrastructure, including outfalls to streams and roading stormwater networks.

Not content simply working in the field she loves, Emily retains a passion for academia, fulfilling this by lecturing at the University of Auckland and Unitec. She is also involved in a Water Sensitive Design in Schools programme, funded by the Auckland Council and local boards.

"I find these environments rewarding – it allows me to share my passion for water management with young students and open their eyes to opportunities in science and technology, and expose soon-to-graduate engineers to water sensitive options and a collaborative approach to stormwater management."

Awarding professionalism

Emily Afoa is the recipient of the CH2M Beca Young Water Professional of the Year 2017 award, presented at the Downer Conference Awards Dinner for the Water New Zealand Conference and Expo.

Her entry for the award was supported by Morphum Environmental's directors and Mark Iszard of Auckland Council's Healthy Waters, Infrastructure and Environmental Services team.

The key aspects that influenced the judges' decision included her success in academia, her growing position as a leader at Morphum Environmental, and her involvement in education at multiple levels.

Emily leads Morphum Environmental's engineering design team, and frequently represents the company at industry events. She holds a PhD in Civil Engineering, specialising in urban stormwater management.

The Young Water Professional of the Year award provides recognition to a water professional in the early stages of his or her career, who has contributed to the water industry and community, and has demonstrated exceptional achievement.

It is open to individuals under 35 years of age, with between one and 15 years' experience. Emily is the second Morphum Environmental team member to receive this honour: director Caleb Clarke was 2011's Young Water Professional of the Year.

New Zealand's 'clean, green' marketing image simply does not reflect many of our waterways, says Emily, and she wants to do what she can do to improve the situation.

"I'm delighted to see that the water knowledge of young children is much higher than it was when I went through school – many school stormwater drains have 'I only drain rain' and the like painted around them, and the children have a raised awareness to what happens to water once it goes down the drain.

"It's great to see it's changing."

For Emily, she would like to see the water industry working toward water sensitive cities, where design recognises that holistic water management can enhance receiving environments and mitigate flood risk, while also enhancing biodiversity, open space, community connectivity, and cultural values.

"I am excited by the future of the water industry and want to work towards my water sensitive vision, be it through teaching future engineers or by providing technical design for clients as a consulting engineer." **WNZ**

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Tony Cussins
Discipline Manager, Hydrogeology

Tony is an expert in contaminant hydrogeology and human health and environmental risk assessment. This role requires him to work closely alongside clients to ensure they are empowered in highly sensitive, technically complex projects. Tony's 20+ years' experience in successfully delivering technically challenging projects was critical in his role as project leader on the Hastings District Council's investigations into the cause of the Havelock North Campylobacter outbreak.

Mark Pennington
Senior Water Resources Engineer

As a Chartered Professional Engineer, Mark combines a high degree of technical excellence with extensive experience in hydrological and hydraulic investigation. His expertise and personal commitment to high quality environmental outcomes enable him to balance the competing needs of flood protection with ecological and environmental protection.

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Lessons in reservoir building

This is a précis of a paper by Lance Haycock from Hamilton City Council and Johan Meintjes from Opus.

Hamilton city's water distribution system consists of a single water treatment plant and distribution via a ring main system to eight reservoirs throughout the city.

In order to cater for current and future city growth, Hamilton city invested $21 million in a new 24-megalitre reservoir in Rototuna, which was completed by September this year. In addition to facilitating city growth the new reservoir will provide significant benefits to network operation and resilience.

Geographically 95 percent of the city's current water storage is located on the western side of the city, with only one operational reservoir located on the eastern side. The city is therefore critically reliant on strategic river crossings to provide water to the east in emergency situations. A total power failure at the WTP would prevent water being pumped into the network. The reservoirs would then be expected to provide continued service to consumers by gravity, albeit with a limited storage reserve. So, the Rototuna Reservoir is designed to provide some balance to the east/west storage.

This strategic shift changed the intended purpose of the reservoir pumphouse from simply supplying water at a steady head to the ring main, to supplying a primarily residential zone with a dynamic flow range of between 35 litres per second to 650 litres per second.

This project faced challenges in the design phase including seismic requirements and geotechnical challenges, and how to get water to the reservoir at the opposite end of the city from the treatment plant and at a high RL.

The Rototuna Reservoir was recommended in the 2002 report, 2020 Water Supply Network Strategy Plan, in order to support the growth of the city and improve the storage bias between the eastern and western side of the city, and land for this reservoir was bought and designated in 2002.

A 24-megalitre reservoir was designed with an associated two-plus-one pumphouse (two operational and one standby) to facilitate the current network philosophy in 2010 with expectations to have the reservoir operational by 2012. However, with external factors such as the global financial crisis, fluctuating growth, and a conservative approach being taken by council with respect to incurring debt large capital projects such as the reservoir were deferred.

By 2014 development and demand had continued to grow with the water to supply the Rototuna area being provided by Pukete Reservoir as an interim solution. The Pukete Reservoir reached its operational limitations for supplying its geographic extents, so the Rototuna Reservoir implementation was started.

In the time between design in 2010 and 2014 a number of critical events occurred that impacted the design and performance of the reservoir. These included the Christchurch earthquakes, the Health and Safety at Work Act, Network Operation Philosophy, and the Waikato Expressway.

A key risk to the implementation of the Rototuna Reservoir was the impact the reservoir would have on the network itself.

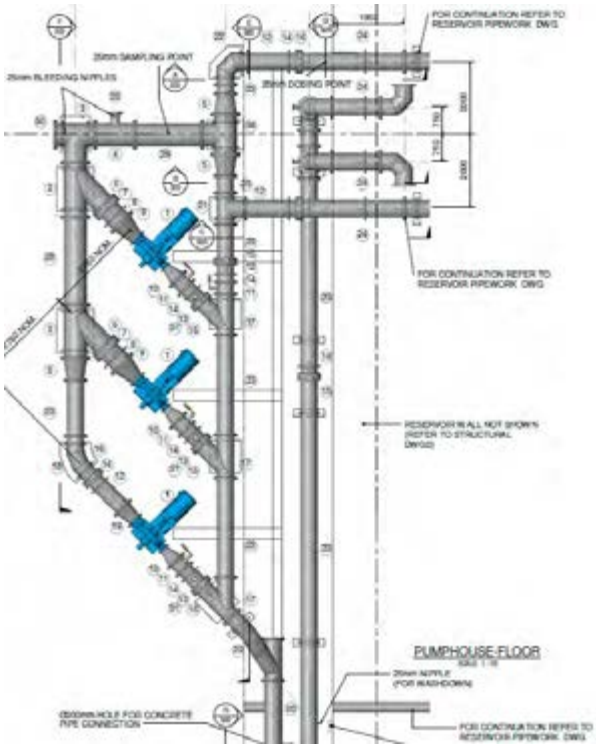
It became apparent during the transition to the reservoir becoming operational that, because the surrounding area was not yet configured to create a DMA, the reservoir would have negative effects on the WTP's ability to service the city. This is because the WTP would be operating at capacity during peak demand times to supply the un-DMA network, but with the Rototuna Reservoir coming online outside of a DMA the WTP would now be asked to fill an additional 24-million litre reservoir at a high RL in an area in which it was already known to have pressure issues in peak demand periods.

In response to this risk, the following actions were taken. The programme for creating the DMA zones was advanced to alleviate the network demand from the WTP and increase

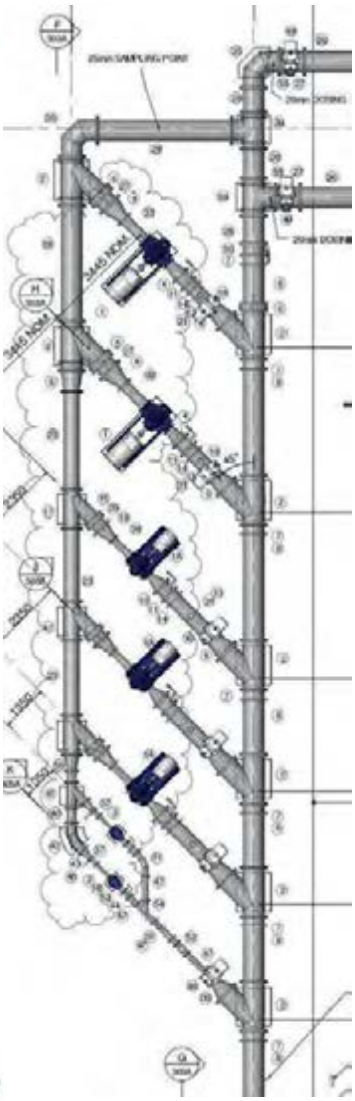
Hamilton City Bulk Water Network

- Existing Reservoirs
- Rototuna Reservoir
- Bulk Water Mains
- Water Treatment Plant

Comparison of original pump design to the new pumphouse aligning with the new operational philosophy.

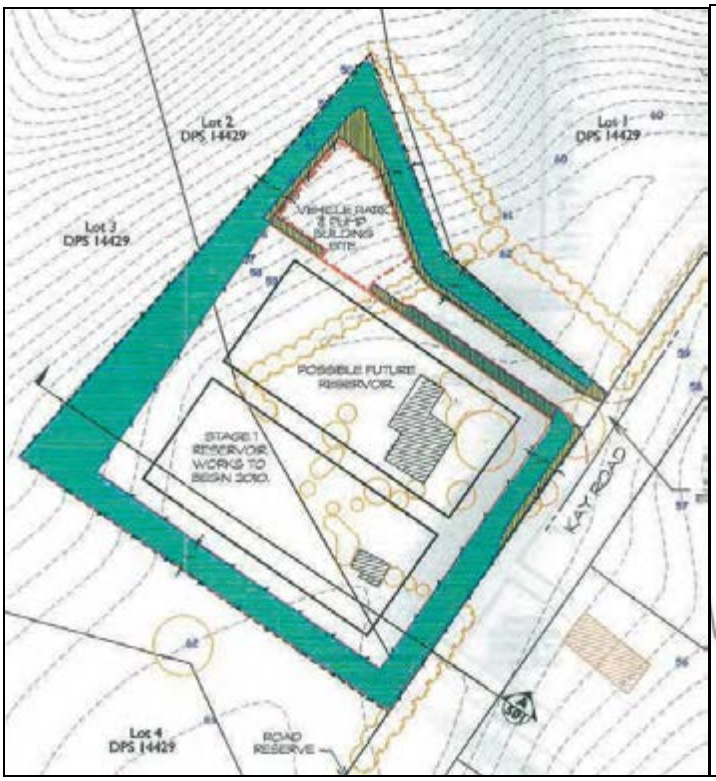


Original Pumphouse Manifold Design



Revised Pumphouse Manifold Design

Rototuna Reservoir



Initial site layout.

Revised site layout.

First pour of 950m³ showing two concrete pump cranes.

Second pour of 950m³ showing the over pump configuration.

the efficiency on the network as a whole; the more DMAs that are implemented the closer the WTP could operate as a flat line output.

The duplication of the bulk mains to the Pukete Reservoir (which currently feeds the Rototuna area) was installed to allow dedicated 'fill and feed' operations. This was fast tracked to give the Rototuna zone additional resilience to peak demand periods by alleviating the WTP.

A booster pump was provided for in the Rototuna Reservoir Dedicated Bulk Water Main design, which would allow for a booster pump to be used to increase the pressure to fill the reservoir. This would only be required in the unprecedented situation of three consecutive days of peak demand exceeding 90 million litres for the city from the WTP. An average demand is about 45 million litres.

As the design of the reservoir began some five to seven years prior to beginning the shift in operational philosophy, some elements of the reservoir design and intended operation had to fundamentally change to adapt to the expected operational LOS. For example, the reservoir's original intent was to act as a storage facility and to subsidise flow and pressure to the network during emergency events or peak demand periods with the WTP to supply and pressurise the network.

Several alterations were made to adapt to the new demands placed on the reservoir by the change in philosophy. These included changing the design outputs of the pumps from 101 litres per second peak with a 2+1 pump arrangement, to a flow range of 30 to 650 litres per second, which required seven pumps with different and overlapping ranges. It also involved adjusting the number of pumps in response to the flow range needed to supply the primarily residential Rototuna area which has a high peak daytime demand and extremely low night-time demand.

Other design alterations included more than doubling the size of the pumphouse to accommodate an additional four pumps; providing pumps with Variable Speed Drive (VSD) to meet the new pump design profile with a consequential increase in the electrical room footprint; and altering the designation to accommodate the increase in the pumphouse footprint.

A review of the original assessments and designs also took advantage of learnings from the Christchurch earthquakes.

Further to the above challenges, a separate New Zealand Transport Agency (NZTA) designation for the Waikato Expressway applied to an adjoining property. This roading project proposed to make an 18-metre cut on the eastern boundary of the Rototuna Reservoir to form an underpass to enable the existing road to pass above (Kay Road). This cutting was at a safe slope with no engineering structure (retaining wall) as support. This represented a significant unknown risk to the reservoir in a seismic event.

To mitigate this seismic risk and differential settlement two options were available: Preloading the site to a target consolidation target over a period of 12 months; or installing pile foundations to enable almost immediate construction to start. Preloading was selected due to its significant cost savings and time flexibility in the programme, which required about 12,500 cubic metres of material to place a 1.4t/m^3 load, compacted and monitored with a settlement target achieved within 12 months. This equated to a 4.5-metre high load of material placed on the entire footprint of the reservoir. A blue/brown rock was selected due to the cost and was placed and compacted over a six-week period.

By the time the placement of the preload was scheduled to commence, development pressures had increased and options of accelerating the programme were being re-examined. This resulted in increasing the load to 1.65t/m^3 or 6.2 metres high and installation of wick drains that was expected to reduce the programme to nine months duration.

Acknowledging learnings from the Christchurch earthquakes around liquefaction and the neighbouring 18-metre cut for the Waikato Expressway, approval to proceed with the additional load to accelerate the programme was given. Opus designed the Expressway slope and managed the safe slope limit with the Rototuna Reservoir in place. However, onsite measures need to be

taken to ensure no undermining of this slope occurs, ie, saturation of the soils from a leak in the reservoir, all points raised, has been accommodated in the design.

As part of constructing a concrete reservoir a number of staged large-scale pours were required, the largest of which was the two stages of the floor pours totalling 1900 cubic metres.

To deliver this amount of concrete in one pour would require two concrete pump cranes working from 5am to 4pm constantly. With the site being constrained for access, a standard reach of concrete pump trucks could not access the back edge of the foundation, therefore two long reach pump cranes were used (one 44 metres and one 52 metres reach) to reach the extents of the foundation on the first pour, with a third standing by in reserve.

The workability for the second pour of the slab was further constrained due to nearly half the site being closed from the first concrete pour. This forced the contractor to be creative in placing the concrete. This was achieved with a double over pump, where concrete was delivered to a pump crane, which pumped it over the screen planting and site cabins to a second pump crane which then pumped the concrete in place on the footing. This allowed a third pump crane to be located close to the site entrance and deliver the concrete the second pump crane would be placing. This meant on this pour we had four pumps onsite, three pumping and a standby.

Construction

The successful tenderer was Hawkins Infrastructure, which developed engineering options with the council and the Opus design team. The three major options considered were: disposal of preload material; post tension slab; and pre-casting off site.

Preload removal

Discussions with the NZTA and its alliance team constructing the Waikato Expressway provided a solution to the removal of the 12,500 cubic metres of preload from the site prior to the construction of the reservoir. As part of the enabling works for the Waikato Expressway they would need material suitable for the construction of haul roads through their sites.

So, the solution for both parties was for the council team to relocate the reservoir preload material onto the Expressway project site at no charge. Effectively, this saved the reservoir project $480,000 and the Expressway team material and transport costs.

Post tension slab

Moving from a concrete mass foundation to a ‘post tension slab’ was proposed by the Hawkins team after developing the design with its structural team and Opus. This change in design resulted in a reduction in concrete volume of 640 cubic metres and reduced the reinforcing required by 240 tonnes. This saved the contract nearly $360,000 in net project costs once all overheads and other costs were accounted for.

Additional non-financial benefits included the reduction in cold joints in the floor slab. Under the original option the floor slab was to be poured in six individual sections, which would result in two cold joints in each tank. With the post tension slab option, this was significantly reduced as the only joint between the two concrete pours, each being 950 cubic metres, would be located under the central wall dividing the tanks.

Another non-financial benefit was environmental, such as fewer vehicle movements needed to deliver the concrete and steel.

Off-site concrete pre-casting

Due to the physical constraints of the site (posed by screen planting) the construction team needed to be creative in how the site operated. Initially, the design methodology looked to use a poured in-situ structure. This concept was dismissed early because the formwork needed would essentially require closing the site from additional works.

Instead, Hawkins moved pre-casting components off site, and this had the advantage of improved QA control, consistency in product replication, and programme efficiencies through concurrent works and safety.

This was a cost neutral alternative, however it proved a worthwhile engineering option that improved overall safety, reduced the onsite works and storage needs, and improved overall ‘workability’ on site.

Safety aspects

A key outcome of these changes was the consideration of the health and safety of workers through the life of the assets operation.

Initially a caged ladder was deemed appropriate for access to the roof of the reservoir, but was identified as a potential safety issue for staff access. Considering the frequency of access, the number of times it would be accessed during the assets life, and the cost to install a set of stairs to the roof instead of a ladder system would only be $38,000 (equating to $32 per access), it was a straightforward decision to install a stairway instead.

Some simple improvements for mitigating risk were identified for the pumphouse, such as the fluorescent tube lighting located on the roof eight metres from the pumphouse floor, which provided significant risk and cost during bulb replacement. For this reason the lights were relocated to the walls and changed to LED type, which removed both access risk and frequency of replacement.

Lessons learnt from other reservoirs were to consider the accessibility and ability to remove the heavy pumps and gearboxes. In response the pumphouse was designed on a single level and in an open plan to enable a two tonne electric gantry crane to be located over all components.

This meant the components could easily be moved to the garage door forebay where a vehicle could be positioned to receive the component lowered onto it with absolutely no lifting required from staff.

An ‘at level’ safety hatch was located on each of the two reservoir water tanks to provide access for plant and

equipment that would be used during an internal inspection, wash-down or maintenance task. This hatch was 800mm in diameter and designed to be used as a stretcher retrieval point in an emergency in lieu of lifting an injured person eight metres up to the roof hatch.

During construction of the reservoir a handrail system the full length of the roof perimeter was added to the design reflecting the standard requirement of five metres each side of an access point.

After understanding the future maintenance and inspection requirements of the roof seals, and the potential maintenance and repairs required over the asset life, the $50,000 cost to improve overall safety was reduced to just $41 each inspection.

This was a missed opportunity as a temporary handrail system was put in place by the contractor for edge protection during construction. If this had been considered earlier additional savings would have been achieved, as the permanent solution would have negated the need for temporary edge protection.

Conclusions

The change in operational philosophy of a city's water network or the construction of a water reservoir of this size are not activities frequently undertaken by local authorities in this country.

A change in operational philosophy, although well thought through and extensively modelled over a number of years, is predominantly a theoretical activity, and once challenged with the need of certainties to inform detailed design can result in overly conservative assumptions of network performance.

This can be challenging to manage; especially when trying to manage risk of supply to customers. However, by becoming comfortable with the approach the information is derived from, an element of certainty can be derived from the model outputs.

The extensive time difference between construction of a project of this nature, or even the time between planning and execution of a project like this, can mean any lessons learned from the last build are either forgotten, poorly documented or not relevant to current standards.

To overcome this flexibility and experience is essential to identify and respond to these challenges in delivering a product that the council's asset and operations teams find acceptable.

Having experienced designers and competent contractors who openly communicate also added to the success of this project. All parties were willing to understand all proposals and assess each on their merits without being protective of their respective roles.

Underestimating a blue sky suggestion without further investigation may develop into a missed opportunity that can save the project time, money and/or improve safety. **WNZ**

A veteran of the backflow sector

From prisons to paradise, Graeme Mills is looking at retiring after over 50 years in the water industry. He spoke to **MARY SEARLE BELL** about his career and his passion for clean water.

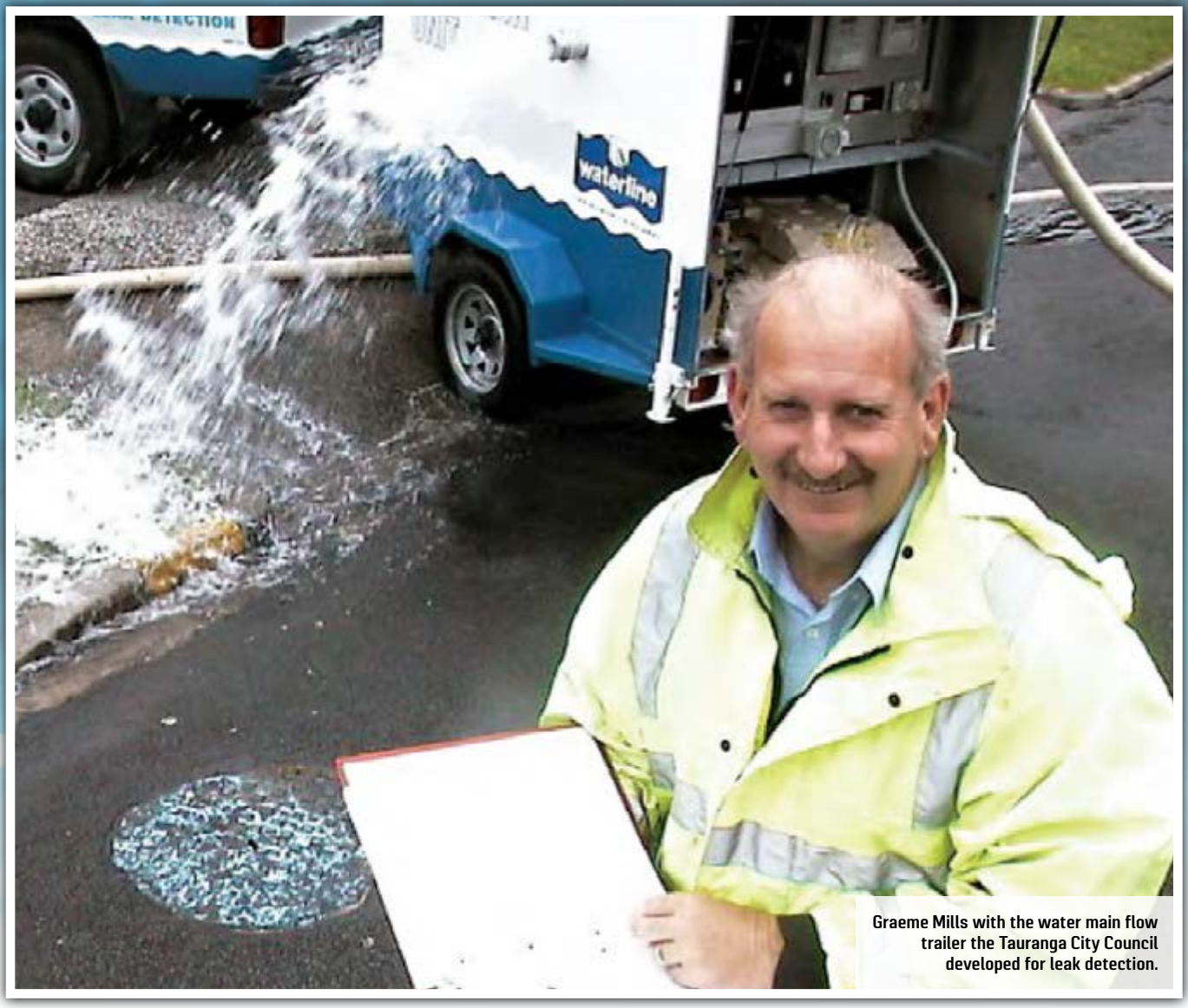
In 1964, 16-year-old Graeme Mills signed on for a plumbing apprenticeship with a small business on Auckland's North Shore. Back in those days an apprenticeship took six years or 12,000 hours, and young Graeme wondered what he'd signed himself into.

When the end was finally in sight, the system was reconfigured – the term was lowered to five years or 10,000 hours. The thing was, Graeme had finished his five years under the revised system but was yet to sit his final trade certification – something the plumbing industry did not appear to have a resolution for.

"There were a few of us caught in the apprenticeship transition, and the plumbing industry didn't seem to want to make a decision as to when we could sit our final exam," says Graeme.

"There was a lot of uncertainty and no answers. It was very disheartening.

"I very nearly threw the whole thing in at that point. I'd gone as far as applying to join the police force. Fortunately, or unfortunately, I was too lightweight for the police – back



Graeme Mills with the water main flow trailer the Tauranga City Council developed for leak detection.

in those days, you had to be at least 10-and-a-half stone."

In 1970, Graeme got a job as a maintenance plumber at Paremoremo maximum security prison, a role he held for almost three years. He finally was able to complete his trade certification too. However, he couldn't see himself as a plumber, so when the opportunity arose to move into water and wastewater, he leapt at the chance.

"Because the prison was isolated, the water and wastewater wasn't connected to a public network," he says.

"It had its own schemes."

He achieved C Grade certificates in both water and wastewater through the Ministry of Works training scheme in 1971. He then had a one-year stint at Waikeria prison as an assistant plant operator for both its water and wastewater treatment plants, moving back to Paremoremo in 1974 to fulfil the same role.

"By 1977, I was thoroughly disheartened with working at the prison. The location was very isolated – we had no car and the bus service was infrequent. There was a lot of stress too, and when the neighbour's wife committed suicide I thought, 'I can't put my wife and family through this'."

So, Graeme got a job with the Cambridge Borough Council as a water and wastewater treatment plant operator, and moved his young family south.

"The plant was on the banks of Lake Karapiro, just above the dam. When I arrived, the grounds were an overgrown mess and I was asked if I would tidy it up as the World Rowing Champs were to be hosted there in 1978.

"And so I did, creating a nice space for me to put up a deck chair and watch the races – in my own time of course!"

After seven years in the role Graeme was looking to broaden his scope. His role at Karapiro was a solo one and he wanted to get some experience in staff management. Consequently in 1984, he took a position as water overseer with Mt Maunganui Borough Council, responsible for looking after the town's water from catchment to meter, with a team of four under him.

Local government reform in 1989 saw the council sucked into the Tauranga City Council. A LATE (Local Authority Trading Entity) was created to manage the water

Graeme Mills speaking at the Water New Zealand conference with entertainer Frankie Stevens.

and Graeme was appointed as its water overseer, working through Aspen Contractors.

With a staff of 20, he looked after the water and wastewater networks, right through to 1997.

"I decided to get out of Aspen and went back to the council in 1997. They were considering moving to universal metering so were looking at water conservation in a big way. Two of us were appointed," says Graeme.

"One dealing with domestic customers, while I dealt with commercial customers, helping them manage their water use to improve their bottom line. We also did leak detection and night flow testing too."

The role later shifted focus to water quality, and Graeme was responsible for the city's backflow programme, mitigating potential hazards through backflow, crossflow control, and responding to water quality complaints that could be associated with cross-connection contamination.

"It was at this time I got involved with the backflow industry. The Backflow Group was an incorporated society that later joined forces with Water New Zealand, becoming a special interest group within the association."

In his 20 years with the group, Graeme has served as chair for more than 10 years. His generosity with his time, knowledge and skills saw him awarded Honorary Life Membership of Water New Zealand this year.

As his citation reads, "Backflow is one of our more active and successful groups and much of that is because of the effort that Graeme has put in over the last decade. During his time as chair, the Backflow Group developed a number of important initiatives including:

- NZQA backflow testing standards 23847 and 23848,
- The Backflow Code of Practice,
- The New Zealand Industry Standard for field-testing backflow prevention devices and verification of air gaps,
- Organising numerous conferences throughout New Zealand, and
- Facilitating a large number of backflow forums in association with the local branches of Master Plumbers.

Now, after 20 years with the Tauranga City Council, he is looking forward to retiring in January next year, having already cut his work back to just four days a week.

"I have nothing but gratitude and respect for my current employer. But retirement will give me the opportunity to travel, as well as more time for my other interests."

Graeme remarried in 1996, and he and his wife breed German Shepherd dogs on their lifestyle block. He is also heavily involved in the local community patrol group, and until last year was one of a number of search managers of the local group of Search and Rescue.

He remains passionate about water however.

"Water protection is always placed in the too hard basket. They say it's too expensive, but that's a myth. The expenses in the aftermath of a waterborne disease outbreak would be catastrophic – not just in the cost of clean-up but also the impact on tourism and the credibility of the water provider.

"You do what you think is right," he adds.

"Some people will love you, others will hate you, but you need to be proactive, and retain your individual integrity and principles." **WNZ**

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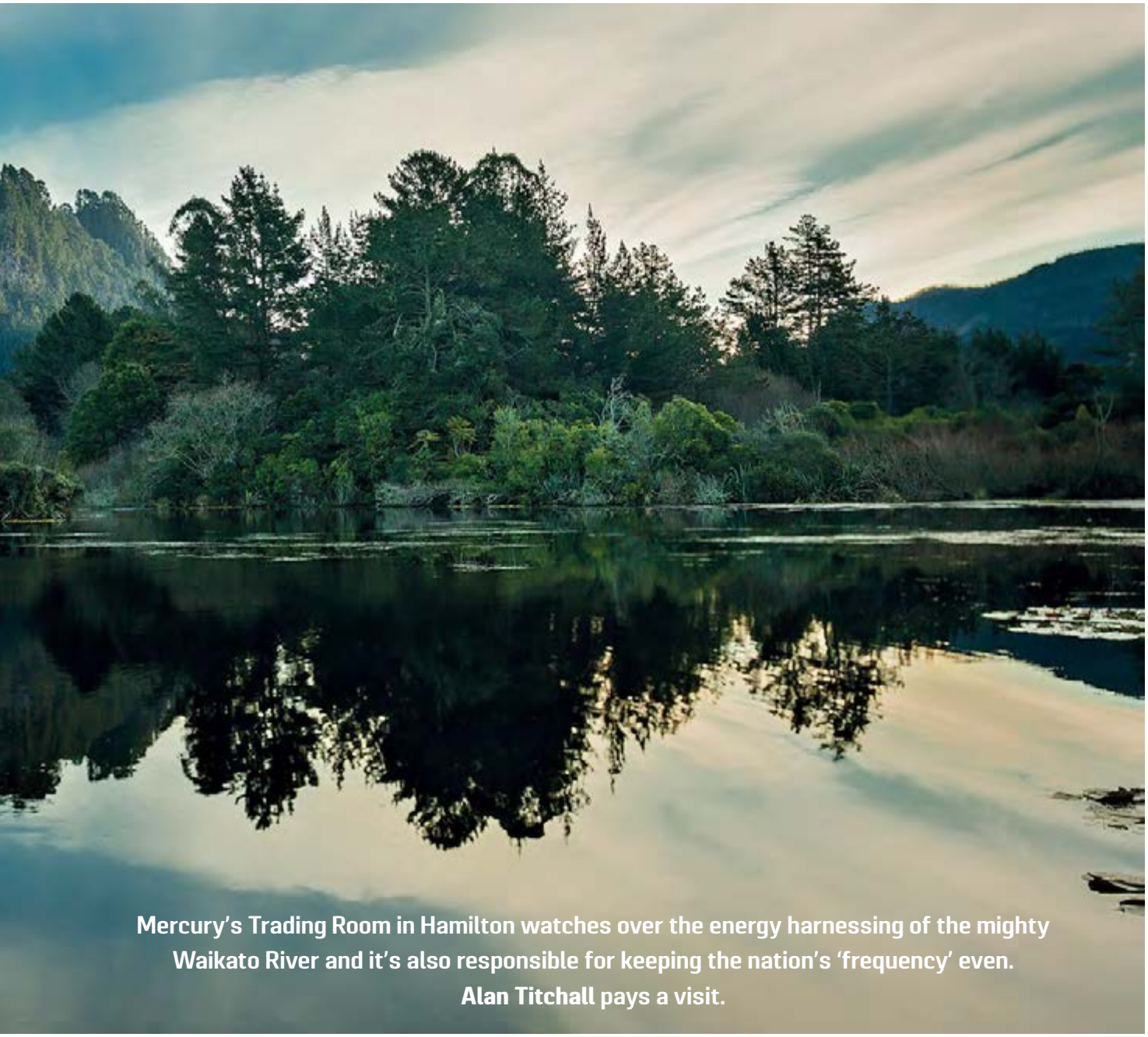
The river room

Andrew Anderson.

Julian Antoniazzi.



Mercury's Trading Room in Hamilton watches over the energy harnessing of the mighty Waikato River and it's also responsible for keeping the nation's 'frequency' even. Alan Titchall pays a visit.

Three years ago Mercury moved into new premises in Hamilton overlooking the Waikato River, which it controls from Lake Taupo down through nine hydro stations on its way to the west coast.

It takes 24 hours for a body of water to travel from the Taupo control gates at the northern end of the lake to Karapiro, the last dam on the river, and a well-trained computer controller, in a 12-hour shift, is in charge of using its passage through each power station to produce the energy requirements for a lot of the country, while working the entire living river for many other social benefits.

Andrew Anderson, the trading manager at Mercury, meets me alongside the controller at the time, Julian Antoniazzi, to explain how it all works.

Armed with a mouse and keyboard Julian is constantly monitoring a bank of computer screens and technology using sophisticated software supplied by Honeywell (see side box).

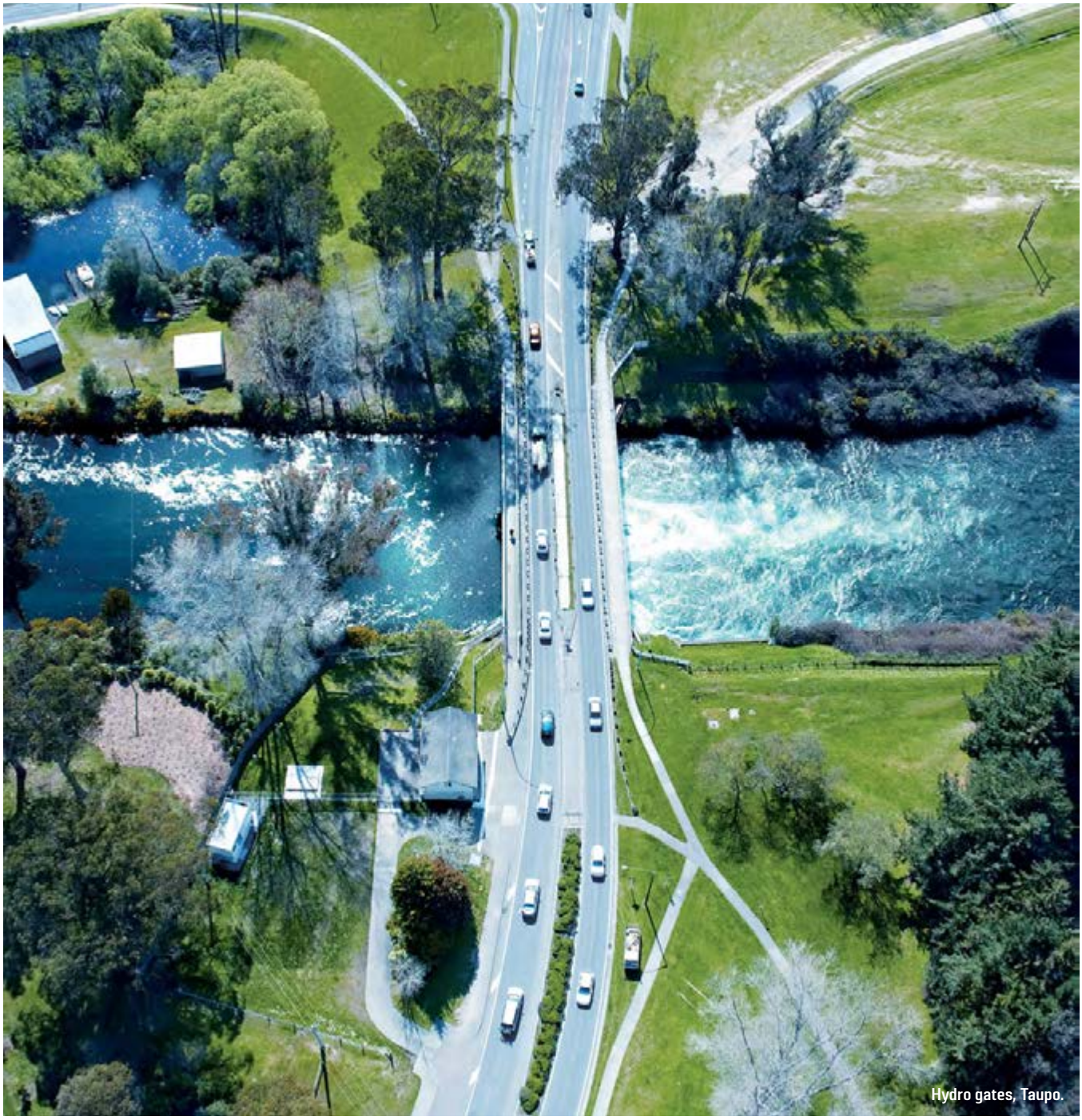
A hooter alarm, like the crash dive warning in an old submarine, blares out from one of the computer screens. What the hell is that?

It is Transpower, the body that operates the national grid, letting us know its requirements, says Andrew.

"We make offers to them on what we potentially can generate and then Transpower works out the most efficient and cheapest way to supply market energy requirements. It then sends us a dispatch, which is the hooter sound that you heard, and asks us to generate the exact megawatts it needs."

The hooter blares out again and Julian is unflustered.

"In general we get a blast on the hour and the half hour, but as the electricity load changes throughout the country a



Hydro gates, Taupo.

The bee says it all

When Mighty River Power rebranded to Mercury it dropped the logo with the Mercury man and his lightning bolt and replaced it with a bee.

The bees are hard working, native to New Zealand, have wings shaped like an infinity sign to reflect the renewable nature of all of Mercury's 100 percent renewable generation, have antennae (listening to customers) and the lines around the torso are like the water reservoirs Mercury uses to operate and hold its fuel sources.

dispatch from Transpower can come through once every five minutes," he says.

On top of these requests, the controller also has to look after the national system frequency, which runs at 50 hertz to keep everything in sync and make sure your home appliances don't have an electrical meltdown.

Any movement from supply and demand makes the frequency move one way or the other, Andrew explains.

"If there is more supply than demand you will have a high frequency. If you've got more demand than supply you will have a low frequency."

If the nation's frequency gets too low you run the risk of cascade failure of the power system, he adds casually.

"So the frequency is kept very close and we operate with generators called 'frequency keepers' – their job is to alter their load for small changes in demand and supply to keep the frequency at 50 hertz."

So what is the worst thing that can happen to a controller on one of these shifts?

"More significant events include actually losing large power stations creating a big drop in supply and frequency," says Andrew.

"Then, automatically, governors on every plant around New Zealand and the river will respond and lift up generation to counter the frequency fall.

"In really large events the system operates on what's called N-1 security where Transpower will cover the single biggest generation risk to the market and carry enough power and reserves to replace that within potentially six seconds."

Comforting to know.

"Yes, very important," Andrew adds. "All the control rooms around the country are integral to the power system and there's five significant ones – us, Trustpower, Meridian, Contact and Genesis."

In charge of a river

The Waikato River features eight dams and nine hydro stations and during my visit Julian was in control of the lot in terms of generation and 'hydraulic management', or making sure the water was in the right places at the right time to generate for evening and morning peaks.

"Because the river is not actually created equal," Andrew explains, "there's bottlenecks in different stages of the flow.

"Meridian [a South Island energy generator in charge of the Waitaki power scheme] has manmade canals and they actually know exactly the volume of water in those canals.

"We manage a natural river, and the bed changes with erosion and other things so it's a constant changing beast. As we can't model flows so easily our hydro controllers have a very skilled job on their hands."

Andrew says there are eight hydro controllers, all based in Hamilton, who work 12-hour shifts from 7am to 7pm in a 24/7 operation.

"I only need six to run my roster of hydro controllers but of those eight, five of them are dual trained and can trade the electricity market as well. What power a trader puts into the market, the hydro controller will deliver an hour later."

Originally from the UK, Julian tells me he trained here with Mercury where he has worked for 16 years.

"I first started on the trading desk, cut my teeth there for six years and then cross trained over a period of a year on hydro controlling," he says.

"The training is for six months but you're really learning the job for a number of years before coming up to speed."

How do you sit in front of a bank of screens for 12 hours at a time?

"The workload depends on how many people are communicating with you at any one time. It's a bit of a learned skill, and some people are better at concentrating for periods. We do have breaks and colleagues that can sit in for us."

I ask Andrew why the shift is so long?

"It's basically the best design for the health and safety of the traders. We had a look at the rosters and worked out that for the circadian rhythm and sleep patterns of the traders it's much more efficient for them to do two 12-hour day shifts and then do two 12-hour night shifts, instead of doing like five eight-hour night shifts.

"Basically, if you only do two night shifts your body clock doesn't change so therefore you can get back into a normal sleep pattern.

"If you're doing, say, a midnight to 8 o'clock shift five days in a row – your body clock changes sync and it's very hard to actually switch back into the next shift run."

Working with the weather

This country swings between wet and dry years, not as extremely as states in Australia, but our weather has a significant impact on hydro flows and generation. Mostly, generation from the bottom of the South Island flows north through the High Voltage Direct Current (HVDC) link across Cook Strait. This year, the southern dams were so dry, power had to flow south.

"This year we had the wettest on record," says Andrew.

"From January to September we've had 100 percent inflows which basically indicates it's about the wettest we've seen in 100 years of rain for a period of nine months.

"Which means we have been 'volume' focused in terms of moving river volume as we only have limited storage in Lake Taupo.

"We only have a 1.4 metre range with the lake and we use that range depending on the inflows. Between five and seven times a year we'll cycle that 1.4 metre range in Taupo.

"Obviously that's not top to bottom because as we are generating more rain goes into the lake so we tend to bounce around a bit."

The big reservoir

Andrew says in terms of generation storage, Lake Taupo contains 600 gigawatt hours worth of electricity storage, while the Waikato River contains 22 gigawatt hours of storage.

Of this total river storage capacity, 18 gigawatt hours are held in Lake Ohakuri, one of the first lakes on the river.

"The intermediary lakes don't have massive amount of storage, but they are very consistent," says Andrew.

"Under our consents we have to keep a constant flow out of Taupo, and we have 50 cubic metres per second coming out of the lake to feed the river. At the bottom we need to have 148 cubic metres per second coming out of Karapiro.

"I know we have a little bit of a mismatch there, with 50 in the top and 148 out the bottom, but down the side of the river are tributaries that feed in the extra 100 cubic metres.

"This 148 cubic metres per second has got a bit to do with the cooling requirements of the Huntly power station, in that we can't have the river too low, otherwise the power station (run by Genesis Energy) will have cooling issues on its thermal units. And that's part of our resource consent.

"It's also to keep the river being a 'river'. If we didn't have the minimum flow out of Karapiro the river could become too empty. Which obviously is not good, so the river is always maintained as a river and will always keep flowing."

Lake Taupo's 600 gigawatt hours worth of electricity storage represents around three months of market power, adds Andrew.

"So, as a storage pond, this is not a huge resource, and we have to focus on potential dry periods, and making sure we've got enough water to get through those dry periods.

"January to May is generally the driest period for us. We tend to start January with Lake Taupo reasonably full just in case we actually do go through a dry period, and we have enough fuel to carry us through to the start of winter. In general in May it starts to rain a lot and we get to refill the tank."

The technology

Before 1993 the company's hydro stations were staffed and operated 24/7. In 1993 it adopted the Landis+gyr SCADA system by which it could control all hydro operations from one site, based in Hamilton.

In 2011 the SCADA system was upgraded to a Honeywell SCADA system called Experion. The hydro controller uses Experion to manage eight dams, nine power stations and 39 generating units as well as the ancillary equipment and security systems.

There are over 80,000 alarmed variables across the hydro system, which feed into the Experion system.

The system can be run from Hamilton or any of the hydro sites along the river chain. In disaster recovery mode the system can also be run off laptops if, and when, required.

Social responsibility

Andrew says Mercury is mindful that the Waikato is a river enjoyed by communities along its length.

"We get around 60 flow and level requests a year from different stakeholders along the river asking for different lake levels.

"Karapiro is a popular spot for rowing, water skiing, hydro planes, other events, and triathlons and from October through till March and April we get flow and level requests every weekend so people can undertake their activities safely.

"In general, we meet every single one of those requests. If it doesn't pose a health and safety threat to our plant, or to our people, we will actually go out of our way to make sure that happens."

The exception, Andrew adds, is if someone is to make a commercial outcome of it.

"For example, for the filming of *The Hobbit* at Aratiatia, when they asked for an extra spill so they could film the dwarves going down the river in barrels, they were charged.

"But most of the requests come from non-commercial entities like Karapiro Rowing or New Zealand Rowing, and water skiers."

Waiting for the unexpected

With 39 generating units down the river anything can stop working, says Andrew, keeping controllers on their toes.

"We need to take them out for maintenance from time to time which throws a cat amongst the pigeons in regards to the hydraulic management of the river.

"So, no two days are the same for a hydro controller when he or she sits down because there is a chance they might suddenly not have a plant to use. They also have to be mindful not to overfill any lake, otherwise we will be forced to spill water and we don't like spilling water because it is energy down the drain.

"Which means we do have to be very forward looking in regards to outage planning. We aim to have full capacity over winter and get stuck into our maintenance over our summer months.

"But sometimes a plant fails in the middle of winter. So it can appear to be quite sedate at times but it can change at the drop of a hat. A controller can be sitting here trucking along, everything happening happily, and then we lose a plant and their whole day changes and they've got to rearrange their hydraulic views and how they manage the river.

"This is why, when it comes to the type of people we look for in a hydro controller, we look for very calm level-headed people who can make decisions very quickly and calmly under pressure." **WNZ**

From a contractor's point of view

Alan Titchall talks to Tim Gibson, the executive general manager Citycare Water, about the council-owned company's national maintenance division that was formed in 2010. The cornerstone of the division's success to date has been its three waters maintenance business that has 'quietly' taken some 60 percent of the local authority contract base for three waters maintenance in this sector.

Tim – tell us about Citycare and its business.

Citycare Group is owned by Christchurch City Council, but we have been operating in Auckland and other regions around the country for over a decade now. The business has just been through a significant transformation to push our focus on the key market sectors we operate in – water, property and civil.

Our main focus is on long-term asset management and optimisation but, in spite of being council-owned, even in Christchurch we are treated no differently to any other contractors and we need to compete on the same commercial and service terms as, for example, a Downer or a Fulton Hogan.

Citycare Water itself has over 500 full-time employees spread across the country, with major depots in Auckland, Christchurch, Wellington and Dunedin and we carry out a range of three waters maintenance services depending on the make-up of each regional contract.

Citycare Property and Citycare Civil are each similar sized operations and their focus is in property and open spaces maintenance, and civil construction and roading maintenance respectively.

Can you provide some detail of the three waters work?

We currently maintain over 19,000 kilometres of piping networks, so we estimate about 1.5 million people are served by the networks we are looking after for the four key metropolitan councils – Auckland, Wellington, Christchurch and Dunedin – as well as in areas like Banks Peninsula, Hawkes Bay, New Plymouth, Masterton, South Wairarapa, Timaru and Waikato District.

It's probably the metro/regional blend of our business that puts us in a strong, you might even say unique, position. We're keen not just to be seen as another contractor, but to actually be part of the nation's conversation about three waters.

In Auckland, we manage the maintenance and asset optimisation requirements for the southern network, on behalf of Watercare. If there is a burst water main or blocked sewer, for example, we are the guys who go in and fix it, but we work closely with all our clients to make sure there is a strong balance between the proactive and reactive maintenance of the assets and we collect an enormous amount of data on our customers' assets too, which helps

BioGill above ground bioreactors

Apex Environmental, a subsidary of Citycare, is the distributor for BioGill bioreactors which are said to 'turbo charge' nutrient removal from sewage.

The technology is designed to supplement underperforming systems or to substitute biological treatment in decentralised and municipal sewage systems, and is based on a premise of concentrating and maximising microbiology to remove solids, especially, in the biological secondary stage of the sewage treatment train.

At the technology's core is a uniquely designed nano ceramic membrane, or 'gill', that provides the support media to grow a thick treating biomass. As the biomass on the membrane is suspended, with one side receiving the high nutrient waste-stream and the other an abundant air supply, growth and metabolic performance is said to be maximised.

The patented membranes are arranged in multiple, suspended vertical loops with water delivered to the top of each loop. wastewater flows down the surface of the gills where the metabolic activity of the bacteria generates a convective air flow, moving upward in the air side between each set of loops. No blowers or aerators are used to provide oxygen for the biomass. BioGill membranes can achieve biomass density as high as 50,000mg/L or better.


Tim Gibson.

both us and them with planning and forecasting to stay on top of the network challenges.

We have a similar relationship with Wellington Water and with other clients around the country and we are also starting to grow our construction business in Auckland, having enjoyed strong success in that area in Christchurch through our inclusion in the SCIRT alliance.

We maintained Christchurch City Council's network before the earthquake, so as soon as it hit, we were directly involved in the initial response.

We provided hundreds of people and 30 to 40 tankers around the city supplying water. We've been a part of the Christchurch fabric from the initial first-response, through its recovery and then into the rebuild.

Following Havelock North, 'water' has been very much in the public face this year.

As you will know from attending the Water New Zealand conference, there are a number of urgent and inherent challenges associated with three waters network management – resilience, especially in light of the ageing asset base: funding challenges; the whole 'safe water' issue brought into the spotlight by the Havelock North incident; not to mention the impact that technology will inevitably have, noting that it's been termed 'disruptive' technology for a reason.

The Havelock North incident has obviously stirred things up considerably, with the topic of safe drinking water becoming a political hand ball in the recent election, but more importantly, the impact that has had on public trust in their water supply… and that erosion of trust, will necessarily have an impact on water maintenance in the short term.

We are right in the thick of all of this and it's both very exciting and very daunting at the same time.

Does innovation play a part in the water division's success?

Innovation has an increasingly important part to play in any asset maintenance operation.

Data is foundational to understanding pressures on networks, the likely timing and cost of future investment and expected future service needs. The right kind of data, such as maintenance trends, spend patterns, event correlations, all needs to be collected in a consistent and comparable way so that infrastructure condition and performance can be meaningfully compared and benchmarked, and infrastructure providers can better understand network inter-dependencies and critical service pinch-points.

For Citycare Water innovation has to be built around driving technology that better enables 24/7 'real-time' field service diagnostic and scheduling capability and closes the gap between reactive asset servicing and proactive asset management.

We need to help our customers understand how the proactive use of smart asset condition data informs the capital works programme for that asset or network of assets and significantly reduces the long-term cost of asset ownership, through less disruption to service and the ability to reduce unscheduled maintenance.

Can you provide a specific innovative technology?

There are lots, but if I could single two areas out where we think we have a technology solution that puts us into a better space than many of our competitors, it would be our proprietary EventManager technology and our major shareholding in a water treatment specialist business called Apex Environmental.

EventManager is just a data-collecting beast. We have over 3000 current users, all able to use the technology to help manage their asset data, tasks and events in real time, as well as being used by our teams in the field for workflow management, data collection and electronic time sheeting.

Apex is a treatment plant design build company run by two exceptionally smart design engineers who are always looking to bring new and useful technologies into the country, like BioGill, which is the product we promoted at the 2017 Water Conference (see side story).

Where do you think the chlorinated debate will end up?

It's difficult to say. The keynote speaker's presentation (Dr Steve Hrudey) at the Water New Zealand conference clearly showed that it doesn't take much to inadvertently poison a whole lot of people. He showed case studies in Canada and Europe where water supplies got infected and caused deaths and Havelock North is our own example of this.

We don't have a regulator in this country, so the responsibility lies in the hands of the local councils and they each currently have different opinions on chlorination.

In Christchurch, for example, the water comes from really good quality and secured aquifers, so they don't chlorinate – although they did disinfect in some areas as a precaution after the earthquakes. And there are a number of other councils around the country that don't currently disinfect their water.

You need robust Water Safety Plans … and probably a good maintenance contractor! **WNZ**

FOG
Fats, oils and greases

Treating FOG using bioadditives in grease converters and their alternative uses, by **Keith Davis**, former technical adviser to a community liaison group of residents affected by the building of Wellington's Moa Point Wastewater Treatment Plant.

In 2008-09 a problem began to appear with FOG build up in the wet well of Wellington's Moa Point treatment plant's inlet pumping station.

Not only was there a problem with the build up of odorous FOG that had to be physically tankered away but there was also interference with the station's pump control systems.

This warranted further investigation as the build-up of FOG coincided with the introduction of proprietary FOG interceptors termed grease converters using a technique of adding bioadditives that would break down the collected FOG mass into carbon dioxide and water.

The following is a summary of what was found after an investigation was carried out as to just how well the grease converters operated and if they meet suppliers' claims.

While there have been improvements made regarding the bioaugmentation process of recent times the following facts and opinions may be useful to those who use or are interested in the process.

Bioaddtives and bioaugmentation

Bioadditives can be best described as a mixture of bacterial cultures together with a range of nutrients plus lipase to act as a starter.

The bacterial cultures produce more lipase, the essential element that by the process of hydrolysis breaks the FOG into its two basic compounds, fatty acids and glycerol. Whether or not carbon dioxide and water were the likely end products was to be determined.

There are a number of FOG formulations on the world market, many of which can be added directly to the waste flow or to the 'grease converter' and consisting of lipase, selected bacterial cultures and nutrients.

What the investigation found

Much of the FOG was not 'treated' due to lack of contact and mixing with the bioadditives.

Chemical analysis showed that the bacterial cultures had brought about hydrolysis of some of the FOG resulting in a drop in pH due to the fatty acids being produced.

The findings did not support the commercial claims that carbon dioxide and water were the main end products of the bioaugmentation process.

FOG cannot be readily acted on by bioadditives action unless it is well dispersed into the FOG mass where it can be broken down to produce fatty acids and glycerol (a full explanation is available on request). As the FOG contents are acting in an anaerobic environment no further action is likely to take place.

Commercial claims appear to have been based on data supplied by the bioadditive manufacturers whereby patent application data showed that all tests were carried out under carefully controlled laboratory conditions of contact time, mixing, temperature, pH and oxygen availability, using a respirometer.

Such conditions being far removed from that found in a grease converter where there was no control over contact time, mixing, temperature, pH and availability of oxygen. As a result, the end products were those found, fatty acids and pH as low as 4.5.

Issues raised

Local authorities may be concerned with the low pH values in effluents from grease converters and what controls or treatment and what conditions could be imposed on the discharger.

The VFAs are miscible with water and are weakly dissociated. They show up as pH values as low as about 4.5 and being so weak are unlikely to present any major problems in terms of corrosion in the sewer network.

There are three options available. Simply ignore low pH values where there is substantial flow in sewer, require the effluent to be neutralised or amend trade waste bylaws to exempt FOGs and grease converters from pH control.

Once the effluent is mixed with the main-stream waste flow there should be sufficient buffer available to

A grease converter in action.

accommodate the discharge from a grease converter.

If neutralisation is to be preferred then the cheapest and safest agent would be sodium carbonate but this introduces more costs, management and maintenance problems.

If an authority has seawater intrusion into the wastewater network, the fatty acids could aid the reduction of sulphate in the seawater to produce hydrogen sulphide which in turn could be oxidised, under aerobic conditions to corrosive sulphuric acid.

Improved grease converter performance

The key to the success of bioaugmentation, at least to the end of the hydrolysis stage of treatment, is the keeping of the organism's lipase mixture in contact with the FOG at all times. This is best done by some form of mechanical mixing but would be impractical in most cases and defeats the purpose of FOG water separation which needs quiescent conditions to be effective.

It is understood that some improvements to tank design have been made over the last year or two and these changes may not be enough to maintain continuous contact between the bioadditives and the FOG. Continuous contact is the key to the success of the process as it has the potential to minimise blockages in wastewater disposal systems.

Commercial entities may need to give further thought to improve the hydrolysis of FOG wastes.

> **"Used prudently the bioadditives may minimise the risk of blockages in wastewater treatment systems or as a clean-up tool involving FOG spillages that cannot be dealt with by any other means."**

Alternative uses for bioadditives

Bioadditives have a role to play in the clearing of blocked drains and for general purpose cleaning of sewers and pump station wet wells provided that the intimate contact problems can be overcome. It has recently been noted that 'bioadditive sticks' for kitchen use have come on the market.

Used prudently the bioadditives may minimise the risk of blockages in wastewater treatment systems or as a clean-up tool involving FOG spillages that cannot be dealt with by any other means.

It is suggested that a technical group be set up to further enhance FOGI design and operation as well as bioaugmentation and alternative uses for bioadditives in today's environment where FOG blockages in wastewater systems appear to be on the increase. **WNZ**

How SMEs can win
game-changing contracts

With major plans to upgrade or build three waters assets over the coming years, there are many opportunities for small to medium enterprises (SMEs) to get a piece of what is an ever-increasing pie. **By Heather Murray**, from Plan A.

One of the best things about being a bid writer is helping a client win that 'game-changing' contract. What is even better is watching them grow off the back of that win, providing more people with jobs and the market with more options.

Unfortunately, many SMEs are reluctant to bid. There are a number of reasons why – ranging from the belief that government organisations are only interested in working with the 'big guys', to being daunted by the process or simply under-resourced.

Bidding is not as hard as you think. It's about understanding the process, finding the right opportunity, resourcing appropriately and appreciating the risks.

It starts early

Most government tenders have mandatory requirements especially when it comes to health & safety, quality and the environment. These requirements are often eliminators for SMEs that are ideally suited to the contract.

Identify what upcoming contracts you are interested in so you can address any barriers to entry. The Australia & New Zealand Infrastructure Pipeline (ANZIP) website is a good place to start as it provides a forward view of public infrastructure activity across both countries. Watercare, Wellington Water, the NZ Transport Agency and a number of councils publish their pipeline of work on their websites.

This is also the time to start building those relationships and letting your future customers know you're ready and keen to work with them.

Get your foot in the door

Most government agencies rely heavily on your past performance when awarding a contract. Start by tendering for smaller contracts which will place you in a stronger position for the 'big' win. This is about getting your foot in the door and building those relationships and credibility.

Partnerships and subcontracting

Aligning with a large player is a good way to get some bigger projects into your portfolio. If an opportunity comes up that you are ideal for, but don't stack up for in terms of experience and track record, then consider a partnership.

If you've got a working relationship with a company that is already involved in government contracts, try to secure as much of their subcontracted works as possible, which will provide you with some 'big' contract experience.

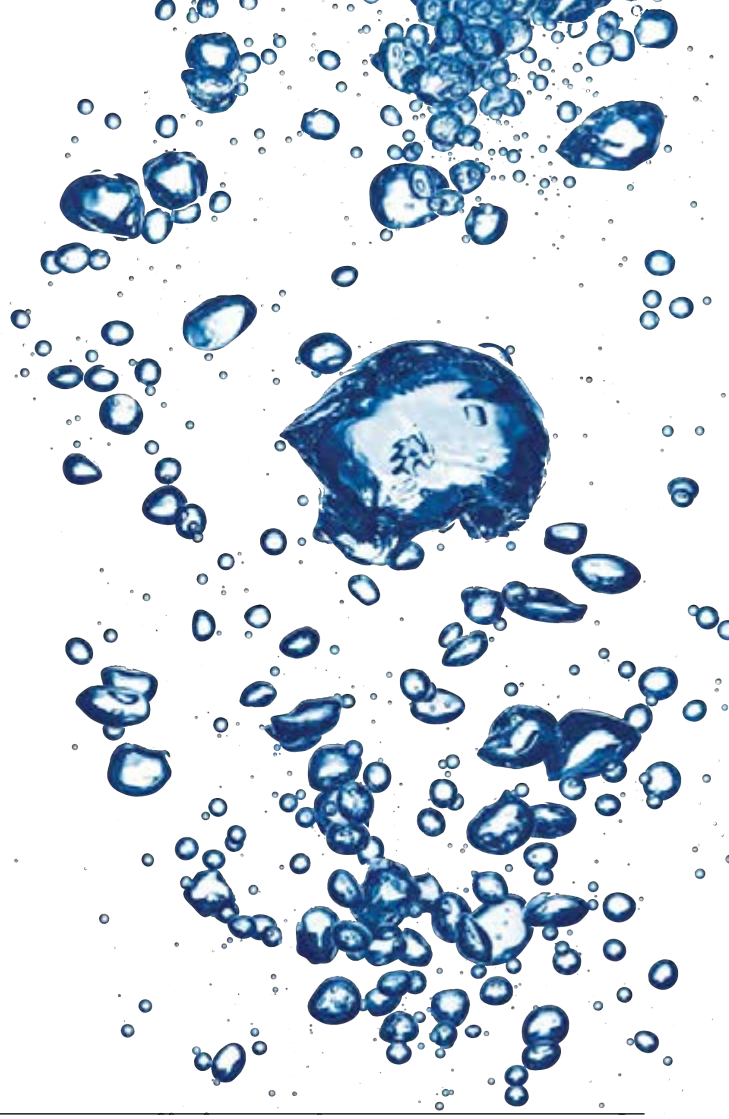
If it's possible, use those opportunities to build relationships with end clients such as councils. A quote from a member of the public on the great work your team did can be very valuable.

> **"The Australia & New Zealand Infrastructure Pipeline (ANZIP) website is a good place to start as it provides a forward view of public infrastructure activity across both countries."**

Go for industry awards!

Once you have a project under your belt, it can be extraordinarily valuable to you if it is entered into regional or national awards, such as the Water New Zealand annual awards. There are categories for all kinds of contracting jobs, even small, private jobs – and the publicity if you become a finalist can really put you on the map.

Tender scoring systems today often place award-winning past projects at the top; so they could launch you into winning future contracts.



Invest time and money

Government tenders require time and effort. Large companies often have entire bid teams whose sole purpose is to win work. For SMEs, this is seldom the case. You have to find time alongside your day job to put what is often a very complex document together – and still find the time to make it compelling.

An independent bidding expert who works with SMEs all the time, helping them to develop a win strategy which is interwoven into the document, can help you to determine 'what good looks like', and push your team to deliver a bid worthy of contract selection.

This means not only answering all the questions, but knowing what the answers should look like from a best practice perspective.

Importantly, the right investment in bid preparation can reap ongoing benefits. Having an 'attribute library' of base material (that can be used in the next bid) can significantly reduce time and cost for subsequent tenders.

Even if you lose, it's not all lost

While you may not win your first bid, your potential client now knows you're ready and able to step up so keep at it. They will have read your attributes and learnt essential information about your business that simply cannot be achieved through traditional marketing avenues. And if you win, the next tender is yours to lose as you're now in the game! **WNZ**

Water wash up

By **Helen Atkin**s, partner, **Vicki Morrison-Shaw**, senior associate, and **Rowan Ashton**, solicitor, of Atkins Holm Majurey.

Introduction

After a year which has been described as "the year it didn't stop raining"[1], water remains a hot topic this spring. The general election is now over with a change of government for the first time in nine years. The new Labour and New Zealand First coalition government is likely to bring a number of changes – including to the water sector.

The recently released Labour and New Zealand First Coalition agreement has signalled a number of priorities for the water sector. These include a commitment to higher water quality standards for urban and rural areas and a requirement for water bottling operations to pay royalties. A general water usage tax is however off the table – at least for the next three years. The Labour and Greens' confidence and supply agreement likewise prioritises water quality but also mentions funding for freshwater enhancement and winding down government support for irrigation.

Outside of those big-ticket items exactly what changes will be wrought and the impacts on water policy rules and regulations will only become clear once the new government has its feet firmly under the table.

In this article, we therefore take a slightly more retrospective view in focusing on matters that have already occurred or are in train. We commence with a brief overview of the changes to consenting provisions under the Resource Management Act 1991 (RMA) that recently came into force. We then move on to outline the Ngarururo Water Conservation Order application and its current status. We conclude with commentary on two recent cases which are of interest as they discuss sentencing principles for undertaking works in water bodies without consent, and the need for clear wording in district plan rules to exclude activities from notification.

Finally, as this is our last article for the year, we would like to take the opportunity to thank you for reading our articles this year and to wish you all a safe, happy and relaxing festive season and a happy and prosperous New Year.

Recent changes to RMA consenting provisions

On 18 October 2017 a raft of changes to the consenting provisions in the RMA came into force. The changes were enacted as part of Resource Legislation Amendment Act (which was passed in April this year) but their implementation was delayed to allow time for councils (and others) to make necessary changes to forms and processes and to enable guidance materials to be produced. The Ministry for the Environment has now produced a number of guidance materials and fact sheets detailing the effect of the various changes.[2]

Some of the key changes to the consenting provisions include:

- exemptions from consent being required for "boundary activities" (such as minor setback breaches), and certain marginal or temporary rule breaches;
- new fast track (10 day consent) processes for non-notified controlled activity consents and other activities specified in regulations;
- a new step by step process to determine whether to notify consent applications;
- confirmation that certain consent applications cannot be notified – those prescribed by regulations and most controlled activities;
- a requirement for decision makers to expressly consider positive effects and measures proposed to offset or compensate for any adverse effects;
- the ability for regulations to be made to require councils to fix charges for certain consent decisions, commissioners and hearings;
- the ability for an applicant to require that its objection be heard by an independent commissioner for certain consent applications; and
- limited appeal rights in relation to residential and boundary activities.

While the intention of these changes is to reduce red tape and speed up consenting for certain (mostly residential type) activities, such changes may also indirectly impact other consent activities. This is because councils only have limited resources to process consents. So while it may result in more specialist staff and fit for purpose processes being developed, it may also (particularly where resources are stretched) result in priority being given to the fast track activities, over non-fast track or more complex activities. Only time will tell what impact the flow on effects of the changes will have for other non-fast track activities.

Water Conservation Order

Ngarururo River Water Conservation Order Application to be heard before Special Tribunal

A Special Tribunal has been appointed by the Environmental Protection Authority to hear a Water Conservation Order (WCO) application in respect of:

1. the entire length of the Ngarururo River;
2. the tributaries and hydraulically connected groundwater to the Lower Ngarururo River; and
3. the seven-kilometre-long Clive River.

The WCO is sought by the New Zealand Fish and Game Council, the Hawke's Bay Fish and Game Council, Ngati Hori ki Kohupatiki, Whitewater New Zealand, Jet Boating New Zealand, and the Royal Forest and Bird Protection Society of New Zealand. Their application states that the rivers have certain outstanding values including:

1. significance in accordance with tikanga Maori;
2. cultural and spiritual purposes;
3. habitat for rainbow trout;
4. angling, amenity and recreation;
5. habitat for avifauna;
6. habitat for native fish;
7. boating amenity and recreation;
8. wild, scenic and natural characteristics; and
9. scientific and ecological values.

The applicants seek protection of these values through a number of prohibitions and restrictions. These include rules to maintain flow rates in the waterbody by limiting abstraction and precluding the grant of resource consents for discharges of contaminants that would cause water quality criteria to be breached.

The WCO application has proven controversial as it is being heard while the TANK (Tutaekuri, Ahuriri, Ngarururo and Karamu catchments) process is proceeding. TANK is a collaborative stakeholder group which was established in 2012 to recommend water quantity and quality limits for the Greater Heretaunga and Ahuriri catchment, in order to give effect to the National Policy Statement for Freshwater Management. The group is made

1 *http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11925217*
2 *http://www.mfe.govt.nz/publications/rma/resource-legislation-amendments-2017-fact-sheet-series#fseight*

up of approximately 30 representatives from agricultural, horticultural, and public health sectors; environmental and community interest groups; regional and district councils, and tangata whenua. Some water users see the WCO application as cutting across the collaborative TANK process.[3]

The WCO application has also been controversial as it includes "hydraulically connected groundwater". When the application was lodged in December 2015 the extent of the hydraulically connected groundwater was not known. The science developed through the TANK process has indicated that the extent of the groundwater hydraulically connected to the lower river groundwater is greater than first thought and also affects the lower river. This means that the WCO application is likely to affect more users and industries than first thought. There is therefore potential for the application to be re-notified as it applies to the lower river.

The Special Tribunal has issued directions for a hearing to commence with respect to the upper river in December 2017. This split hearing is intended to enable TANK science to catch up with the WCO process so that the Tribunal has a verified authoritative hydrological model of the river.

Recent cases

In this section we profile a case on prosecutions for unlawful works in relation to a wetland which is a timely reminder of the need to ensure consents are obtained, prior to undertaking works, and of the sentencing principles that apply if a prosecution is brought. We also summarise a notification case that is of interest as the court makes findings on the wording of plan rules which purport to exclude notification of certain activities.

Marlborough District Council v Gill Construction Company Limited and Anthony Charles Gill [2017] NZDC 20237

The defendant, Gill, diverted a water course that fed a high value wetland on its property in order to develop a vineyard. The work was undertaken prior to securing consent. A report undertaken for the Council showed that if remediation was not undertaken the works would have very significant long-term adverse effects on the wetland.

The defendant undertook some restorative work immediately and obtained a resource consent to carry out additional site works including remediation and enhancement of the wetland.

Council prosecuted Gill for undertaking the work without consent and Gill pleaded guilty to the charges. The issues in this case were therefore around the application of the relevant sentencing principles. The court confirmed that the principles to consider in sentencing were:

- the nature of the environment affected and the environmental damage inflicted;
- the degree of culpability or deliberateness in the offending;
- the gravity or seriousness of the offences committed;
- the size and nature of the defendant's operations, financial position and other circumstances;
- deterrence both personal and general; and
- the defendant's attitude.

In considering these principles the court found that Gill made a deliberate choice to undertake unlawful work and deal with the consequences later. Gill was a well-established local contractor that deliberately flouted its legal responsibilities for commercial gain and in doing so compromised the capacity of the Council to fulfil its statutory functions (under s 6(a) of the RMA) to preserve the natural character of the wetland. Gill set a bad example by its actions and it was important to show others that crime does not pay. The court determined a fine and an enforcement order to be an appropriate penalty.

In terms of quantum the court considered fines imposed in other cases, but noted that it was always difficult to find a case that is on all fours with another. The court decided on $50,000 as a starting point, and then reduced that amount by 25 percent for an early guilty plea, 20 percent for extraordinary remorse, five percent for the defendant's clean record, and a further small reduction to produce a final figure of $25,000 (or half the starting point). The Council sought a reparations order to cover the cost of the report it had commissioned on the wetland. However, the court refused this on the basis of the extent that the defendant had and would be going to restore and enhance the wetland.

Sydney St Substation Limited v Wellington City Council [2017] NZHC 2849

To notify, or not to notify, that was the question at issue in this case. Equinox Capital Limited (ECL) applied to Wellington City Council for consent to construct a 10 storey (39.5 metres tall) building to be used for residential and hotel purposes. The site was directly next to the Sydney St Substation – a two storey heritage building that had recently been restored.

Prior to the consent being granted the owners of the substation expressed concerns to Council and indicated that they considered the proposal would have significant adverse effects on their building.

The Council considered the proposal and concluded that the effects were minor and no-one would be affected – including the owners of the substation. The Council recognised the owners' interest but indicated that such an interest did not amount to an adverse effect and was not a special circumstance requiring notification. Also as the proposal was a restricted discretionary consent the Council considered it was precluded from notifying the consent due to rules in the District Plan which stated that such applications "do not need to be publicly notified" and "do not need to be served on affected persons". The Council therefore granted the consent non-notified. This decision was judicially reviewed.

The High Court disagreed with the Council and found that the wording of the District Plan rules did not preclude notification:

> "[86] In any event, on a straightforward and literal approach the idea that something 'need not' or 'does not need to' be done is not the same as 'precluding' the doing of that thing. Something that is precluded is prohibited. Not being required to do something is not the same as being prohibited from doing it.
>
> "[87] The view I have formed based on the plain meaning of the word 'precludes' is fortified by the fact that the effect of any preclusion in the rules would be to limit (and in fact obliterate) natural justice rights otherwise conferred by the statute (albeit contingent ones). While I accept that that is what the new ss 95A and 95B contemplate (a matter which is, in itself, somewhat objectionable), I consider that the relevant wording would need to be much stronger and more unequivocal in order for it to have that (preclusionary) effect."

This is an important finding as councils commonly word their non-notification rules in this manner. That practice will now need to change if notification is to be precluded for certain activities.

The court also queried the wisdom of the relatively widespread practice of issuing notification decisions which depend on the substantive decision:

> "[66] ... Because the reasoning in relation to the notification decision is dependent on the reasoning in relation to the substantive (s 104) decision (and I must confess I have some doubts as to the wisdom of this conflationary practice) it is necessary to consider the substantive decision first."

The High Court set aside the both Council's notification and substantive decision and granted costs to the owners of the heritage building. **WNZ**

3. http://www2.nzherald.co.nz/the-country/news/article.cfm?c_id=16&objectid=11917567

We never know the true value of water until the well is dry


Numerous events are occurring across the globe that are increasing awareness of the real value of water. By **Dr Verno Jonker** (left) and **Dr James Cullis**, both from Aurecon Group.

Recently, Australia experienced a one-in-1000-year drought, while two separate state-wide emergencies were declared in California, USA – both of these related to droughts.

In early 2016, countries in southern Africa were experiencing the worst drought in decades with record low levels in lakes, rivers and reservoirs resulting in severe water and power shortages in the region. Large parts of Johannesburg, the economic hub of South Africa, were without water for almost a week due to heat waves and operational issues.

Also in South Africa, the city of Cape Town initiated the penultimate Level 3 water restrictions (and later, with dam levels critically low, the maximum Level 4 restrictions), forcing households and business to take extreme action to comply with critical water-saving measures.

Almost every day, there are constant reminders of the increasing scarcity of water and the importance of managing this essential natural resource in the face of ever-increasing demands, degrading environmental conditions and natural climate changes.

It was Benjamin Franklin (1706-1790) who famously said: "When the well is dry, we know the worth of water."

The value of water

Clean and safe water is the single, most important prerequisite for life, the environment and for healthy living.

Sadly, while many countries spend up to 20 percent of their national budgets on healthcare, investment in quality water supply remains inadequate. Globally, 1.1 billion people still do not have access to safe drinking water and 2.6 billion people – half of the developing world – lack even basic sanitation facilities.[1]

As a result, four out of five illnesses in developing countries have been linked to poor water and sanitation, and one in every five child deaths worldwide (under the age of five) is related to waterborne diseases. Even in developed countries, a lack of attention to the protection of critical water supply sources can have significant human health implications.

Food production is totally dependent on water. Without water security, our crops and livestock are put at great risk. By 2050, it is expected that food production will demand 20 percent more water than it does currently due to the increase in global standards of living, and the trend towards diets consisting of meat and dairy products. The volume of water intrinsically required in the cultivation and production of food and other products is significant. It takes 600 litres of water to produce 500 grams of wheat, 1000 litres of water for one litre of milk, and 4600 litres of water to produce one 300-gram beef steak.[2]

World leaders are now realising the true value of water and how improved water stewardship pays high economic dividends in the long term. At the 2017 World Economic Forum Annual Meeting in Davos, Switzerland, water once again took centre stage in the forum's Global Risk Report.

The report reflected a growing recognition that diminishing supplies of reliable, clean water will significantly impede the economic growth of poor and rich economies alike. Water is also considered to be one of the primary channels manifesting the social and economic impacts of climate change.

According to a recent World Bank report, the price of poor water stewardship or water scarcity could prove costly to economic growth. In some regions, GDP growth could decline by as much as six percent in just a few years, primarily due to the impact of climate change on water resources availability.[3]

The increasing risk of reduced water security forces governments and businesses to focus on the value that water brings, and the importance of investing in the careful management of this precious resource.

Big businesses now recognise the true value of water, prompting many to consider the availability of water resources when making decisions about where to invest or locate their facilities, while also making significant investments in improving their water use efficiency.

Considerations around unreliable water supplies, more

1. Source: UNICEF and World Health Organisation Report (2015). 25 Years of Progress on Sanitation and Drinking Water. Available from: www.wssinfo.org

2. Source: www.waterfoorprint.org.

3. Source: World Bank report (2016). High and Dry: Climate Change, Water and the Economy. http://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy

frequent and extreme floods and droughts, water pollution and the threat of climate change that may put bottom lines at risk, are now becoming the norm.

This has resulted in companies proactively making efforts to protect critical water resources areas through catchment rehabilitation, while supporting the development of water supply systems to surrounding communities, as well as to their own factories and plants.

Water-dependent sectors such as agriculture, fishing, power, mining and industry, as well as downstream sectors such as manufacturing, are major contributors to employment particularly in developing economies.

According to the '2016 United Nations World Water Development Report on Water and Jobs', three out of four jobs worldwide are water-dependent. This further highlights the co-relationship between water and socio-economic development.

Access to clean drinking water and sanitation is also necessary for a healthy and productive workforce. Cities, the primary economic drivers for most economies, are dependent on water supplies, and have traditionally developed in areas close to a reliable source of fresh water.

Hydropower, which represents approximately 16 percent of total global electricity production, poses huge opportunities as a clean and renewable energy source, particularly in Africa. However, it needs to be carefully managed and planned for to avoid unintended consequences and to mitigate future uncertainties.

Improved water stewardship also contributes to other social and ecological co-benefits. This is demonstrated by the highly successful programmes implemented by the South African Department of Environmental Affairs: Working for Water, Working for Wetlands, and other 'Working for' programmes – excellent examples of what is considered 'quality infrastructure' by the Infrastructure Consortium for Africa (ICA) – essential for future sustainable development.

Water as a catalyst for peace

One of the greatest challenges for the future is how to ensure sufficient and sustainable water supply for a global population in excess of seven billion. Sustainable water resources management requires collaborative partnerships among diverse stakeholders that aim to unite different interests, consolidate knowledge, maximise benefits and manage conflict.

While the human right to water and sanitation acknowledges water as a shared resource, this right brings with it complex hydrological, social, environmental and economic interdependencies. Our growing world, with more people and general activities, will demand more water and generate more pollution. This impacts and threatens ecosystems, water sustainability, peace and security.

Along with other global human factors, such impacts threaten the future and certainty of our global water supply. Exacerbated by inadequate infrastructure spending, maintenance and poor management or governance, risks are set to deepen, and today's extremes might become the norm.

The equitable sharing of water and a holistic approach to basin development and management could however be the necessary catalyst for improved cooperation between countries, and a major contributor to regional peace and security in shared river basins. This is especially relevant taking into consideration that 40 percent of the world's population live in close proximity to shared river and lake basins. Africa, for one, has 59 transboundary river basins.

Looking ahead

The growing funding gap to keep up with the rehabilitation, operation, and maintenance of ageing water infrastructure is a global concern, particularly in the current age of austerity. Water also suffers from the 'tragedy of the commons', in that it is often thought to be somebody else's problem to ensure sustainable management of the resource.

It is pivotal that new water systems are built to cope with increasing populations, shifting consumption patterns, improving technologies, an uncertain future and a changing climate. This is the only way we can guarantee the security of our water in the complex times of our future.

How do we tackle these challenges? We need to think differently. We need to create new sustainable and resilient

water realities based on a comprehensive understanding of problems, imaginative approaches, cooperation, new paradigms, and new technologies.

Aurecon's contribution in ensuring the global future of water

For over 80 years, Aurecon has been contributing to improved water security through sustainable water resources planning and management in many of the large, transboundary river basins across Africa.

Projects include integrated water resources and management development plans, catchment management strategies, hydromet network designs, catchment rehabilitation and various planning, feasibility and operational studies ranging from small hydropower projects to large and complex water resources systems.

A showcase project was the pilot application of the Nile Basin Decision Support System.

Aurecon is involved with climate change studies related to water resources and recently completed a study of the economic impacts of climate change in South Africa, and the critical importance of an integrated bulk water supply infrastructure system to mitigate these impacts.[4]

4.https://www.wider.unu.edu/publication/uncertainty-approach-modelling-climate-change-risk-south-africa

Aurecon is also currently supporting the Department of Environmental Affairs (DEA) with the rehabilitation of numerous wetlands as part of the Working for Wetlands programme in South Africa.

In addition to water resources management, Aurecon designs and develops bulk conveyance systems and innovative water treatment and wastewater treatment plants. Examples include the Preekstoel Water Treatment Works in South Africa, which has provided cost-effective and innovative means of securing the water supply requirements of the Greater Hermanus area, and the Adelaide Desalination Plant in Australia, which has made the introduction of desalinated drinking water into Adelaide's water supply network a reality.

Both projects have gone on to win a number of industry awards such as the 2015 Construction World Best Projects Award in South Africa, and Project of the Year at the 2013 Project Management Institute Awards in Australia.

These are a small selection of our water-related projects that showcase 'out-of-the-box' solutions, the benefits of which the local communities enjoy and will keep enjoying for years to come. Looking ahead, Aurecon will continue to deploy its global pool of creative thinkers to address critical water resource challenges of the future. As part of our Design to Innovate philosophy, we invite you to join us.

Together we can co-discover innovative solutions that realise the true value of water. **WNZ**

Manuka planting for water quality

By Maria Gutierrez Gines, Institute of Environmental Science and Research; Brett Robinson, Canterbury University; Jennifer Prosse, Lowe Environmental Impact; and Juergen Esperschuetz, Minakshi Mishra and Jacqui Horswell from Lincoln University.

The recent report 'Our Fresh Water 2017' by the New Zealand Ministry for the Environment states that more than half of the river sites monitored in the past two decades have increased their nitrogen concentrations.

Only 34 percent of the monitored lakes are in a good state. Compared to rivers running through native ecosystems, our urban and rural waterways have levels of *Escherichia coli* that are 10 to 20 times higher.

As a consequence of this increasing degradation of water quality (and quantity) 72 percent of native fish, 34 percent of native invertebrates and 31 percent of aquatic native plants are threatened with, or at risk of, extinction.

Run-off from farming areas, livestock waste, fertilisers, pesticides, septic tanks, wastewater, and stormwater are the main contributors of nitrogen, phosphorous and pathogens into waterways and groundwater.

In addition to this, the deforestation of many areas adjacent to waterways has increased the erosion of river banks, and removed the natural barrier that reduced the inputs of nutrients (mainly N and P), sediments and pathogens to streams from agricultural and urban areas.

Nutrients, sediments and pathogens are the three main agents causing pollution to freshwater and coastal systems. Reducing these 'big three' has become part of regional council plans and policy throughout the country and establishing vegetation adjacent to waterways demonstrably improves water quality in most regions.

The benefits of restoring native vegetation along river and lake margins are numerous. Apart from the obvious value of ecosystem restoration, native vegetation can be a source of valuable natural products, which is a key economy sector recognised by New Zealand Trade and Enterprise. Manuka honey and essential oils brings in some $280 million per year to our economy.

There are developing markets for new natural products including kanuka essential oil, horopito antifungal medicine and horopito cooking condiments, and the totara antioxidant compound totarol. Less obvious, but critically important, is the contribution that restoring native vegetation can have on improving water quality.

Ten years ago, researchers of the Centre for Integrated Biowaste Research (CIBR) started investigating ways of using native species to improve environmental quality in rural and urban areas. The first step was to investigate whether the well-known antimicrobial properties of manuka and kanuka (*Leptospermum scoparium* and *Kunzea ericoides* – both natives to New Zealand and Australia) could be used for environmental purposes. They discovered that root extracts of these plants inhibit the growth of *E. coli* and other pathogens[1,2].

Since that discovery, many experiments demonstrated how the beneficial properties of these species could be used to treat organic wastes. Greenhouse experiments revealed that manuka and kanuka could reduce the survival of *E. coli* and *Salmonella* sp. in soil compared with pasture. The time taken to achieve 90 percent reduction in *E. coli* (decimal reduction time) was just five and eight days for kanuka and manuka respectively compared with 93 days for rye grass[3]. These results show that biowaste, including sewage sludge, biosolids, effluent, or dairy shed effluent, could be used to establish these species on marginal lands, where other farming activities are not possible. Both manuka and kanuka grew well in the high fertility environments created by the biowaste application, and reduced the pathogen load of such biowaste.

Since most pioneer species in New Zealand (such as manuka and kanuka) are adapted to low fertility soils, it was not clear whether they could thrive in the high fertility conditions created when biowastes are applied to land, as biowastes are a rich source of nutrients.

Further experiments with up to 13 pioneer species showed that they benefit from the addition of such nutrients[4,5], showing better growth and nutrient composition, so their use for land application of biowaste could be an excellent way of deriving those wastes from landfilling.

In the same way that manuka and kanuka roots systems had been demonstrated to reduce the growth of pathogens in soil, the idea of "what could they do" with the soil bacteria related with nitrogen cycling started to take form.

In vitro experiments with *Nitrospira* sp. and various plant extracts demonstrated a reduction of nitrate production in the presence of manuka and kanuka extracts[6]. Nitrate is generated by microbial organisms in the soil by nitrification from ammonium (Figure 1).

Due to its high solubility, nitrate is the main species of nitrogen responsible for pollution of rivers, streams and lakes, causing algal blooms. In the following years, the research moved from test tubes to small pot and lysimeter experiments where manuka and kanuka were grown with different sources of nitrogen such as urea, or different biowastes like dairy shed effluent or sewage sludge. The results of all the experiments demonstrated that manuka and kanuka can significantly change the nitrogen cycle. When sewage sludge was added to the soil, the total amount of nitrate leached under manuka was just one third of the nitrate leached under pasture.

When urea was added to the soil, the nitrate leached under manuka and kanuka was 25 times less than under radiata pine[7].

Similarly, the emission of nitrous oxide – a potent greenhouse gas – was seven times lower when kanuka was growing than when pasture was growing, after applying dairy shed effluent[8].

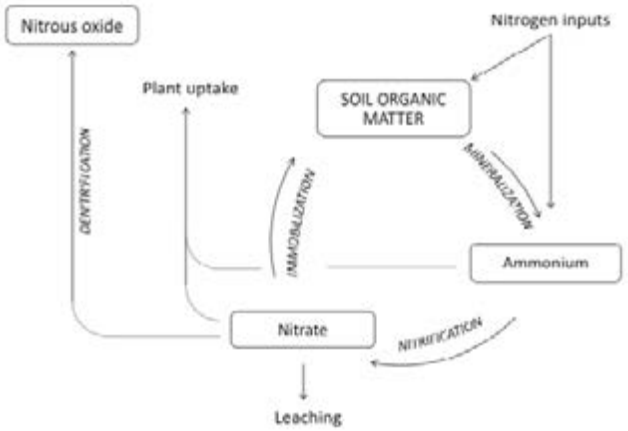


Figure 1. Nitrogen cycle.

The root architecture of manuka and kanuka is a crucial factor affecting their interactions with pathogens and nitrogen.

Our experiments have shown that under high irrigation regimes, the roots of manuka and kanuka create routes of preferential infiltration, compared with pasture. In pasture water can pond on the surface for long periods of time.

This means that under heavy rain events, or high application of liquid biowaste – such as treated municipal wastewater or dairy shed effluent – manuka and kanuka could contribute to reduced run-off, and increase infiltration of biowaste and water into the root systems, where the antimicrobial effect takes place.

Moreover, when solid biowaste (ie, biosolids) is applied to land, manuka roots forage patches of biosolids [9], increasing the presence of roots in the biosolids, where roots will uptake nutrients, reduce the conversion of ammonium to nitrate and inhibit the growth of pathogens.

The implications of such findings are highly important, since these plants are not only able to reduce the pathogen and nitrate leaching from biowaste, but also access the nutrients those wastes contain. So far all our experiments have been conducted in controlled conditions ie, laboratory, greenhouse and lysimeters; we now need to move into real problems in the real world.

There is a general interest in increasing the land application of treated municipal wastewater, and to divert discharge from waterways, where it can increase the nutrients, creating algal blooms.

We hypothesized that manuka, kanuka, and other native species could be used to land-treat this effluent, since these plants would reduce the leachate of nitrate, pathogens, and would benefit from the nutrients present in the treated wastewater.

Christchurch City Council funded a project carried out by the CIBR team investigating the potential of discharging treated municipal wastewater into different assemblages of native vegetation.

After two years of irrigation into native species, results show an increase in growth of all the species tested, compared with non-irrigation.

Furthermore, we have not found any evidence of nitrate leaching, or any negative effects of irrigation on soil structure. These results led us to propose a real scheme of land treatment of treated municipal wastewater over a manuka and kanuka plantation.

The Freshwater Improvement Fund (Ministry for the Environment) and Horowhenua District Council are funding a project led by Lowe Environmental Impact, where CIBR is collaborating, for irrigating 10 hectares of manuka and kanuka with treated wastewater, and demonstrate a reduction of inputs of nitrogen into Waiwiri Stream, caused by the current irrigation on a pine plantation.

These above experiments led us to pose the question of introducing native species into the livestock exclusion zones around waterways.

As well as the well-known benefits of riparian plantings (increased infiltration and reduced erosion), the presence of native species such as manuka and kanuka could actively reduce the pathogen and nitrate leaching into the waterways.

The Waikato River Authority is funding a five-year project that will look at re-planting four hectares of manuka dominated native ecosystems on the banks of Lake Waikare in the Waikato.

The project is a collaboration between Nga Muka (Ltd), Te Riu o Waikato (Ltd), Matahuru Marae/Nikau Farm Trust and the Waikato Regional Council.

CIBR, along with representatives of the local Maori interests, will monitor the water quality at the site to determine if manuka-based ecosystems effectively attenuate pathogens, plant nutrients and sediment entering the lake.

A similar field trial is being undertaken around Lake Wairarapa with support and assistance from Greater Wellington Regional Council, Rangitane, Kahungunu ki Wairarapa and Manuka Farms.

Although we are optimistic about the scientific results that we will obtain with these projects, the working in real scenarios poses new challenges and opportunities that are not evident in the laboratory environment.

A key aspect of on-farm planting is the costs and incentives for the land-owner. While the improvement in water quality is a laudable and near-universal aim for all stakeholders, retiring areas of productive farmland and

paying for fencing, planting and maintenance of on-farm planting is expensive, sometimes prohibitively so.

Also, these experiments take place in areas with their own history, and local communities have their own expectations and values that are far beyond scientific purposes.

According to local Maori, at one time Lake Waikare was a source of sustenance, with history and connection for them. It was then safe to swim in. The degradation of the lake over the years has negatively affected the relationship of the iwi (local Maori) with the lake, so re-planting the lake margins goes beyond the potential of manuka to reduce nitrate and pathogen leaching. In this regard, this project is incorporating a significant amount of 'matauranga' Maori (pre-European Maori knowledge).

The field trials around Lake Waikare and Lake Wairarapa will provide working examples of the manuka-dominated planting that can be used as 'flagship' sites to promote future plantings. The data gathered can provide robust data on nitrogen and *E. coli* reductions for potential incorporation into farm models such as OVERSEER.

Most importantly perhaps, the trials involve direct involvement and participation of the local communities to maintain and monitor the sites and develop local capabilities.

It has taken nearly 100 years to degrade the water quality in many of our rivers and lakes, and we expect it will take at least a decade to restore the ecosystems.

Given time nature can heal itself, and our research has shown that native species have amazing properties and capabilities, many of which are still to be discovered. **WNZ**

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First BRE Global certification

Opus International Consultants is the first company in this country to be awarded BRE's highly sought-after Building Information Modelling (BIM) Level 2 certification for three of its New Zealand offices.

Awarded by BRE Global, the BIM Level 2 Business Systems certification is increasingly being used by engineering and infrastructure companies as it provides world-leading collaborative working processes for improving the quality of information provided at the design, construction and operational phases of an asset's lifecycle – from earliest conception right through to its demolition.

Opus' group director of buildings Lee Arasu says that, while the NZ-listed company was the first in the country to receive BRE Global's certification, he anticipates the industry will soon follow because of client expectations to reduce long-term asset ownership costs.

"Internationally, the building industry is increasingly using BIM to plan and mitigate issues, and many clients even demand it.

"By making building design and planning processes more efficient, BIM provides a multitude of opportunities for cost savings while improving competitiveness.

"Through our own BIM Level 2 certification, we will be able to offer our New Zealand clients a world-leading service that will help them better capture and manage their data, and enhance the value of their asset."

Opus CEO, David Prentice, adds that BIM was underpinning new innovations in the sector that would have a tangible impact on how buildings and other assets are designed and project managed.

"It's clear that the innovations emerging in response to the use of BIM will shape the future of the industry. It is part of the movement towards smart use of big data and a more connected society. New Zealand should be one of the frontrunners in maximising the use of this technology, just like we are in many other industries."

Virtual reality at treatment plant

Veolia Australia and New Zealand is utilising virtual reality (VR) technology at the Wellington Moa Point Wastewater Treatment plant, which it says signifies a new era in how engineers perform routine asset inspections.

The high-quality technology is allowing employees to obtain operational insights in real-time, enhancing safety and efficiency, it says.

Serving a population of 188,000, the Wellington Wastewater Treatment Plant is the largest of its kind in the region and holds some of the tightest odour consents of any treatment system in the country.

Sophisticated VR technology is allowing Veolia to identify complex issues when they arise and effectively reducing delay times and increasing productivity, says Roger Dunn, Veolia's national operations manager forNew Zealand.

"By lowering a VR camera directly into the treatment plant's assets our team can review and assess the condition from the safety of the office. Engineers can use their smartphones inserted into a VR headset to get a fully immersive experience."

He says this innovative technology sets a precedent in the grading of assets that have, until now, had challenging access requirements as they cannot be taken off-line and often have high-risk confined space entries.

"VR is giving Veolia new possibilities, allowing us to 'see' into places that we've traditionally not had access to.

"From what we understand, there are no other wastewater treatment facilities in the region using VR for this purpose."

For a 3D virtual tour through the Inlet Pump Station:

www.youtube.com/watch?v=fcv_nnJ-KpE

Potable water samples

Around the time of the Havelock North incident, Eurofins-ELS started to look at the entire process of collecting drinking water samples from the time the sampler arrives at the sample point until the sample is received at the laboratory.

This process is also part of the Havelock North enquiry.

"We reviewed other laboratories' techniques, and contacted many of our customers to ask them how they sterilise their sample points prior to flushing," says the company.

"We received many different answers with the most common techniques being: flaming with a propane burner; flaming with methylated spirits; wiping with alcohol wipes; wiping with detergent based wipes; pouring methylated spirits over the tap; combinations of the above; and no sterilisation – just flushing.

Sterilisation of the tap

"We performed dozens of tests using these techniques to work out which is the best. Our test process saw us pouring diluted effluent onto a tap then using a sterilisation technique prior to collecting an *E. coli*/Total Coliform sample.

"We discovered that while all techniques apart from 'flushing only' reduced the presence of *E. coli*, flaming the tap with a propane burner was the best technique.

"However, flaming is not always ideal in the field. Any taps with plastic fittings would be damaged and the risk of setting fire to dry grass or even wooden fittings is always present.

"The best second option we found was to use either alcohol wipes or methylated spirits ensuring all parts of the tap are cleaned (inside as well) and with at least 30 seconds contact time."

Flushing the tap

"Once the tap has been cleaned and sterilised we recommend that it be flushed for sufficient time for the mains water to be pulled through. This can vary from site to site and can usually be confirmed by recording a steady chlorine reading or temperature. Most taps require at least two minutes."

Transporting samples

"When carrying the samples around the sample run we recommend using a purpose built holder. Many samples are received at this laboratory rolling around at the bottom of a chilly bin and this can lead to cross contamination from unclean chilly pads or the bin itself."

Eurofins-ELS says it has designed and built a sample holder (see picture) and has sent these to customers with instructions on the best way to use them.

Temperature control, it adds, is also very important when transporting samples with the objective of maintaining them at between zero and 10°C, but not frozen, when they arrive at the laboratory.

Arrival at the laboratory

"When your samples arrive at the lab we will check the temperature and condition of the samples and ensure the correct bottles have been used. If we find any problem we will get in contact with you.

"Following the correct process from start to finish will ensure that we deliver the most accurate results, and we will work together to achieve this objective."

Wedeco UV solution for Gothenburg drinking water plant

The Challenge: The city of Gothenburg, Sweden's second largest city, supplies water from two drinking water plants to the city's 500,000 residents.

Xylem was tasked with providing a validated ultraviolet (UV) solution that would fit and operate in one of the plants, which is 62 years old and had not been originally built to facilitate such technology.

The requirement for this project was a solution that could be integrated into the existing facility with minimum disruption, as well as delivering the lowest possible life cycle cost.

UV validation is an important prerequisite for providing performance data under real-life conditions prior to the unit's actual installation and operation. The City of Gothenburg accepted the third party validation of UV systems as described in the US Environmental Protection Agency (EPA) UV Disinfection Guidance Manual (UVDGM) from 2006.

The inlet and outlet conditions of a UV system are seldom optimal, particularly in retrofit projects, and can therefore have a significant negative impact on dose delivery. For example, a 90-degree bend in the inlet piping can promote short-circuiting, eddies and dead zones within the reactor.

The UVDGM requires that, "the inlet and outlet piping to the ultraviolet reactor in the ultraviolet facility results in an ultraviolet dose delivery that is equal to or greater than the ultraviolet dose delivered when the reactor was validated."

A CFD model of the Spektron UV reactor and final piping arrangement for the Gothenburg WTP was developed to predict flow fields and hydraulic behaviour within the piping and reactor at the given design parameters. It could be demonstrated that despite the challenging inlet conditions, the Spektron was able to provide the required disinfection performance.

The Spektron UV systems were selected as they offered the lowest lifecycle costs. They are equipped with the latest Wedeco Ecoray UV lamp and ballast technology. Used in combination with the variable power option, the lamps feature excellent energy efficiency under all operating conditions; particularly in dimmed mode when they realise an average saving of 20 percent of the energy.

Fourteen Xylem Wedeco Spektron 650e systems were successfully installed by Xylem's representative Christian Berner, together with Malmberg Water, at the facility.

On-site tests proved the CDF simulation to be correct and that the performance is met under all conditions.

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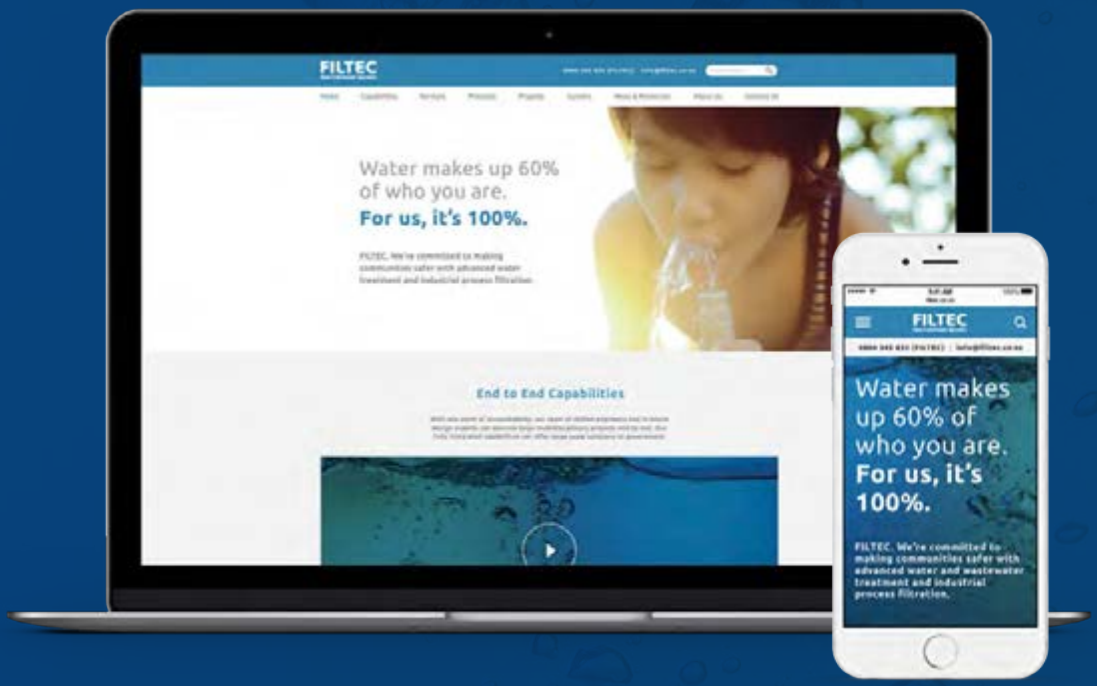

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