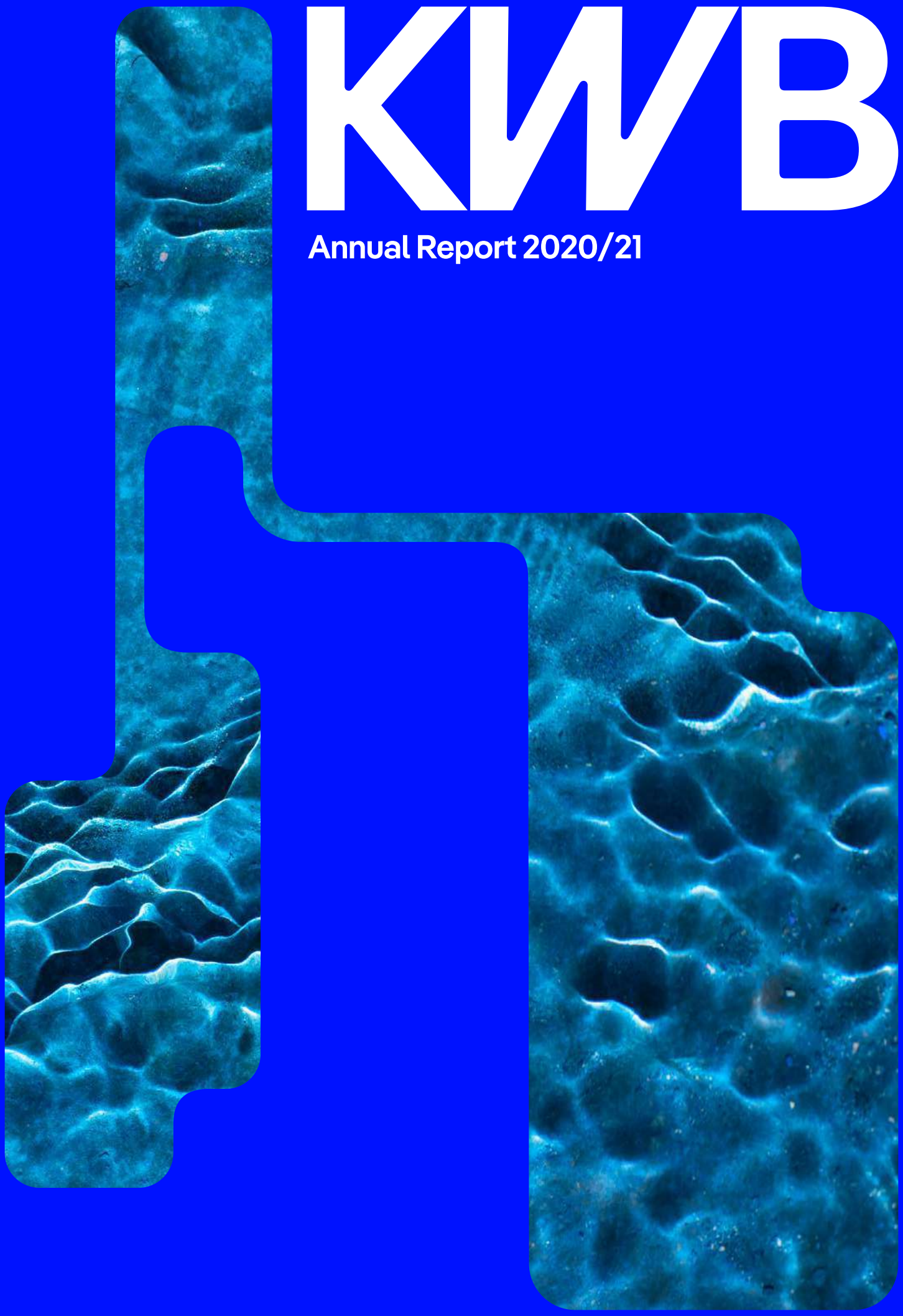
KWB

Annual Report 2020/21



Editorial

Immersion

Swimming out

Docking

*W*elcome

The disastrous flooding in western Germany in the summer of 2021 was an unmistakeable message. There is an urgent need to act to adapt our infrastructure to the repercussions of climate change! Water has a significant role to play here, and we're offering to provide you with a better understanding of the way the water cycle changes so that we can make our water supply and treatment systems more sustainable and more resilient.

Frank Bruckmann (left)
Nicolas Zimmer (right)

It must be recognised that integrative, cross-sector approaches will be the only way (given the complex economic, ecological, climate-related, social and demographic challenges involved) to sustainably protect people's quality of life, especially for those living in urban areas.

K*W*B has been working on research projects for many years, and these projects have now yielded specific courses of action for scalable programmes. Topics such as heavy rain, extreme heat, resource efficiency, the circular economy, as well as energy efficiency in water supply and wastewater treatment are just a small sample of the broad, cross-sector research topics examined by K*W*B.

K*W*B was quick to understand that the digital transformation for towns and cities was crucial at an early stage. And it was K*W*B who brought corresponding projects to address this need to life. Consider this: the European research project digital-water.city, which seeks to find digital solutions for future infrastructure through a consortium of 24 partners from 10 countries, is led by K*W*B. For new mega-projects such as the European Green Deal projects PROMISCES and IMPETUS, we out-performed hundreds of other research proposals to secure funding. IMPETUS focuses on innovations for climate resilience to expedite the implementation of the EU Green Deal and achieve climate neutrality by 2050. In this context, K*W*B will be developing solutions to adapt to climate change repercussions on water management in the Berlin/Brandenburg region, with the direct involvement of the Berlin Environment Authority.

The logical approach followed by K*W*B is reflected by additional successes this year. Under the new management of Professor Jochen Rabe, our application to participate in the support programme Smart Cities and model projects belonging to the Federal Ministry of the Interior, Building and Community, which we submitted jointly with the Berlin Technology Foundation and the Berliner Wasserbetriebe (BWB), was accepted. This allowed K*W*B to acquire considerable funding for urban digitalisation work and constitutes another area in which K*W*B is establishing itself thanks to our networked, cross-sector activities as a national and international driver for positive change, which plays an important leveraging role for Berlin. As shareholders, we will be supporting such immensely relevant work on both the strategic and conceptual levels as well as facilitating its implementation.

This successful, continued development is only possible because K*W*B possesses excellent specialists who are committed team players and understand how to passionately and effectively lead major consortia to acquire the necessary funding. We would like to thank all our employees for their extraordinary commitment: we wish them all the success, and we're looking forward to continuing to work with them on exciting projects for our future. It's good we've got K*W*B.

Frank Bruckmann
CFO, Berliner Wasserbetriebe (BWB)
CEO Berlinwasser Holding GmbH

Nicolas Zimmer
CEO Technologiestiftung Berlin (Berlin Technology Foundation)

Mission Statement

Perhaps you've already noticed it: there's a fresh breeze blowing through K*W*B! And we're using this new momentum as an opportunity to clearly and meaningfully present our mission. We've identified the following 3 positions in our mission and will continue to expand them in the future:

Thought Leader

In the midst of critical challenges and questions about the future on climate change, water crises, digitalisation, coupling sectors, urbanisation and the Smart City, K*W*B is developing innovative knowledge through committed, practical research. Our work is grounded in science, highly innovative, at times even uncomfortable, but the relevancy and urgency of it should never be underestimated.

Honest Broker

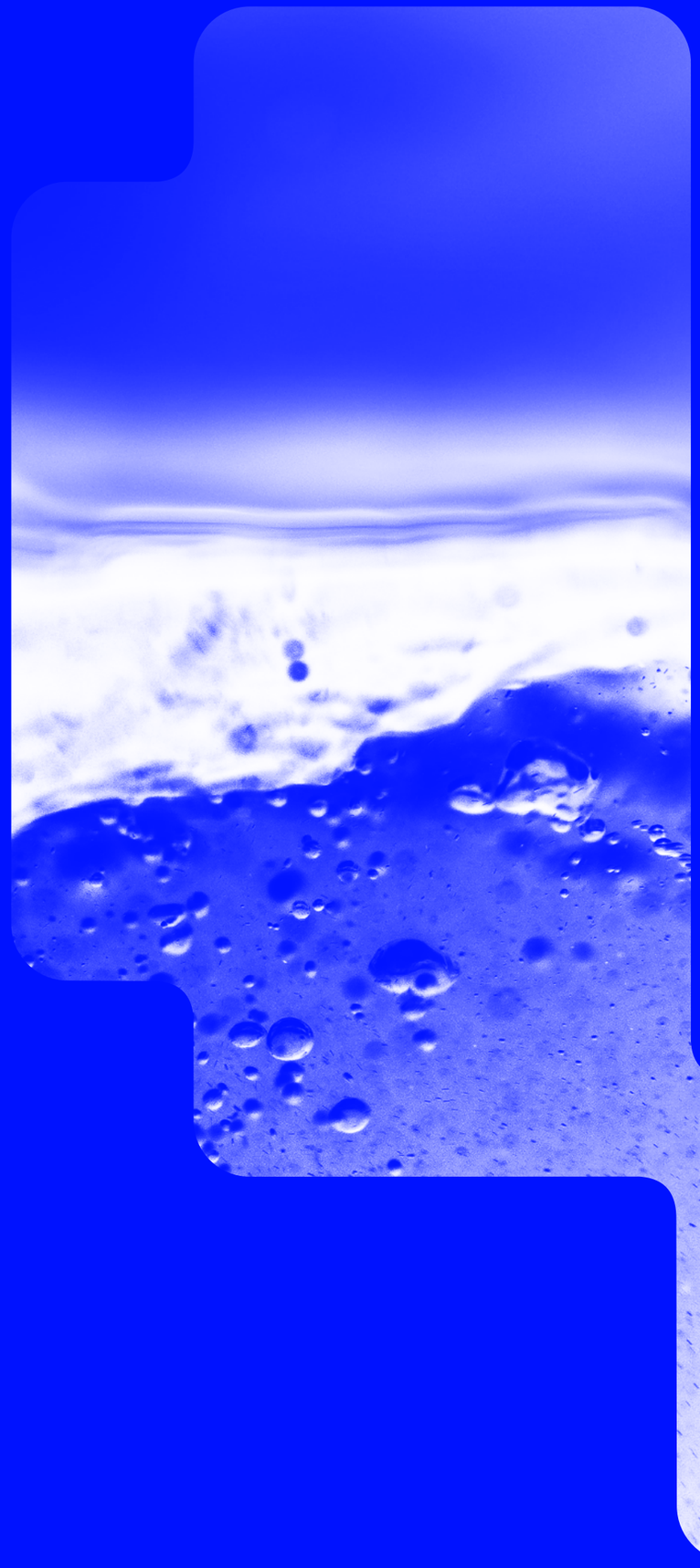
Over the last 20 years, K*W*B has worked closely and productively with numerous national and international partners from the fields of science, economics and the government. We have commitments in networks both within the water sector and far beyond it, too. We connect loose ends and we network amongst key players, stakeholders and relevant organisations. With our expertise and ideas, we facilitate vibrant exchanges as well as innovative changes.

Driver of Change

K*W*B conveys valuable knowledge. This is a process in which we communicate far beyond any exclusive circle of experts. Our work is of great value to society. That's why we don't just share our knowledge with our various stakeholders, but also with the broadly interested public. The knowledge which we convey becomes the basis for informed decisions and thus helps bring about positive changes. It also flows into the development of practical services and innovative products.

Immersion

In this chapter, we're going to immerse you in K*W*B's most recent developments and what's happening right now. This chapter will put the spotlight on our directors, look back on the last 20 years of K*W*B, and present our revamped communication and a selection of on-going projects.



Read through the following articles to find out what's keeping us moving right now:

▶ Executive Summary
▶ 20 years of K*W*B
▶ Scientific communication at K*W*B
▶ Selection of projects

Refer ▶ page 21 for more information about these forms

Executive Summary

Challenges with suppling and disposing water, as well as the related social, ecological and economic considerations along the entire water cycle, are immense. In the 20th year of its existence, K*W*B is in a better position than ever to seize the fantastic opportunity to more quickly and more successfully meet these challenges.

Managing Director
Prof. Jochen Rabe

Our Articles of Association and shareholding structure have laid the way for future-oriented, interdisciplinary and cross-sector collaboration both in Berlin and far beyond. As scientists, we must play a key role in shaping, communicating and actively implementing this transition.

In the past, KWB focused on implementing research projects. This meant that our communication was predominantly confined to contributing project reports, mainly reserved for a specialist audience (please refer to “Modern scientific communication in relation to KWB”, in which we’ll show you the progress we’ve made in communications). Our research in our capacity as “thought leaders” is and, of course, remains at the centre of KWB and we welcome dialogue among experts as well as communication with our highly valued collaboration partners! In the future, we’re planning on getting more involved in implementing our research results and taking on a larger role in establishing and raising awareness of a topic relevant for all of society - water.

Our understanding of how to successfully implement and scale research results allow us to precisely determine economic, ecological and social consequences alike, as well as optimise them! Our capabilities in this area contribute to major EU research programmes. The bodies funding such innovations are also keenly motivated by “impact”. What does it take to achieve impact? The simple answer is that only evidence-based knowledge of effects is valuable. Given that water is perhaps the broadest overlapping issue in society, we need new forms of interdisciplinary exchange. And that’s not all: the expertise required for conducting research also includes work which transcends disciplines. This means cooperating and communicating with parties from all parts of society, which includes direct exchange with citizens. It’s here that we were able to draw on our wealth of experience and in line with our image as an “honest broker”, we’ve significantly ramped up our activities on issues relating to the water cycle. Just take a look at our activities charts. These were developed together with the Berlin Senate Department for Urban Development and Housing and with research and practice partners in netWORKS4, a Federal Ministry of Education and Research project. These charts offer a simulation-based approach to urban development which specifically addresses water in addition to promoting multidisciplinary and inclusive planning processes. Since they were published, these activities charts have been used for various public and private development projects, and – with their support – we’ve been able to successfully implement planning-related objectives.

Our Articles of Association and shareholding structure have laid the way for future-oriented, interdisciplinary and cross-sector collaboration both in Berlin and far beyond. As scientists, we must play a key role in shaping, communicating and actively implementing this transition.

Furthermore, continued development of our commercial business operations is also important for KWB – and not only to transfer knowledge from practical implementation to new research topics. Thanks to the expansion of these activities as part of our Articles of Association, we’ve gained a more accurate understanding of the needs of decision-makers and stakeholders while remaining mindful of the limits our status as a non-profit organisation. This allows us to anticipate future issues with a greater degree of precision and thereby increase the leverage of our work.

With the goal of establishing a productive relationship between research and the economy, KWB’s relocation – scheduled for 2022-23 – will not only provide a major opportunity to create an inspiring work atmosphere for our employees, but also mean that we have found a site which meets a fresh challenge – becoming part of Berlin’s innovation ecosystem.

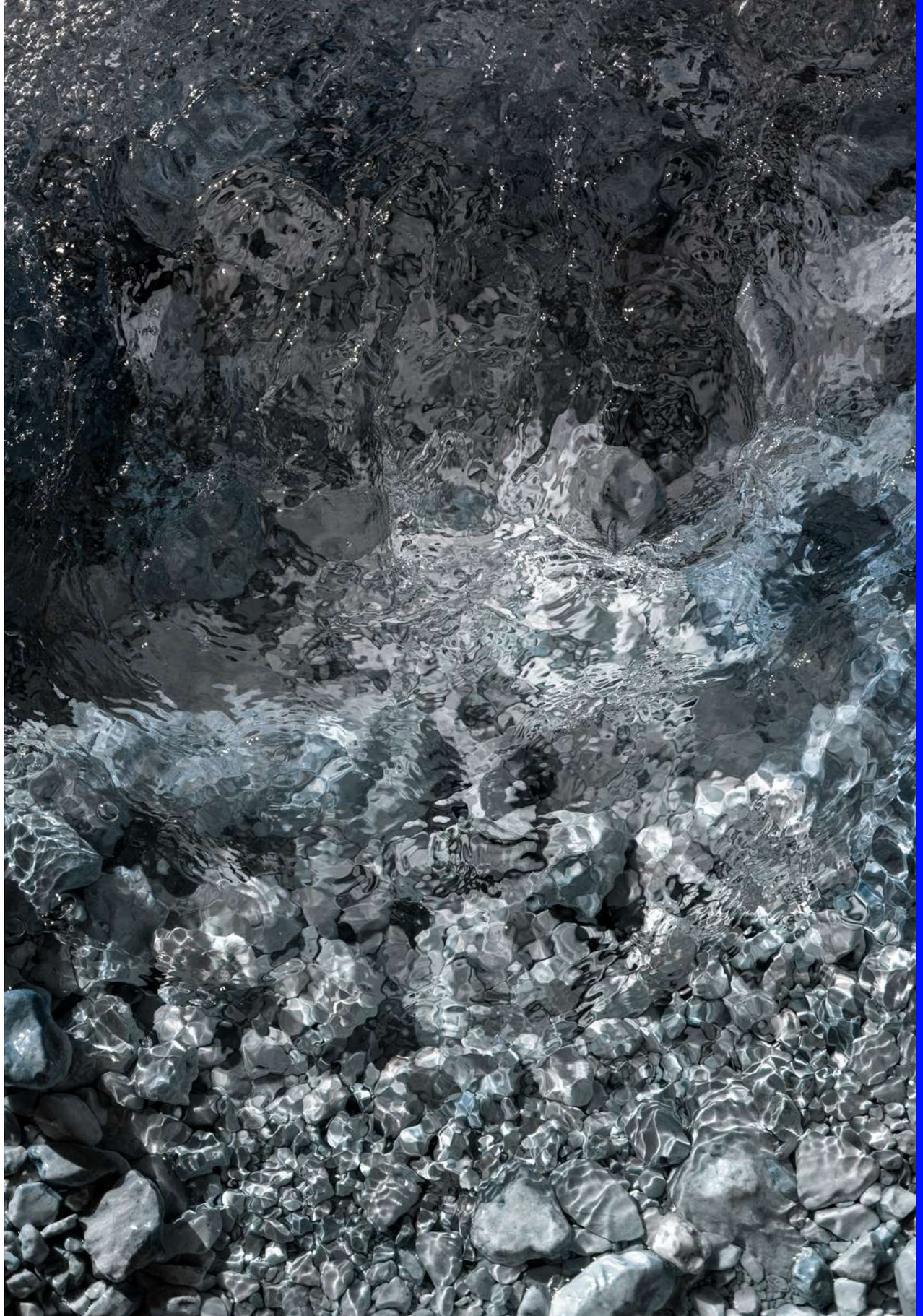
Our economic development in 2021 went according to plan and successfully met our expectations. The confirmed project resources for the coming years also showing excellent growth. Developing and acquiring new research projects is among KWB’s core disciplines, and our long-term success reflects the impressive merit of our employees. By the way, we ranked 20th out of 1,821 Berlin institutions receiving research funding in 2020 as part of the Horizon 2020 support programme. When normalised to the number of our employees, we’re one of the most successful institutions when it comes to securing European research funds. Just to prove it: at the beginning of this year, KWB participated in 6 full EU Green Deal proposals. This was a major feat which underlines our established position in the European research landscape. As a result of our hard work, two of those proposals were accepted: “IMPETUS” and “PROMISCES” began this fall (to find out more about them, please consult “KWB in Berlin and in Europe” in the section titled “Swimming out” in this annual report). ▶

In the IMPETUS project, we'll be able to investigate the repercussions of climate change on regional water management. This project is an excellent opportunity (in addition to the significant research funds secured) to enhance KWB's commitment to client-based research. Regional water management is an extremely urgent problem for Berlin, and for that reason we're particularly proud to have secured the Berlin Senate Department for the Environment, Transport and Climate Protection (SenUVK) as an active consortium partner.

In the PROMISCES project, we're part of a closely collaborating group of experts including the Berliner Wasserbetriebe (BWB), the German Environment Agency (UBA) and the Federal Institute of Hydrology (BfG) analysing the presence of "forever chemicals" such as per- and polyfluoroalkyl substances (PFAS) and developing a working approach to conduct toxicology assessments in Berlin's semi-closed water cycle. PFAS, which are used in numerous products because of their capacity to repel oil, stains and water, are an extremely relevant topic currently. They constitute a particular challenge for the circular economy because they can be especially persistent, mobile and potentially toxic.

As part of the successful acquisition and implementation of projects in the field of hydrogen research and the Smart City in conjunction with the Berlin Regional Authority and the Federal Ministry of the Interior, KWB is also establishing itself as the interface between water and the city, climate change and digitalisation. We want to be seen as a driver of this rapidly developing topic, acquire even more projects and fulfill our mission as a "thought leader, honest broker and driver of change", which we presented at the beginning of this annual report. ●

Prof. Jochen Rabe
Managing Director | November 2021



20 years of KWB

KWB: the first year

20 years of research on the urban water cycle

We can look back on our first 20 years with pride. Our history is intertwined with Berlin's water cycle. For a metropolis of Berlin's size, the city is unique in that its entire water supply is sourced from water resources located in the city. There are very specific challenges characterising the cycle between groundwater, drinking water treatment plants, industry, households, the sewer system, wastewater treatment plants and bodies of water. For example, what happens when contaminants enter the cycle? If surface water seeps into the groundwater, are there natural processes in the subsurface which can adequately protect drinking water quality? Or is there a point in time when the protective capacity of the subsurface will be exhausted?

The new shareholders Berliner Wasserbetriebe were among those concerned with such questions in the early years of KWB's existence. They were searching for a well-established scientific basis for ensuring bank filtration as a reliable component of drinking water production over the long term. Fortunately, KWB was able to assist and we were commissioned to help gather and compile all the key scientific principles governing the biological, chemical and physical processes associated with bank filtration and groundwater recharge. Our first major collaborative research project was born: NASRI.

Over a period of six years, more than 30 scientists compiled principles and results which are still in use today. Recognition of this work goes well beyond the city's limits: it's well known at the international level. Subsequent projects followed, some of them in other European countries, some of them in India. Currently, the groundwater team who worked on those projects is tackling questions on the influence of climate change on processes involved in creating drinking water, and rising salt water levels in low-lying soil zones essential for ensuring sustainable water supply for Berlin.

This was followed by more wastewater-focused research projects dealing with the Berlin water cycle. The OXERAM project was an important starting point in this direction. Together with the Berliner Wasserbetriebe KWB tested various filtration methods at a pilot facility in the Ruhleben wastewater treatment plant to determine which achieved the greatest possible efficiency in enhancing the separation of phosphate. OXERAM results were used to develop technical measures for achieving regional water quality targets.

This work laid the foundation of our "Process innovation" team, and we can now look back on countless international projects in all future-oriented topics surrounding wastewater treatment: removal of trace organic substances, recovery of resources and energy from wastewater, and water reuse, amongst others. In the meantime, KWB's acquired its own ozone facility which plays a role in numerous projects, particularly for developing technical solutions to remove trace organic substances.

Another field in which we're now active is located underground - combined sewer systems. Although initially, combined sewer overflows (CSO) into water bodies during periods of heavy rain were not as much of an issue as they are today, people were (rightly) concerned that the risk of overloading the sewer system would get worse as urban development and paving of municipal areas increased. However, when it came to planning countermeasures, there was a notable lack of information about the repercussions of overflows. CSOs occur only irregularly, and until now, the pollutant mix is unknown, but highly variable. And so our "Urban systems" team was born. Many further projects – including SAM-CSO and MIA-CSO – followed in the wake of the initial drive to develop a modelling system for simulating repercussions of sewage overflows. As a result of these projects, the Berlin Senate Department for the Environment, Transport and Climate Protection and the Berliner Wasserbetriebe have implemented our research results when planning stormwater and combined sewer management.

Looking back, it's remarkable how much our focus on "Decentralised stormwater management" and "Smart Cities" – developed through our project work – contributed towards establishing these topics as a permanent part of Berlin's environmental and urban policy. One of KWB's current areas of specialisation, creating aging forecasts for sewer network operators to manage their assets, was also a direct result of our work on sewer networks.

We're living in a world moving at breakneck speed. All of us are now inevitably concerned by the major issue of climate change, along with all of its conspicuous repercussions in the form of extreme weather. 20 years ago, it was completely different. Even amongst experts in the water industry, the topic of climate change was discussed only occasionally. Although it had already been demonstrated that climate change was real, the available models and data at the time did not predict heavy rain and increasing frequency of floods. Nevertheless, inspired by our national and international partners in business and administration, we began grappling with the emerging challenges of ▶

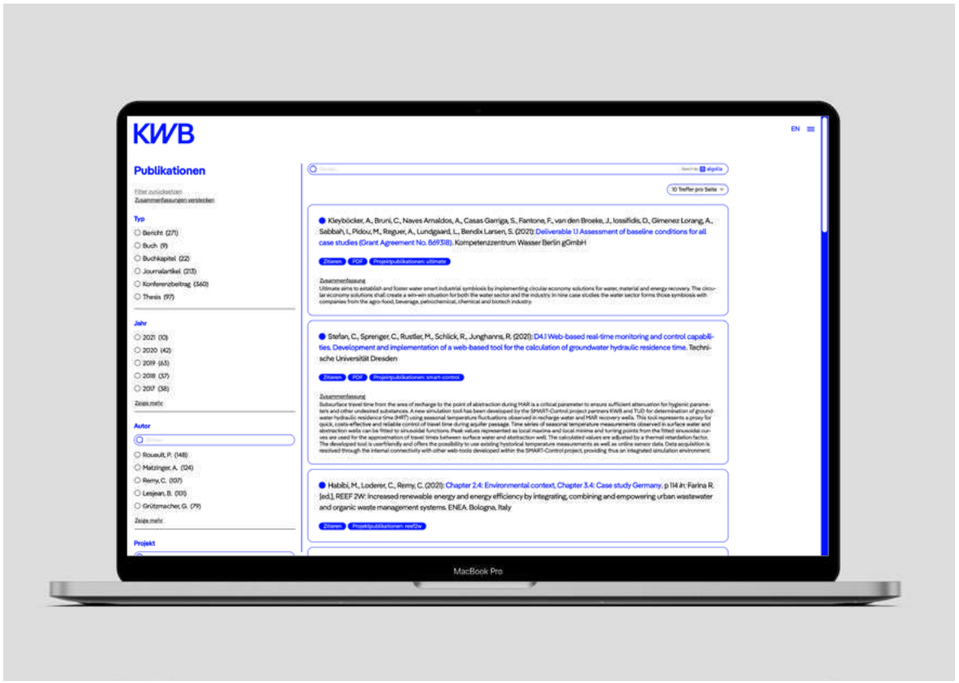
climate change at an early stage back then. Additionally, energy efficiency in water management systems, climate resilience in cities, asset management for aging urban infrastructure, water protection measures, and efficient use of resources with simultaneous protection of water supply and wastewater treatment are topics which have been high on our agenda for many years, and are only garnering increased attention as the effects of climate change progress.

Behind all these topics stands a team which has grown continuously over the years, comprised of committed specialists who possess a huge wealth of knowledge and experience. With creative, committed and practical research, we'll continue to overcome the challenges which lie ahead of us – and of course, properly celebrate our 20th birthday! ●

◀ KWB: 10 years completed

▶ KWB: 20 years later

Scientific communication at KWB



Our new website:
www.kompetenz-wasser.de

We've renovated our entire corporate design. This is our new logo.

How does KWB actually communicate?

What does it communicate? And to whom? If you look at our Articles of Association, you'll find what is currently only a brief comment noting that "we want to offer interested citizens up-to-date information on research trends and developments relating to the topic of water". That's rather general. But what's really included in the topic of water, who are these interested citizens, and what does this actually have to do with the modern scientific communication promised in the title? So many questions!

First, let's take a look at the content of our activities. They are scientific, specialised and complex. Underneath these activities is a great curiosity, a desire for answers and research, all of which is particularly relevant when it comes to pressing future issues (keywords: climate change, digitalisation, water crises etc). We want to include all of this in our communication activities as well as to do justice to the humans and scientists behind the projects.

We have a balancing act to perform in terms of the groups we're addressing: we don't want to inform and inspire only specialist scientific audiences, but also stakeholders in government, politics and the economy. And while that's also true for the "interested citizens" we mentioned at the beginning, our topics are relevant not just for Berlin, but for all of society far beyond the city limits and national borders. Actually, another target group is us! KWB employees don't just learn about the work of their colleagues in other departments, but our communication activities reveal opportunities to identify with KWB outside of their projects. This is important if we're going to increase our capacity for continuous innovation and if we want to understand and address upcoming topics.

Furthermore, when we report on our work, we want to build on our existing networks in addition to creating new ones (please refer to the "honest broker" section of our mission statement at the beginning of this annual report). Finally, we're committed to putting our passion into tackling the challenges of both the present and the future in regards to climate change, water crises, digitalisation, sector coupling and urbanisation as well as bring about positive changes (please refer to the "driver of change" section in our mission statement) – an area where communication will also have a key part to play.

Once upon a time...

This leaves us with the question of "how" in our communication – and thus also the question of modern scientific communication. There's a keyword for this which has been resurfacing recently but which builds on a long tradition: storytelling. For our purposes, this amounts to placing the facts in a narrative style, as opposed to the "straightforward" communication of facts and research results. Depending on the target audience and the topics involved, storytelling enables content to be adapted to be more or less complex. However, the theatrical structure of exposition, confrontation and resolution always stay ▶

the same, to communicate knowledge in a more accessible way. This makes sharing knowledge, and sharing it in detail, easier. Of course, this doesn't mean that storytelling is always the method of choice for all scientific communication at KWB. It'll be used when it's helpful.

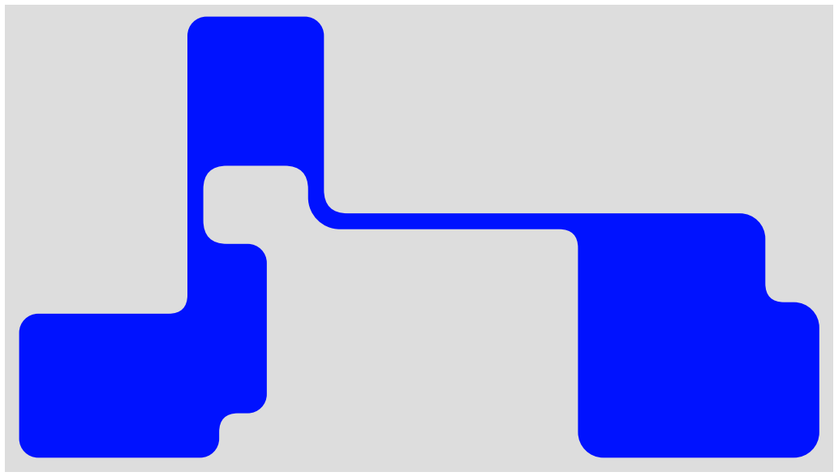
So, is that already the end of our story? No, it's only just beginning.

So fresh and so clean

In modern scientific communication, visual presentation is as important as the content and the structure of the facts. You may have noticed that the annual report in front of you has been completely redesigned. And the same applies to the entirety of our public image, including the logo, the colours and fonts, our website, our newsletter and our social media channels on LinkedIn and Twitter. After 20 years, the old design was due for retirement. Minimalist, clear, uncluttered, conspicuous and bold, prominent but not overwhelming, perfectly supporting and promoting the content – that's how we'll be presenting ourselves to you from now on.

So, is that already the end of our story? No, it's only just beginning. Or, to put it another way, there are so many exciting stories at KWB – and so many storytellers! We're talking about our employees, whom we're going to spotlight in our communications more often, and who are more frequently putting a human face to KWB on social media.

In re-establishing and reconfiguring our communication, we've created the ideal conditions for communicating the scientifically well grounded, imaginative, and at times even uncomfortable work of KWB – the relevance and urgency of which should never be underestimated - in a modern, clear, and targeted manner. ●



In the new corporate design, we play with abstract shapes. This one is inspired by Berlins rivers and lakes. You can read more about it on the opposite page.

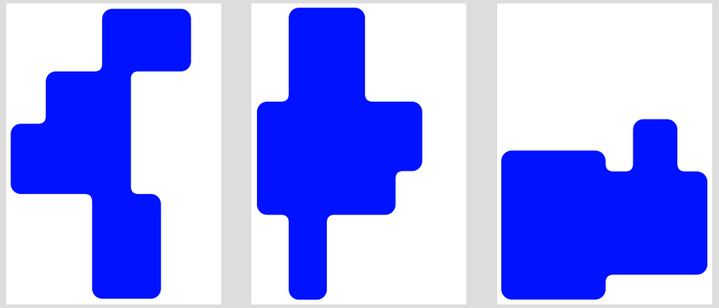
You may have already noticed numerous versions of the same shape popping up over and over again on the pages of this annual report (if you haven't noticed, check out the cover again). What's going on with this shape?

There are various criteria which relate to the classification of water resources. One long-established classification draws a distinction between seawater (salt water), inland water resources and groundwater (freshwater). There are also numerous borderlines and transitional shapes amongst the diversity of water types. Below, you will see examples of shapes which can, for example, be associated with various types of water resources. Although these descriptions are abstract, without imposed boundaries, these forms could be interpreted as droplets, dynamic bodies of liquid, or anything else. This means the abstract form is free from the boundaries of conventional symbolism, thus enabling a new, independent vocabulary of shapes surrounding our core topic: water.

From now on, forms will be an intrinsic part of our external representation: as diverse and variable as our work itself.

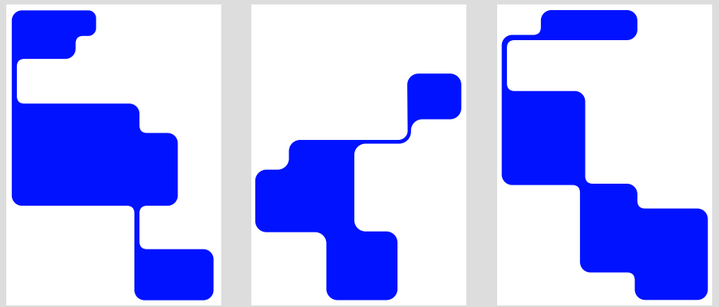
Dynamic bodies of liquid; Seas, lakes

Elements that merge in a plane surface



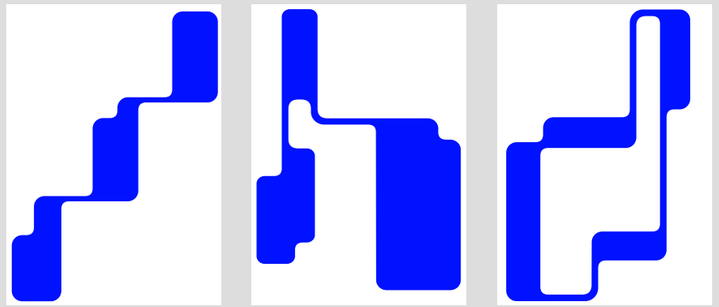
Standing inland waters; droplets with connections like threads

Cohesive forms *w*ith connections and strong contrast

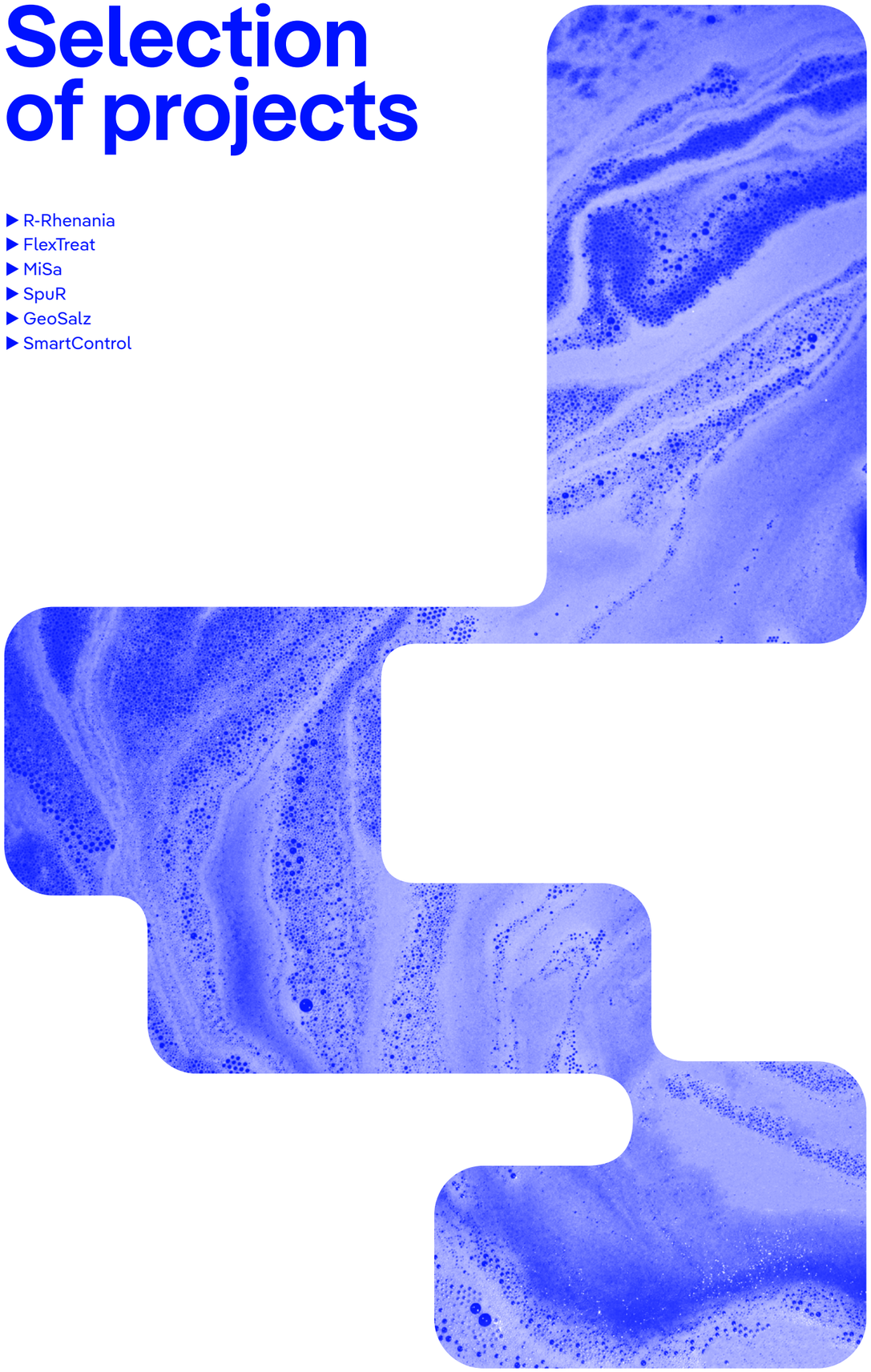


Flowing inland waters

Longitudinal shapes *w*ith several, regular connections



Selection of projects



R-Rhenania

Project volume
€2,709,000, financed by the Federal Ministry of Education and Research

Partners
BAM Bundesanstalt für Materialforschung und -prüfung (coordination), Outotec GmbH & Co KG, Emter GmbH, sepura GmbH, University of Bonn, Kompetenzzentrum Wasser Berlin gGmbH, Institut für Baustoff-Forschung e.V., Bavarian State Research Center for Agriculture (LfL)

Contact
Fabian Kraus

How can phosphate of a suitable quality be recovered with reasonable cost and a high recovery rate? In recent years, this has been the subject of a wide range of research projects and process developments in which KWB has been extensively involved at both national & international level. One example is the “bePhor” project which was funded by the BMBF, where a concept for recovering phosphate from the wastewater path was produced for the Berliner Wasserbetriebe. A system for recovering phosphate from sewage sludge ash after mono-incineration (exclusive combustion of sewage sludge without any other waste components) was developed. For this, wet chemical processes for ash treatment were particularly suitable for producing conventional phosphorus fertiliser products. This enabled the undesirable pollutants to be efficiently separate from sludge ash. bePhor revealed that, for safety and logistical reasons, phosphorus recovery should not be carried out directly on site at sewage treatment plants or sewage sludge incineration plants, as this would notably increase cost of transporting hazardous goods and associated transport risks. Additionally, such recovery processes could not be easily operated by the wastewater treatment plant employees. Therefore, bePhor recommended transporting the sewage sludge ash from Berlin to an external chemical industry park which manu-factures the required chemicals (i.e. mineral acids). By centralising the treatment in this way, with comparatively cheap chemical availability, the costs of phosphorus recovery can be decidedly reduced.

Sustainable phosphate fertilisers produced from sewage sludge ash

Phosphate is a nutrient essential for plant growth and thus an important resource for agricultural crop production. Phosphate fertilisers are extracted by mining from limited deposits. In order to achieve safe and sustainable access to this important (but finite) raw material in Europe, the recovery and recycling of phosphate has become a major political objective within the EU. Sewage sludge, which is produced as a waste during wastewater treat-ment, is a resource available for recovery. The majority of our phosphate requirements could be extracted from sewage sludge by appropriate technical processes. Therefore, phosphate recovery will be mandatory in Germany at medium- and large-sized sewage plants.

Under the coordination of BAM, a large-scale project for phosphate recovery by a thermochemical treatment of sewage sludge ash in Bavaria has been underway since 2020. This R-Rhenania project is funded by the Federal Ministry of Education and Research (BMBF) within the “Regional Phosphate Recycling” programme.

In R-Rhenania, the AshDec process is implemented at industrial scale. The phosphate from sewage sludge ash is converted into a form suitable for crops which meets the legal requirements of the fertiliser regulation. The process involves treatment of ash in a rotary kiln at a temperature of approximately 900°C under defined operating conditions. The goal is to produce a product with practical and economical use for agriculture.

But what about the sustainability and environmental compatibility of this process? This is where KWB comes in, with its extensive expertise in comprehensively analysing and evaluating innovative technical processes.

In addition to the product's carbon footprint and pollutant load, the economic viability of the process is examined to arrive at a realistic estimate of the costs for the operators. After all, only ecologically compatible and simultaneously affordable processes which don’t place an excessive burden on the environment or on those paying fees will ultimately succeed in achieving the goal of phosphate recycling.

FlexTreat

Project volume
€3,770,000, financed by the German Federal Ministry for Education and Research

Partnerinstitutionen
RWTH Aachen University (co-ordinators), Bundesanstalt für Gewässerkunde (BfG), Kompetenzzentrum Wasser Berlin gGmbH, Institute for Hygiene and Public Health)/ University Hospital Bonn, Analytik Jena AG, inge GmbH, Xylem Services GmbH, Autarcon GmbH, PEGASYS Society for Automation and Data Systems MbH, p2mberlin GmbH, Erftverband, Abwasserverband Braunschweig

Contact
Dr. Ulf Miehe
Michael Stapf

▶ (1) Furthermore, FlexTreat will evaluate treatment processes to ensure they comply with microbiological water quality parameters, as well as antibiotics resistance levels, trace organics and transformation products. Evaluating for these latter parameters goes beyond the EU regulation's requirements, which only stipulates compliance with minimum specifications regarding microbiological quality requirements.

▶ (2) A digital twin is a digital representation of a material or immaterial object from the real world in the digital world. It is irrelevant whether the counterpart already exists in the real world or will exist in the future. Digital twins enable an across-the-board exchange of data. They are more than pure data, consisting of models of the represented object or process, and can also contain simulations, algorithms and services that describe or influence the properties or behaviour of the represented object or process or offer services about it.

Source: German Society for Informatics

Fighting the water crisis with reclaimed water

In recent years, many regions including Berlin/Brandenburg, have been struggling not only with heavy rainfall but also increasingly with drought. As the negative effects of these phenomena are sharply felt by the agricultural sector, solutions for sustainable water management are therefore urgently needed (Fig.A) There are even concerns in the short term about drinking water supplies. What can be done about this? Is it possible to mitigate the effects of seasonally recurring water shortages?

A

The topic of wastewater reuse has therefore become increasingly important not only at the European level, but also in Germany. The new EU Regulation 2020/741 on "minimum requirements for water reuse" was passed in June 2020 and provides an EU-wide framework for irrigating agricultural land with treated wastewater, otherwise known as reclaimed water ▶ (1). But how can reclaimed water be safely reused in agriculture? What needs to be considered in risk assessment and risk management? Can synergies with more extensive wastewater treatment eliminating trace substances be capitalized on?

These and other questions are addressed in the FlexTreat project which began in early 2021. In this project, technical and nature based treatment systems, which can flexibly react to the needs of agriculture, are being developed. A total of 12 project partners including KWB are involved in FlexTreat.

Within the project, KWB is mainly responsible for the work package on risk management, which includes the development of an evaluation concept for considering material and microbial risks. A broad spectrum of physical, chemical and microbiological water quality parameters (incl. antibiotic resistance, transformation products of trace substances) is considered when evaluating treatment process combinations. KWB's mobile ozonation plant will also be employed at the Braunschweig wastewater treatment plant. This initiative is supplemented with a filtration stage together with UV disinfection carried out by project partners Xylem. By coupling online measurement technologies with modern data evaluation (keyword machine learning and digital twin), the operational control and monitoring will be optimised so that the required water quality targets can be guaranteed at all times ▶ (2).

Drawing on KWB's extensive groundwater management expertise, further work will include recording and evaluating the effects of irrigating agricultural land with reclaimed water (Fig. B). For this purpose, additional measurement campaigns in the aquifer below the irrigation area in Braunschweig will be supplemented by laboratory and planting experiments. The aim is to create a solute transport model which can be used by planners and authorities for risk management in approval procedures.

In the future, the need to use reclaimed water for agricultural purposes will only continue to grow. The results produced in FlexTreat will contribute to improved understanding of reclaimed water as a resource and increased acceptance for reclaimed water reuse.

B

MiSa

Financing
Financed by the Berlin Senate Department for the Environment, Transport and Climate Protection

Partner
Ingenieurbüro für Wasser und Umwelt

Contact
Dr. Pascale Rouault

The activities conducted in MiSa are based on numerous K*W*B projects. The results achieved by the MIA-CSO project from 2009 until 2013 provided an invaluable starting point. In collaboration with the Berliner Wasserbetriebe and the Berlin Senate Department for the Environment, Transport and Climate Protection, we developed a management tool for planning Berlin's combined sewer system in both conceptual and practical terms. Thanks to this model-based tool, CSOs from Berlin's combined sewer system and their short-term effects on water quality of the Spree River can be simulated and evaluated. Decoupling measures proved to be very efficient measures against CSOs, the frequency of which is expected to increase due to climate change.

Based on this, the following work is conducted in the MiSa project:

1. Development of suitable indicators for assessing the acute impact of CSOs in Berlin
2. Extension of the model to all water bodies in Berlin and adaptation of the model to current conditions (number of residents, wastewater volume)
3. Identification of hotspots for water bodies
4. Development of a workshop format and a strategy for joint creation of realistic scenarios
5. Evaluation of scenarios

The MiSa assessment method was developed and the pollution resulting from CSO in regards to aquatic organisms was analysed using data on water quality (especially oxygen content and electrical conductivity), precipitation, combined sewer system discharges, fish mortality and macrozoobenthos quantities in Berlin's water resources.

MiSa provides a model for the entire combined sewer network in Berlin. It covers the 18 combined sewer areas of Berlin, its 17 main pumping stations and all 176 combined sewer outlets. For each sub-catchment area, the degree of connection and sealing, the number of inhabitants and the surface runoff parameters are recorded.

Using that information, the various SUDS strategies for the sewer network can be simulated and reviewed to determine their effectiveness. Additionally, the efficiency of water protection measures and the cost-efficiency and synergies of climate adaptation and flood protection measures can also be determined.

Surface water protection starts in the sewer system

Over the last 150 years, the combined sewer system has ensured the fulfilment of hygiene standards in our cities, protecting land and buildings from flooding. However, the sewer system reaches its capacity limits during periods of heavy rainfall. Once the combined sewer is completely filled, combined sewage (a combination of sewage and rainwater) is discharged directly into surface waters via combined sewer overflows (CSO). As a result, the water quality decreases enormously, and has consequence such as fish mortality and huge algae growth. To mitigate these effects, a large volume of underground storage space has been created in the sewer network in recent years to collect unusually large water masses and reduce the number of CSO events into surface waters. Regrettably, the current 300.000 m³ storage capacity in Berlin is not sufficient for fully collecting the large quantities of CSOs which suddenly occur during periods of heavy rainfall.

What can be done if no space can be found to build more storage? The answer is to disconnect the surfaces, i.e. to prevent rainwater runoff from entering the sewer system via sustainable urban drainage systems (SUDS). Berlin has set itself an ambitious goal of disconnecting 1% of impervious areas from the combined sewer system every year. There is a wide range of technical possibilities to do this which have already been put into practice and are now known under the term "sponge city". But how can such a goal be systematically planned and realised in a city the size of Berlin? What exactly determines critical conditions for water bodies? Where in the city can paved surfaces such as roofs and roads be disconnected from the combined sewer system to maximally benefit the receiving water bodies?

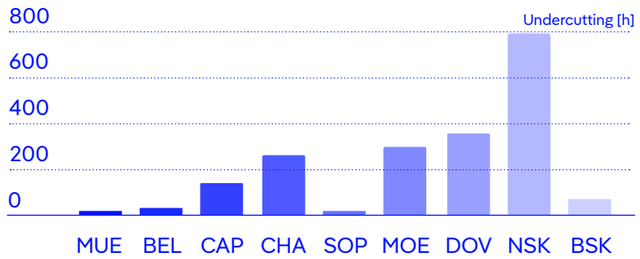
K*W*B has been working on these issues for years and supports decision-makers and the administration in the strategic planning of SUDS measures. The MiSa (combined sewer strategy plan) project, which was commissioned by the Berlin Senate Department for the Environment, Transport and Climate Protection and has been running since the middle of 2018, is the latest milestone in this topic. The project is jointly run by K*W*B and the Ingenieurbüro für Wasser und Umwelt, together with the Berliner Wasserbetriebe and the Berliner Regenwasseragentur, with support from the municipalities of Friedrichshain-Kreuzberg and Charlottenburg-Wilmersdorf in Berlin.

MiSa will produce a methodology for the environmental administration to use in further developing a programme of measures for combined sewer rehabilitation. This is based on a digital tool which simulates the effects of different strategies for CSO mitigation on both the sewer system and the receiving water. MiSa brings all the stakeholders to one table, making it possible to develop realistic scenarios. It's also a tremendous opportunity to discuss the city's goals for adapting to climate change and for environmental protection, especially at a time when resources are tight. Through MiSa, decoupling measures can be initiated in a much more targeted and efficient manner than before. This is a big step forward for achieving Berlin's ambitious decoupling goals.

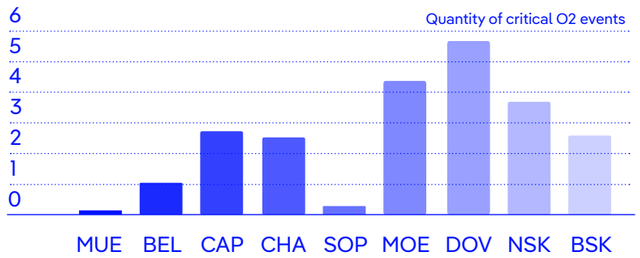
Comparative assessment of water bodies in Berlin

average water condition from 2000 until 2019

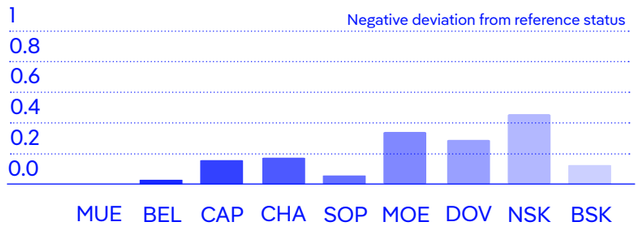
Undercutting of critical O2 concentrations (in hours)



Quantity of critical O2 events in water measurement points



Negative deviation from reference status at the Mühlendammschleuse



MUE = Negative deviation from reference status for Mühlendammschleuse
BEL = Bellevue
CAP = Caprivibrücke
CHA = Charlottenburg
SOP = Sophienwerder
MOE = Möckernbrücke
DOV = Dovebrücke
NSK = Neuköllner Schifffahrtskanal
BSK = Berlin-Spandauer Schifffahrtskanal

SpuR

Project volume
€339,000, financed by the German Federal Environmental Foundation (DBU)

Partner
Funke Kunststoffe GmbH, OST Eastern Switzerland University of Applied Sciences

Contact
Dr.-Ing. Daniel Wicke
Dr.-Ing. Pascale Rouault

▶ (1) For many years, we've looked into the causes, effects and mechanisms of water body pollution in cities. The first projects focused on quantifying classical quality parameters for water bodies and modelling of hydraulic stress situations caused by CSOs during heavy rainfall events (MIA-CSO, Nitrolimit). In other projects, we've worked on strategies for avoiding such situations (KURAS, Networks4). The results were integrated into the "KURAS method," which is now an authoritative basis for planning and implementing sponge city concepts in Berlin.

To achieve cleaner surface waters and to reduce and prevent contamination from toxic compounds, we need a more precise understanding of what factors cause contamination. In the OgRe project, for example, we were able to show that there's a wide range of organic trace substances in the urban stormwater runoff in Berlin. During rain events, this results in elevated concentrations of contaminants in downstream water bodies. This pollution was correlated with the types of urban land use, and our understanding of such systems increased considerably. The results were used to develop a model capable of estimating the total load of contaminants from stormwater runoff entering Berlin's surface waters.

In the ongoing R2Q project, a planning tool to enable method-oriented management of resources in urban neighbourhoods is being developed. The influence of polluted stormwater also plays a role in this tool.

New filtration materials for removing trace substances in stormwater runoff

Nobody likes to see algae on building walls. For that reason, special chemicals are added to facade paints to prevent algae growth. Additional chemicals are used in building products and in vehicles. Unfortunately, these substances (i.e. biocides, plasticisers from plastics, flame inhibitors) are washed off of the surfaces of buildings and roads during rain events. They then pass through the storm sewer network and usually enter surface waters without any reduction in concentration. This likely damages the aquatic ecosystems of our water resources and must be avoided at all costs, especially to comply with the European Water Framework Directive. KWB has already initiated extensive projects on this topic ▶ (1). However, are technical options for efficiently preventing the spread of such substances via stormwater already available?

The recently completed SpuR project investigated and evaluated innovative solutions to this problem. For example, in cooperation with a prominent manufacturer of façade paints, a recently developed paint containing new, environmentally friendly and readily biodegradable substances was investigated. Results of a yearlong investigation verified that, in comparison to a conventional paint, the substances in the new paint were more rapidly and effectively broken down in stormwater.

Additionally, a stormwater filter substrate was further optimised to provide effective retention of relevant trace substances in addition to classic parameters such as solids and heavy metals. Results from a yearlong observation of a test filter equipped with this new substrate were promising: the total retention for all investigated parameters was between 85% and 97%. Finally, pollution hotspots in the city were identified using a computing model further optimised in the SpuR project. This supports decision makers in environmental regulatory authorities in prioritising measures designed to prevent stormwater pollution and developing strategies which consider water quality as an important parameter.

So far, the impact of stormwater on water quality problems has been underestimated. Our research provides important contributions to understanding this problem.

GeoSalz

Project volume
€345,000, financed by Berliner Wasserbetriebe

Partner
Berliner Wasserbetriebe

Contact
Dr. Hella Schwarzmüller

▶ (1) As a result of climate change, in combination with population growth, groundwater has come under increasing pressure. For the Berlin/Brandenburg region, a decline in natural groundwater recharge and greater seasonal fluctuations in surface water runoff are predicted. This goes hand in hand with increased risks of saline water intrusion depending on the location.

▶ (2) Our preliminary study of the historic development of salination in the Berlin area – drawing upon archived data and laboratory measurements – showed that salination already occurred at some locations more than 100 years ago. On the other hand, no obvious trends could be derived, since few long-term measurements are available.

▶ (3) In the GeoSalz project, depth-oriented investigations of groundwater properties are combined with geophysical measurements and evaluation of pumping rates and water levels. Additionally, hydrogeological models of the waterworks' catchment areas will be adapted to represent the dynamics of saline intrusion. These transport models will then be used to simulate various abstraction scenarios in order to predict the evolution of groundwater properties for specific operating conditions.

Strategies for preventing groundwater salination

Berlin abstracts its drinking water exclusively from groundwater. Depending on the location, up to three groundwater aquifer complexes are available, which, together with groundwater barriers, make up the freshwater aquifer. Below this aquifer, and separated by an 80-100 m thick clay strata of the Rupelton, lies a salt water aquifer. This is typical for the entire Northern German Plain and is a relic of extensive primordial oceans.

Glacial erosion processes during the last ice ages eroded the Rupelton so that in some places there is only a very thin or even no separation between the freshwater and the saline aquifers. At these locations, deep saline water can rise unhindered into the fresh water aquifer, which poses a risk to drinking water supply ▶ (1).

Currently, approximately 29% of the Berlin/Brandenburg area is already affected by groundwater salination. The glacial valley and the geological structures below the Havel river, which coincides with where a majority of Berlin's waterworks draw groundwater to supply drinking water, are particularly at risk. In five of the nine waterworks, saline water intrusion was detected either in individual wells or in entire well fields ▶ (2).

Together with the Berliner Wasserbetriebe, the GeoSalz project was launched to develop strategies to deal with salination risks. The project focuses on extensive sampling and the development of new sensors, as well as the optimisation of existing measurement systems, to facilitate early detection of salination processes in drinking water wells. In combination with simulating well operations in hydrogeological models, the objective is to improve the understanding of the phenomenon of saline water intrusion ▶ (3). The aim is to optimise well operation over the long term to avoid or minimise salination of the fresh water aquifer complex.

SmartControl

Project volume
€119,000, financed by Water JPI, Federal Ministry of Education and Research (BMBF)

Partner
TU Dresden (co-ordination), Kompetenzzentrum Wasser Berlin gGmbH, Umwelt- und Ingenieurtechnik GmbH Dresden, Adelphi research gGmbH, French Geological Survey, Lyonnaise des Eaux/Suez, Universidade Federal de Paraíba, Universidade Federal de Pernambuco, University of Cyprus

Contact
Dr. Christoph Sprenger

Even though groundwater recharge mainly takes place in the winter months, most climate projections indicate reduced annual natural groundwater recharge. This has serious consequences for the groundwater supply and is thus an Achilles heel for Berlin's entire drinking water supply. This is because 100% of the drinking water in Berlin comes from the groundwater resources of the city area. About 60% of it is made of bank filtrate, 10% of deliberately recharged groundwater and about 30% of natural groundwater recharge. This makes bank filtration and managed groundwater recharge a significant source for the drinking water supply, which is indirectly fed to a large extent by surface water.

Managed groundwater recharge is intended to increase the availability of groundwater and thus secure the supply of drinking water even during peak loads. Furthermore, targeted groundwater recharge also serves to support groundwater-dependent ecosystems. In managed groundwater recharge, the removal of chemical and biological contaminants from surface water during underground passage plays a central role. Removal processes are often time-dependent and understanding the hydraulic residence times, from the infiltration basin to the point of abstraction by wells, is a key element in the management of groundwater recharge. Important monitoring parameters include the microbiological load of the infiltrated water, the infiltration rate and the residence time in the subsurface. SMART-Control has succeeded in taking a real step forward in better capturing the process of groundwater recharge with online data on residence time and a new microbiological characterisation.

Web-based groundwater monitoring

The controlled infiltration of surface water into an aquifer and subsequent recovery through wells constitutes an important contribution to drinking water supplies worldwide. In Berlin, this managed groundwater recharge makes up around 10% of the total drinking water produced. The principle is as follows: water is taken from surface water, purified in treatment plants, then channelled into technical basins or ditch and pond systems, where it recharges the aquifer. The natural processes that take place during the subsequent subsurface transport purify the infiltrated water, which is then withdrawn again through extraction wells.

However, this type of treatment is more difficult to monitor than technical water treatment and thus represents a certain risk for water suppliers. An important monitoring parameter is the residence time of the infiltrated water in the aquifer before it is extracted by wells. Residence time data could previously only be collected by sampling, as appropriate methods for routine monitoring were lacking. The international research project SMART-Control started two years ago to close this gap. Scientists at KWB and other research institutions have developed a web-based monitoring and control system which can measure the residence time of infiltrated water in the subsurface (Abb. A). For this purpose, sensors are used to continuously measure data on the water level and water

A

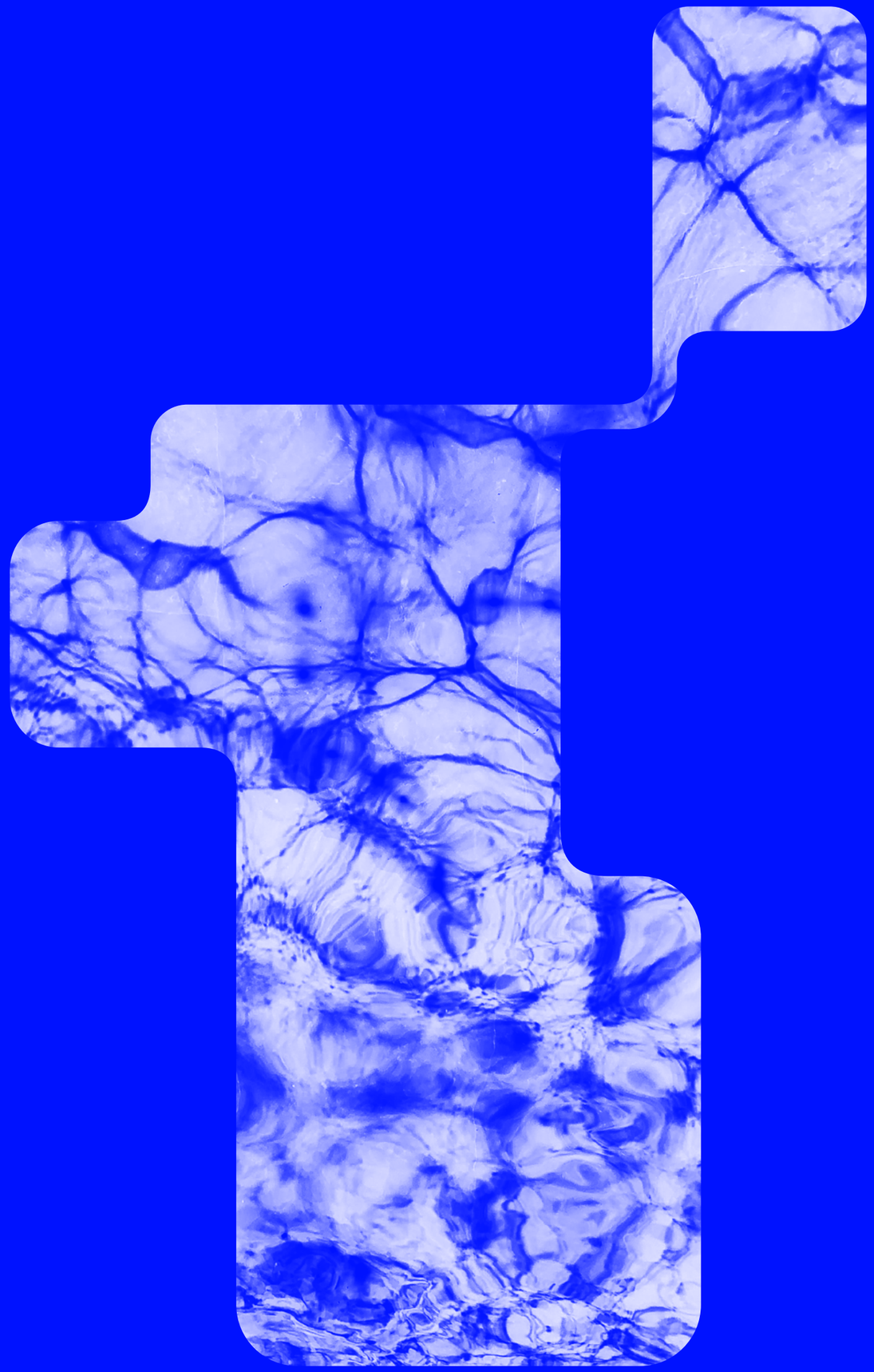
B

temperature in the infiltration basins, selected measuring points and drinking water wells as part of an ongoing case study at the Berlin-Spandau waterworks. Using algorithms developed in-house, the residence time of the infiltrated water is then calculated from the data obtained and displayed on a web platform.

Additionally, hygienic risks to the water quality of the basin and groundwater are analysed by means of a special measuring device installed on site (flow cytometry) as well as by sampling (Abb. B) and classical microbial cultivation. Genetic investigations complement the measurements with microbiological "fingerprinting". The combination of these methods allows assessment of microbial dynamics along the flow path of the recharged water from the infiltration basins to the extraction wells.

Swimming out

What are the major challenges of the future? What part will KWB play? Please read on to find out about our European commitments, including the digital transformation of our cities. We'll also showcase our innovative and future-oriented services.



Read more about our future topics:

- ▶ KWB in Berlin and in Europe
- ▶ It's more than just data that's flowing in the Smart City
- ▶ Services

KWB in Berlin and in Europe

“Our topics don’t just stop at the city limits.“

In 2019, in response to climate change, the European Commission launched the EU Green Deal with the goal of achieving climate neutrality within the EU by 2050 and transitioning to a modern, resource-efficient and competitive economy. Regardless of whether you find the climate objectives to be sufficiently ambitious or not, the direction we take must be the correct one. KWB is proud to have recently received the green light for two major EU Green Deal projects - IMPETUS and PROMISCES – and to have collaborated on planning the roadmap towards a climate-neutral future.

Our vision

Before discussing the projects themselves, let’s break down why they were successful in the first place. KWB’s Articles of Association stipulate the promotion of science, research and development in the field of water. At the same time, KWB’s researchers think well outside the box. They have always recognised the relevance – and the potentials – inherent in the various contexts and sector-transcendent topics relating to water. We can also look back on 20 years of a clear stance on climate change, which has always been grounded in science. KWB sees itself as a campaigner for climate neutrality and is committed to working on solutions to avoid the consequences of climate change. To put it simply: in the pursuit of climate neutrality, we see our work as a quest for the urgent goal of sustainable water resources use.

»IMPETUS is a major opportunity for accelerating climate protection as well as our adaptation to climate change. Berlin and other pilot regions will be contributing to the accumulation of crucial knowledge and solutions in order to drive the EU Green Deal forward and share the valuable findings in a constructive manner.«

Jochen Rabe

Because climate change and especially water do not stop at the city limits, KWB began working on setting up networks outside of Berlin and acquiring and implementing more and more research projects on an international level early on. Linking the regional and the global is part of our DNA, so we strive to develop solutions for increasingly larger scales which are relevant not only for Berlin/Brandenburg, but for Europe and the entire world.

Our Mission

Our mission statement outlines the path for achieving this vision. You will find it in the introduction to this annual report, and at this point we need do no more than to remind you of the keywords. We are thought leaders, honest brokers and drivers of change. This way of seeing how our work contributes to our vision speaks for itself, as KWB ranks amongst the top 20 research and development institutions in Berlin in terms of funding received between 2014-2020 as part of the EU Horizon 2020 framework programme. Compared to our size – the list of top 20 includes the major Berlin universities as well as the Robert Koch Institute – this is quite an achievement. In 2021, we’re especially proud of the fact that our IMPETUS and PROMISCES project proposals – two of only 72 projects funded from over 1,500 proposals – were successful!

Our activities

Centered around the issue of climate change, the IMPETUS project will specifically focus on reducing the gap between what can be achieved with proven solutions for adaptation and what is required to facilitate rapid and far-reaching change. We already see that a step-by-step process of adaptation is not going to be enough to lessen the consequences of climate change on socio-ecological systems in some EU countries. Radical and transformative steps will need to be taken towards mitigating climate issues and building up our resilience. We all need to come together. And that applies to cities, communities and citizens as much as it applies to science, politics and the economy. This is where IMPETUS comes in.

This project involves developing climate resistant solutions in the fields of technology, nature, governance, finance and public commitment and affecting rapid, far-reaching changes. The primary objective will be to support the cross-sector transfer of social, ▸

technical and economic innovations, and to accelerate their rate of propagation. These innovative solutions will be developed for and in seven regional test areas – one in each of the bio-climatic regions of Europe – providing pioneering work and supporting companies and communities on their ecological and economic journey of change. As part of a holistic approach, IMPETUS has brought together 32 partners from the fields of economics, research, regional government and utility companies from eight different countries within the EU and are in touch with many other local players. The project consortium will be developing scalable, cost-effective measures which are sustainable in ecological, economic and social terms, and which will be designed to support major community systems such as water, agriculture, fisheries, infrastructure and health.

KWB will be concentrating its efforts on the "continental" zone and focusing on water in Berlin/Brandenburg. Here, the emphasis is placed on promoting green infrastructure, innovative technologies and sustainable services, placing us resolutely on course towards future-oriented, interdisciplinary, cross-sector joint ventures, with KWB benefitting from leverage thanks to its partners within the project. We are particularly pleased to have brought the Berlin Senate Department for the Environment, Transport and Climate Protection on board this promising and important EU project, thus fulfilling our commitment to connecting regional and global issues.

PROMISCES, the second project which we were awarded, involves 27 partners committed to furthering the circular economy in the EU by tackling industrial pollution and developing zero pollution strategies. The main goal in PROMISCES is to develop new analytical methods and toxicological tools with a particular focus on analysing the ingress of per- and polyfluorinated substances (PFAS) into soil, sediment, and water systems. PFAS are practically indestructible and are used to make consumer goods repellent to water, grease and dirt. But they also come with environmental hazards and health risks. KWB will be working on monitoring and modelling the fate and transport of PFAS and other industrial chemicals in Berlin's surface water and groundwater, and will be establishing probabilistic approaches for chemical risk assessments for human health.

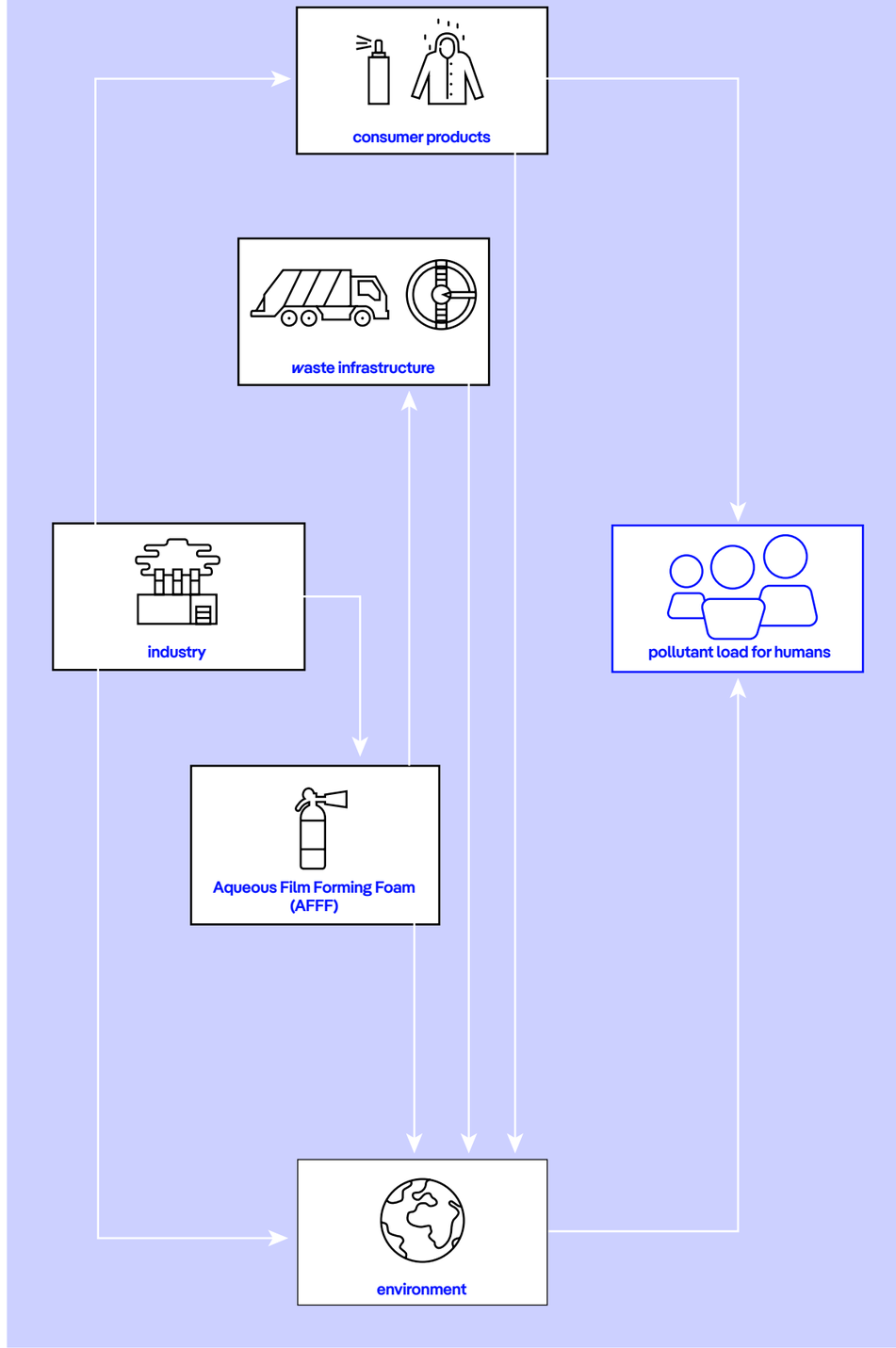
And what else?

Both of these new projects are part of a suite of EU projects currently running at KWB. One of these is digital-water.city, which focuses on enhancing the potential of data and digital technologies for urban water management and involves 24 partners from 10 countries, with KWB acting as the consortium leader. As part of the EU project ULTIMATE, KWB is researching the development of synergies between the industrial and water sectors since last year. Thanks to its passionate and committed work on EU projects as well as the acquisition of additional future-oriented projects at the European level, KWB isn't just making its own visions a reality, but also establishing itself as an important driver of positive change both in Berlin and beyond. ●

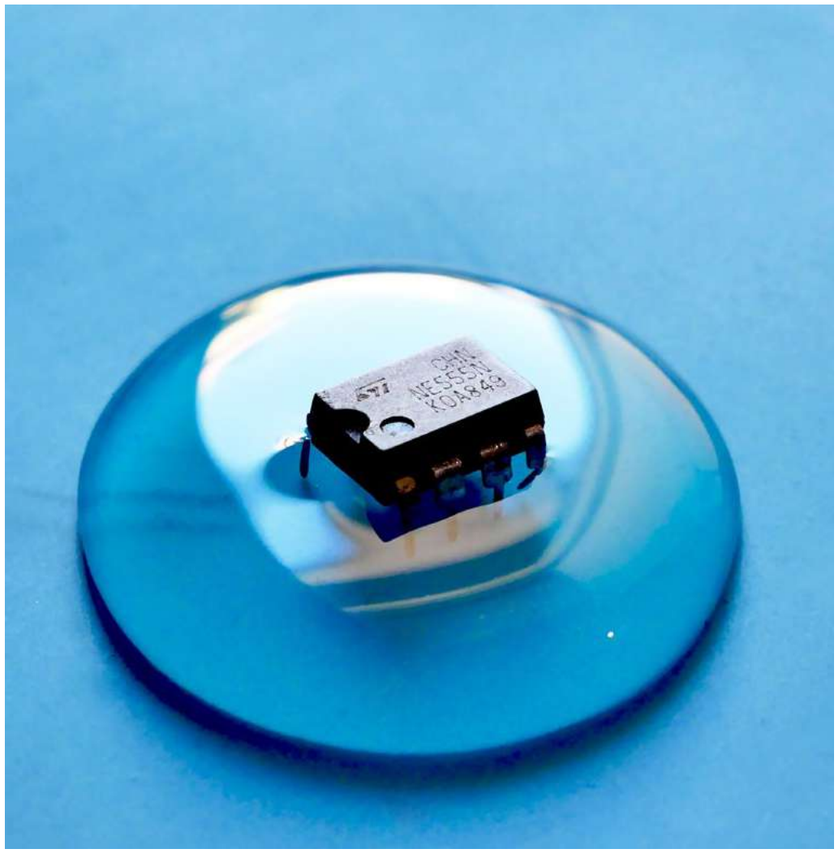
» We are proud of the fact that the Greater Berlin area is the subject of one of seven case studies within the IMPETUS project. This project will be networked with local communities and promote the blue/green infrastructure in order to overcome the challenges presented by climate change.«

Hella Schwarzmüller

PFAS loads and its sources



It’s more than just data that’s flowing in the Smart City



“Smart City” – a term which has been making the rounds and is well known by now. We’re sure the people working this subject area must get tired of constantly explaining what it means. Nevertheless, here’s a brief explanation for those with a vague idea of the relationship between the Smart City concept and urban development and digitalisation: while initially the focus was on technological aspects, today the Smart City debate is about modernising city management using digitalisation tools and associated necessary sustainable transformation. The aim is to use data and technologies to improve urban and infrastructure management, and couple it to other sectors like transport, urban planning, or energy supply. The goal is also to break up and network decentralised structures to make cities more efficient, technologically advanced, and resilient. In accordance with the Smart City Charter of the Federal Ministry of the Interior (BMI) the approach is an activating, integrative and inclusive one with the substantial participation of residents. The Smart City Charter is also the basis of the federal initiative Modelling Projects for Smart Cities (MPSC), which is currently supporting the Smart City Strategy Berlin development process.

But what does all of this have to do with water and with KWB? Quite simply, water is everywhere. And in many places – due to the influence of humans and climate change – water is in an worsening crisis. Either we don’t have enough water or – as we were harshly reminded of over the summer – we suddenly have far too much of it. Not to mention the various sources of water pollution, which we haven’t even mentioned yet. The challenges are enormous and therefore also play a decisive role in the Smart City and in digitalisation processes. However, they’re still not addressed often enough in projects. Our managing director, Prof. Jochen Rabe, and our researcher Dr. Nicolas Caradot, head of the digital-water.city (dwc) project, are also reviewers for the MPSC in addition to their research activities. So far, they’ve only been able to find isolated mentions of water topics in the proposals submitted by municipalities to the BMI (albeit committed ones). At first glance, it seems many people think that water has little to do with the Smart City.

Water: an inseparable component of the Smart City

This is where KWB comes in, both with its consulting activities and much more. We’re committed to bringing water issues more attention and giving them a more prominent position in the Smart City and digitalisation debates. We want to move forward in terms of content and develop solutions for rapidly changing cities to address the many issues relating to water, with its multiple interfaces with other sectors such as energy and urban development. Digitalisation in water and adjacent sectors must keep pace with the speed of population growth, urbanisation, and technological advancements. Resilience strategies need to be developed and implemented, in light of climate change and the resulting complex challenges for smart cities. Here, too, speed is of the essence.

In our mission to bring water issues more into the Smart City debate, we benefit from the fact that Jochen Rabe, in addition to his executive position at KWB, has held a professorship in Urban Resilience and Digitalisation at the Einstein Centre Digital Future for four years. His research focuses include the rapid transformation of the city through digitalisation in the economy, infrastructure and environment, as well as green-blue infrastructure. In addition, there is the aforementioned expert activity at the federal level and, at the local level, membership on the advisory board of the new Smart City Strategy in Berlin. Thus, the KWB is predestined to link "classical" water topics, such as drinking water supply, wastewater disposal and treatment, but also protection against flooding, with Smart City topics, to focus on interfaces of sector coupling and to point and capitalise on out synergy effects. At the same time, however, the risks of digitalisation - for example, the lock-in effect, which makes it difficult to switch to digital solutions, and the necessary independence of municipalities – should always be critically kept in mind.

Implementation has been a long time coming

And what specifically is going on now? In the context of the successful acquisition and implementation of projects in the field of water research and the Smart City with the State of Berlin, the BMI and also at EU level, KWB is establishing itself as a thought leader, honest broker and driver of change (see also our Mission Statement), building bridges between the interfaces of water and cities, climate change and digitalisation. This is embodied by, for example, by the dwc project mentioned above, which is dedicated to harnessing the potential of data and digital technologies for urban water management. The project, under the consortium leadership of KWB, includes 24 partners from 10 countries who are jointly developing 15 innovative digital solutions to address major water-related challenges. ▶

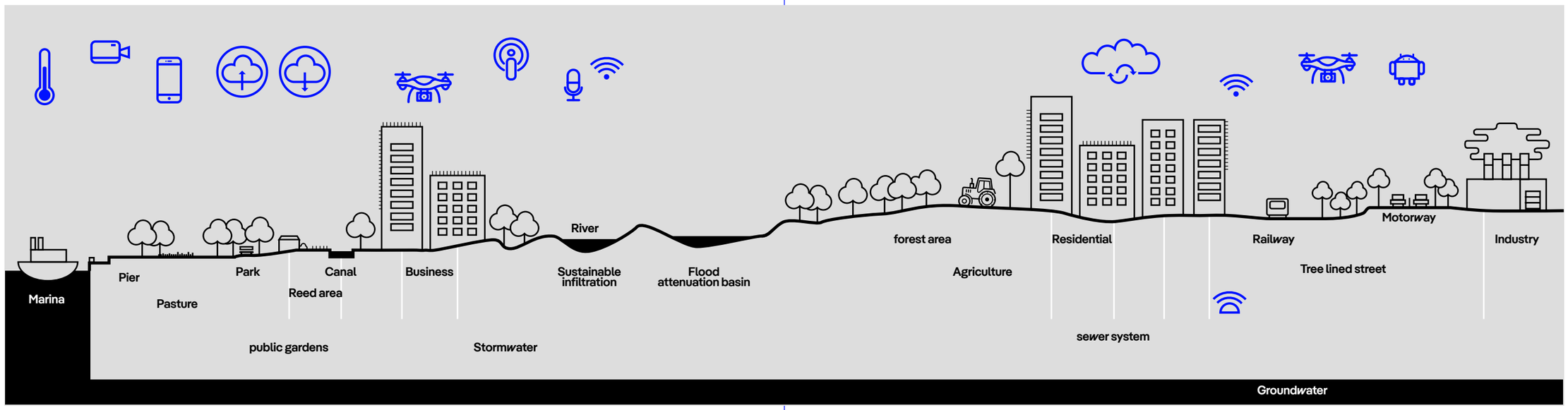
These range from AI-based solutions for predicting bathing water quality, to augmented reality applications for visualising groundwater, to systems for reusing treated wastewater for drought-stricken agriculture.

Moreover, we are no longer "only" active as experts for the MPSC mentioned above, but we also conduct studies for them on behalf of the BMI. For example, the study "Data Cooperation for Resilient Communities" offered approaches for an innovative and cooperative handling of diverse data sources to cope with the manifold challenges in the city. The specific need for relevant data and its availability is often unclear. Through targeted data collaborations, gaps of required data can be filled and also made available for further problems. As a suggestion for how municipalities can systematically deal with the topic of data cooperation, we developed an exemplary questionnaire on the topic of heavy rain events, which established a relation between municipal needs and required data cooperation. Research into this topic showed that of 55 municipalities in the funding program, more than 80% are confronted with flooding after heavy rain, with about half of them reporting moderate and severe impacts. In addition to flooding, this also included hygienic pollution of bathing waters as well as pollution of the aquatic ecosystems caused by CSOs. Our analysis not only resulted in determining which data are needed for which specific solutions, but also provided recommendations for novel data collaborations and pointed out potential obstacles. The exemplary approach conducted on the topic of heavy rainfall in urban areas can be transferred to many municipal applications in order to establish innovative data cooperations for the provision of public services.

Additionally, the KWB, together with the DLR Institute for Transportation Systems Engineering, the Fraunhofer Institute for Industrial Engineering and for Experimental Software Engineering, the German Institute of Urban Affairs, and many others, is part of the consortium that forms the so-called Coordination and Transfer Office (KTS). Since September 2021, the KTS has been in charge of the 73 currently funded MPSCs. As a central point of contact, the KTS supports the model projects and the local actors in organising the exchanges of experience between the model projects and in translating the practical and expert knowledge gained in this way for transfer to the municipal level. To this end, accompanying research is used to systematise the strategies and implementation concepts of the model projects and to derive new findings and needs-based solutions for broad municipal practice, so that added value is created for all municipalities in Germany. The KTS is scheduled to run until the end of 2030. The list of our projects in which digitalisation and networking play a role and which advance corresponding efforts in the Smart City could easily be continued. Our Green Gas project is focused on sector coupling and looks at how to transfer the bio-methane and hydrogen energy from wastewater treatment plants into the fields of mobility, industry and heat supply in buildings. The innovative SEMAplus forecasting tool was born from the focused development and application of artificial intelligence for long-term sewer maintenance.

Digital change in our cities has already begun. It offers a wealth of opportunities but also comes with risks. But one thing is clear: water plays an essential role here, as it does in all areas of life. KWB has become a driving force for introducing water to the Smart City.

Blue-green infrastructure in the digitalised city



Services

- Deterioration forecasts for sewer systems
- Sustainable wastewater treatment plants in the era of climate change
- P-recovery consulting
- Data-driven prediction of water quality at bathing sites

KWB's research activities always have a direct bearing upon practical application. Many of our results have already been implemented in practice by our partner organisations. Following a number of commissioned projects stemming from research projects, we're concentrating on further developing our commercial business in a targeted manner. This not only means that we can remain versatile in economic terms, it also enables us to support our conceptual research activities in the long term. Last but not least, this also means that we can fulfil the expectations of research promoters such as Federal Ministry of Education and Research and the EU by guaranteeing economically viable application or further use of our research results.

In terms of developing business models, we're currently focusing on the services presented on the following pages. We're already establishing successful business connections and are very much looking forward to new projects.

Deterioration forecasts for sewer systems

SEMAplus

KWB in cooperation with Berliner Wasserbetriebe

In total, the sewer system in Germany is over half a million kilometres long and must be constantly renewed. As the ones operating the sewer system, municipalities are faced with the challenge of maintaining an overview of the maintenance and repair requirements of this unseen infrastructure. Camera inspections provide important insights. However, these can only give snapshots of the condition of small sections of the sewer networks. Additional tools are needed for long-term planning of investment and rehabilitation strategies.

In numerous research projects together with the Berliner Wasserbetriebe over the years, KWB has developed the innovative tool SEMAplus, which can be used to very accurately predict the condition of non-inspected sewer sections and entire sewer maintenance systems.

The success of our practical applications in Berlin prompted us to actively launch SEMAplus on the market. In this way, we want to support municipalities in assessing the ageing status of their underground infrastructure and rehabilitation planning.

SEMAplus operates using mathematical processes based on artificial intelligence and statistical models. Two simulators are available:

- With only a limited amount of inspection data, the SEMAplus Pipe Simulator determines the current condition or asset value of sewer pipes and helps to localise urgent rehabilitation needs.
- The SEMAplus Strategy Simulator forecasts the long-term condition or asset value development of your complete network over several decades, taking all preventative measures into account. On this basis, necessary investments for the sustainable maintenance of sewer networks can be planned precisely and effectively.

Particular advantages:

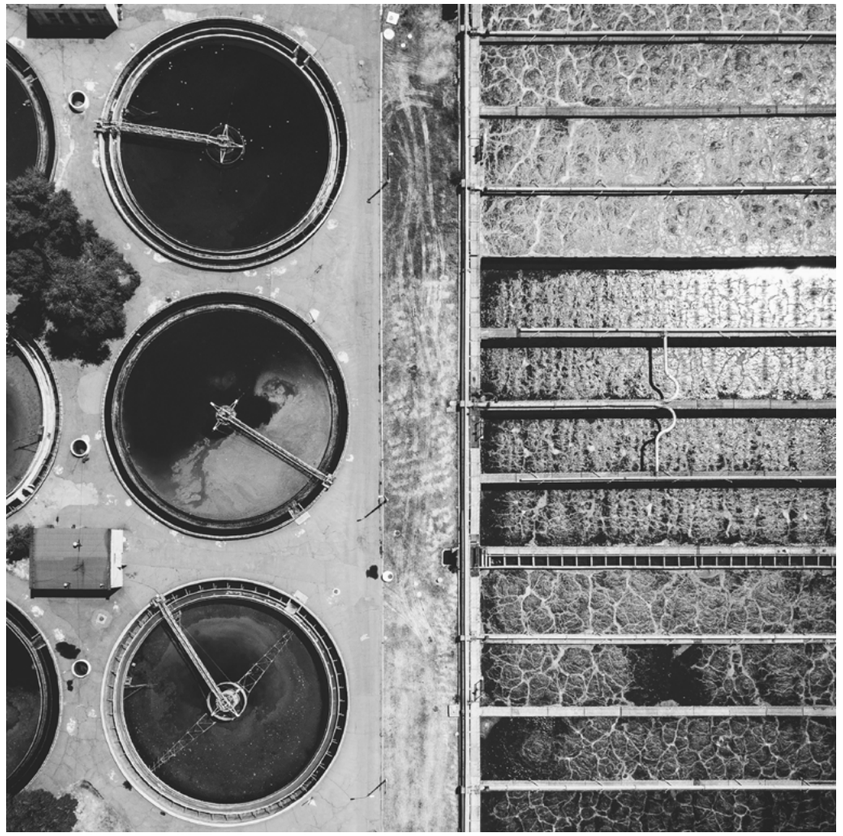
- Precision – even with incomplete data, the models deliver reliable results
- Transparency – with SEMAplus, we focus on maximum transparency, and following training, the tool allows carrying out and adjust the aging forecasts independently. Moreover, crucial information between managers can be exchanged efficiently and understandably. This provides a good starting point for taking appropriate decisions.
- SEMAplus community – Users can join a growing community that develops and optimises the tools together, including free upgrades. This community includes the Berliner Wasserbetriebe, the largest municipal water supply and wastewater treatment company in Germany.

SEMAplus has been in operational use in Berlin since 2019. In the first year of its pilot phase, SEMAplus was awarded the highly-acclaimed Prize for Innovation of the German Association of Municipal Companies.

Sustainable waste-water treatment plants in the era of climate change

Life Cycle Solutions

As large energy consumers and direct emission sources of nitrous oxide and methane, wastewater treatment plants contribute significantly to greenhouse gas emissions. Reducing these energy related emissions from wastewater treatment plants is a particular challenge because compliance with climate neutrality can only be achieved with additional plant technology and higher energy consumption.



With our Life Cycle Solutions, we draw up energy and greenhouse gas balances for wastewater treatment plants and thus support plant operators in redesigning their plants towards climate neutrality in the long term. When drawing up the balance, we cast light on the entire wastewater treatment plant operating process, as well as subsidiary processes, and create a budget for all energy and chemical consumption necessary for operating the plant in addition to waste disposal (life cycle analysis). Our methodology is compliant with recognised certified reporting standards for creating sustainability reports.

Our Life Cycle Solutions are backed by more than 10 years of research and development experience. Thanks to our comprehensive understanding of all technical processes in wastewater treatment, we supply in-depth analyses. This way, we provide innovative, customised solutions which have been tested in practice in the context of increasing demands on energy and resource consumption as well as the achievement of climate targets.

P-recovery consulting

Phosphate is an essential nutrient for plant growth. In order to ensure safe and sustainable access to this important and finite raw material in Europe, recovery and recycling of phosphorus has become a major political objective within the EU.

That's why back in 2017, a binding regulation for the phosphorus recovery from sewage sludge in medium-sized and large sewage treatment plants was passed in Germany, which is due to come into effect in 2029. A large number of process combinations were available to implement recovery. However, it's not easy for wastewater treatment plant operators to distinguish between them in terms of economic efficiency, feasibility and environmental compatibility.

This is where K*W*B comes in with its know-how on P-recycling. With our many years of expertise, we can comprehensively analyse and evaluate both already implemented and emerging P-recycling processes. We explain the technical and economic options for P-recycling from wet sludge and sewage sludge ash that are tailored to your specific requirements and your sewage sludge. In our analyses we consider P-recovery together with sewage sludge disposal holistically.

In addition to assessing the technical feasibility, we also provide analyses of the CO2 footprint and the economic viability of various processes. Our forecasts on the pollution load and the marketing opportunities of the recycled phosphate products will support you in upcoming investment decisions.

With our P-recovery consulting, K*W*B offers independent and practice-relevant services in a market with many different processes and products.

Data-driven prediction of water quality at bathing sites

Early warning system for bathing water quality

Heavy rainfall causes emergency overflows of sewer systems into the surface water. This is one of the main sources of pollution for urban rivers and streams in which more and more city dwellers may want to swim. Municipalities, which are usually responsible for the operation of bathing sites, are faced with the challenge of minimising the health risks caused by the flood of pathogens and other hygienically relevant microorganisms.

The monthly microbiological monitoring required by law is usually not sufficient to guarantee consistent hygienic safety at such bathing sites influenced by the sewage system.

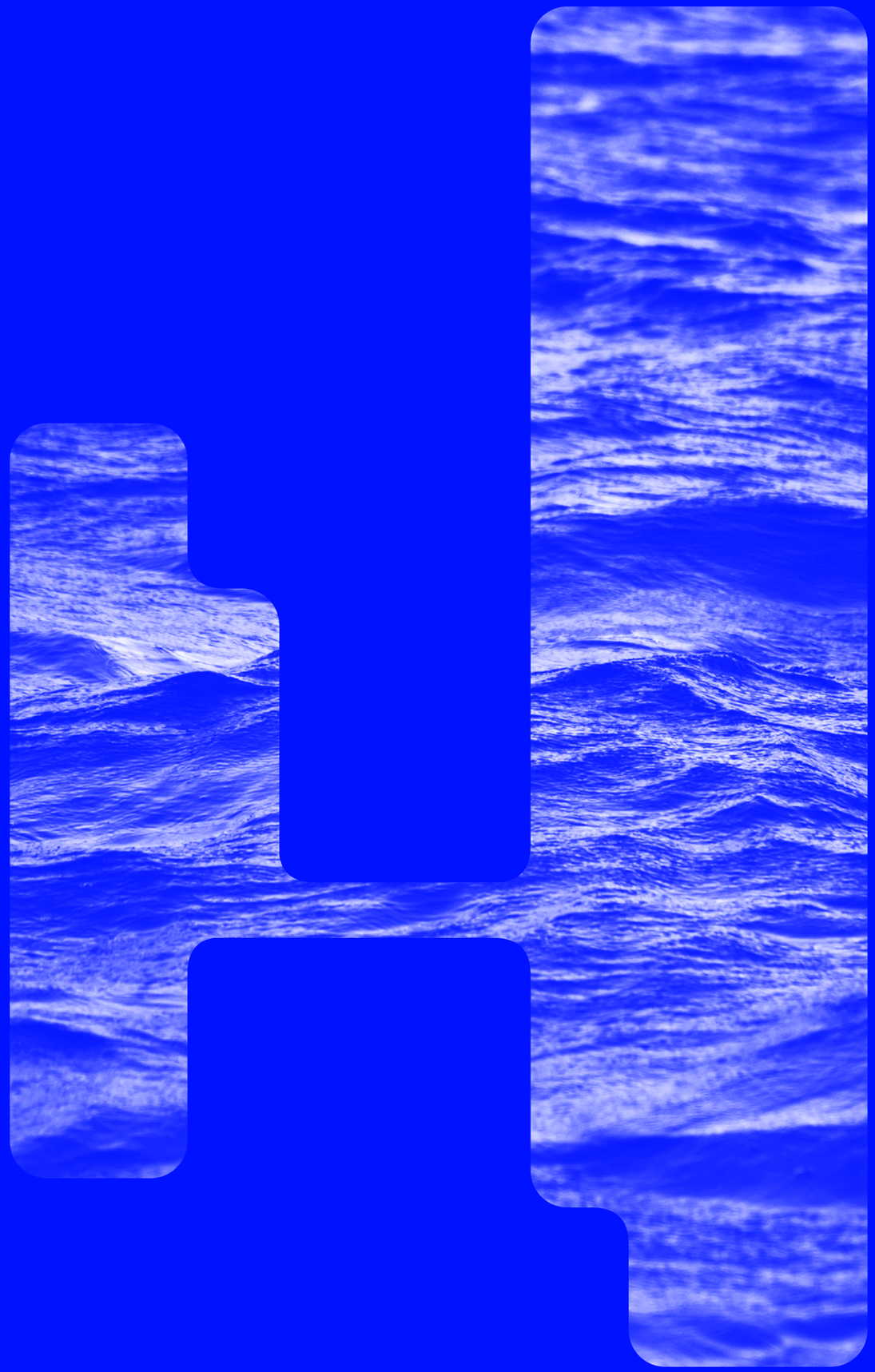
In light of this, *KW*B developed a model for predicting the hygienic water quality in rivers and put it to use in Berlin. A statistical computer model is fed with daily digital data of water bodies and rainfall data in Berlin provided by the Berliner Wasserbetriebe and the Berlin Senate Department for the Environment, Transport and Climate Protection. Since 2019, the residents of Berlin have been able to view to the current bathing water quality at selected bathing spots via badegewaesser-berlin.de. This forecast model was awarded the Berlin AQUA AWARD in the summer of 2019.

This forecasting system is transferable to other regions, which is why we're now extending our solution for Berlin to interested municipalities operating bathing sites elsewhere. The base data for this system is data from the water body and rainfall. Through several individually selectable service variants, we support municipalities in the initial set up of the necessary data collection, in the collection and processing of water monitoring data up to the installation and operation of the forecasting system. Additionally, we also offer to install and operate the online monitoring probes for bathing waters, which provide the data incorporated into the forecasting system.

The forecasting system is currently being set up on the Seine river in Paris as part of the *KW*B-led EU project digital-water.city. It's intended to help ensure pristine water quality for the swimming competitions of the 2024 Olympic Games.

Docking

After a wild ride, it is now time to dock. Below, we have provided an overview of all our ongoing projects and publications from 2020/21. None of this would have been possible without our employees, which is why we're starting this final section with them.



Would you like to see overviews?
You can find these below:

- ▶ Team
- ▶ Project overview
- ▶ Publications
- ▶ Social Media

Team

Status as of December 2021

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Department Leader *Process Innovation*, Group Leader *Treatment Processes*

Process Innovation

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Researcher

Dr. Christian Remy
Group Leader *Energy & Ressources*

Michael Stapf
Researcher

Dr. Anne Kleyböcker
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Lea Conzelmann
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Dr. Veronika Zhiteneva
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Jeannette Jährig
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Dr. Kuangxin Zhou
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Jonas Hunsicker
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Urban Systems

Dr. Pascale Rouault
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Group Leader *Stormwater & Surface Water*

Dr. Nicolas Caradot
Group leader *Smart City & Infrastructure*

Franziska Knoche
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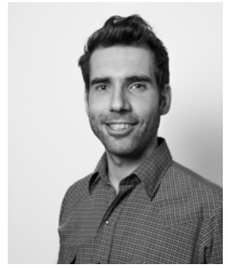
Dr. Daniel Wicke
Researcher

Wolfgang Seis
Researcher



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Malte Zamzow
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Ground-water

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Researcher

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Head of Research Unit *Groundwater*

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Michael Rustler
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Department Leader *Administration & Business Development*

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Multilingual Team Assistant

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Communications Manager

Bianca Cramer
Graphic Designer

Tobias Evel
Commercial Project Management

Kristine Oppermann
Project Controlling, Accounting

Lina Knaub
Student Business Administration

Trainees

KWB is supported by a wealth of up-and-coming talent from a wide range of specialisations. Not only are we proud of being able to provide them with support (such as by assisting them with their numerous final projects), we're also benefitting from their future-oriented ideas.

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William Würpel
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Project overview

Overview projects 2020/2021

Acronym	Subject	Funding Sources	Run-time	Project Management	Department
Ab-luft-2/2.1	Evaluation of the Treatment in the Aeration Tank (Optimisation of Exhaust Air Treatment and Activation Stage)	BWB	Nov. 18 – Oct. 22	Anne Kleyböcker	Process Innovation
BaSaR	Construction and Renovation as a Source of Pollution	Umwelt-bundesamt (UFOPLAN)	Jul. 17 – Jul. 20	Daniel Wicke	Urban Systems
Blue-Planet	Event Series "Blue Planet Berlin Water Dialogues"	BMU, SenWeb	Jul. 20 – Dec. 21	Bodo Weigert	Administration
Circular Agrono-mics	Efficient Carbon, Nitrogen and Phosphorus cycling in the European Agri-food System and Related Up- and Down-stream Processes to Mitigate Emissions (Circular Agronomics)	EU H2020	Sep. 18 – Feb. 23	Fabian Kraus	Process Innovation
CLOOP	Closing the Global Nutrient Loop	BMBF	Nov. 17 – Apr. 21	Fabian Kraus	Process Innovation
CW-Pharma	Reducing Pharmaceutical Emissions into the Baltic Sea Catchment	EU Interreg Baltic Sea, BWB	Oct. 17 – Apr. 21	Michael Stapf	Process Innovation
CW-Pharma-2	Clear Water From Pharmaceuticals	EU Interreg Baltic Sea, BWB	Oct. 20 – Nov. 20	Michael Stapf	Process Innovation
Cyber-security	Analysis of the Future Development of the Water and Wastewater Infrastructure and the Associated Cyber Risks	BWB	Jun. 21 – Dec. 21	Nicolas Caradot	Urban Systems
De WaResT	Decentralized Wastewater Treatment and Water Reuse for Regions with Seasonal Drought Stress	BMBF	Aug. 21 – Jan. 24	Jeannette Jährig	Process Innovation
DWC	Digital Water City: Leading Urban Water Management to its Digital Future	EU H2020	Jun. 19 – Nov. 22	Nicolas Caradot, Hella Schwarzmüller	Urban Systems, Groundwater
E-VENT	Evaluation of Process Options for the Reduction of Energy Consumption and Greenhouse Gas Emissions of Berlin Sewage Treatment Plants	BENE, BWB	Mar. 17 – Jul. 20	Christian Remy	Process Innovation
FlexTreat	Flexible and Reliable Concepts for Sustainable Water Reuse in Agriculture	BMBF	Feb. 21 – Jan. 24	Michael Stapf	Process Innovation
GeoSalz	Dynamics of Saline Intrusion for Early Identification of Endangered Drinking Water Wells and Quantification of the Hydraulic Potential	BWB	Aug. 21 – Jul. 24	Hella Schwarz-müller	Groundwater
Grünes-Gas	Dynamics of Saline Intrusion for Early Identification of Endangered Drinking Water Wells and Quantification of the Hydraulic Potential	BENE, BWB	Jun. 20 – Feb. 22	Christian Remy	Process Innovation
Hydra	Hydraulics of Artificial Groundwater Recharge under Changing Climatic Conditions in Berlin	BMU, BWB	Jan. 18 – Jan. 20	Christoph Sprenger	Groundwater
iBath-Water	Advanced Urban Water Management to Efficiently Ensure Bathing Water Quality	EU LIFE	Sep. 18 – Jan. 22	Pascale Rouault	Urban Systems
IMPETUS	Dynamic Information Management Approach for the Implementation of Climate Resilient Adaptation Packages in European Regions"	EU H2020	Sep. 21 – Mar. 25	Hella Schwarz-müller	Groundwater
KEYS	Smart Technologies for Sustainable Water Management in Urban Areas as Key Contribution to Sponge Cities	BMBF	Aug. 18 – Jan. 22	Kuangxin Zhou	Process Innovation
LIWE	Large-scale Implementation of Tertiary Treatment and Phosphate Recovery in Lidköping, Sweden	EU LIFE	Jul. 18 – Jun. 23	Fabian Kraus	Process Innovation
LoopSee	Thermal Use of Surface Waters Using the Example of a Rainwater Treatment Plant	BWB	Apr. 21 – Dec. 21	Franziska Knoche	Urban Systems
MBR4.0	Development of Digital Solutions for the Optimisation of Membrane Bioreactors	BMBF	Aug. 19 – Dec. 22	Kuangxin Zhou	Process Innovation
NetWO-RKS4+	Planning Criteria for Climate-just Cities – netWORKS4 (Transfer Phase)	BMBF	Jul. 20 – Jun. 22	Pascale Rouault	Urban Systems
NextGen	Water Reuse, Nutrient Recovery and Energy Recovery	EU H2020	Jul. 18 – Jun. 22	Anne Kleyböcker	Process Innovation
PROMI-SCES	On the Way to a Zero Pollution Circular Economy	EU H2020	Oct. 21 – Mar. 25	Veronika Zhiteneva	Process Innovation
R2Q	Resource Planning for City Districts	BMBF	Mar. 19 – Feb. 22	Andreas Matzinger	Urban Systems
REEF-2W	Increasing Renewable Energy by Creating Synergies Between Municipal Solid Waste and Wastewater Management	EU Interreg Central Europe, BWB	Jun. 17 – May 20	Christian Remy	Process Innovation
R-Rhenania	Production of Modified Phosphate from Sewage Sludge Ash for Bavaria	BMBF	Jul. 20 – Jun. 23	Fabian Kraus	Process Innovation

Acronym	Subject	Funding Sources	Run-time	Project Management	Department
Sema-Berlin 2/2.1	Test and Selection of a Model Approach for Supporting Sewer Inspection Strategies	Sponsoring BWB	May 18 – Aug. 21	Mathias Riechel, Pascale Rouault	Urban Systems
SMART-Control	Smart Framework for Real-time Monitoring and Control of Subsurface Processes in Managed Aquifer Recharge Applications	BMBF	Feb. 19 – Jan. 22	Christoph Sprenger	Groundwater
SMART-Plant	Scale-up of Low-carbon Footprint Material Recovery Techniques in Existing Wastewater Treatment Plants	EU H2020	May 18 – Aug. 20	Christian Remy	Process Innovation
SPuR	Measures to Reduce Water Pollution of Trace Organic Compounds in Urban Rainwater Runoff	DBU	May 19 – Nov. 21	Pascale Rouault, Daniel Wicke	Urban Systems
SubKans	Development of a National Standard for the Assessment of the Remaining Value of Sewer and Manholes Infrastructures	BMWi	Jan. 19 – Dec. 20	Malte Zamzow	Urban Systems
Suleman	Technical Treatment of Groundwater Featuring Elevated Sulphate Levels	BMWi, BWB	Jun. 18 – Feb. 22	Jeannette Jährig	Process Innovation
ULTIMATE	Industry Water-Utility Symbiosis for a Smarter Water Society	EU H2020	Jun. 20 – May 24	Anne Kleyböcker	Process Innovation

Caption:

BWB = Sponsoring Berliner Wasserbetriebe

EU H2020 = EU Horizon 2020

BMBF = The Federal Ministry of Education and Research

BENE = Berlin Programme for Sustainable Development

BMU = The Federal Ministry of the Environment, Nature Conservation and Nuclear Safety

DBU = German Federal Environmental Foundation

BMWi = The Federal Ministry for Economic Affairs and Energy

SenWeb = Senate Department for Economics, Energy and Public Enterprises

Publications

Project reports

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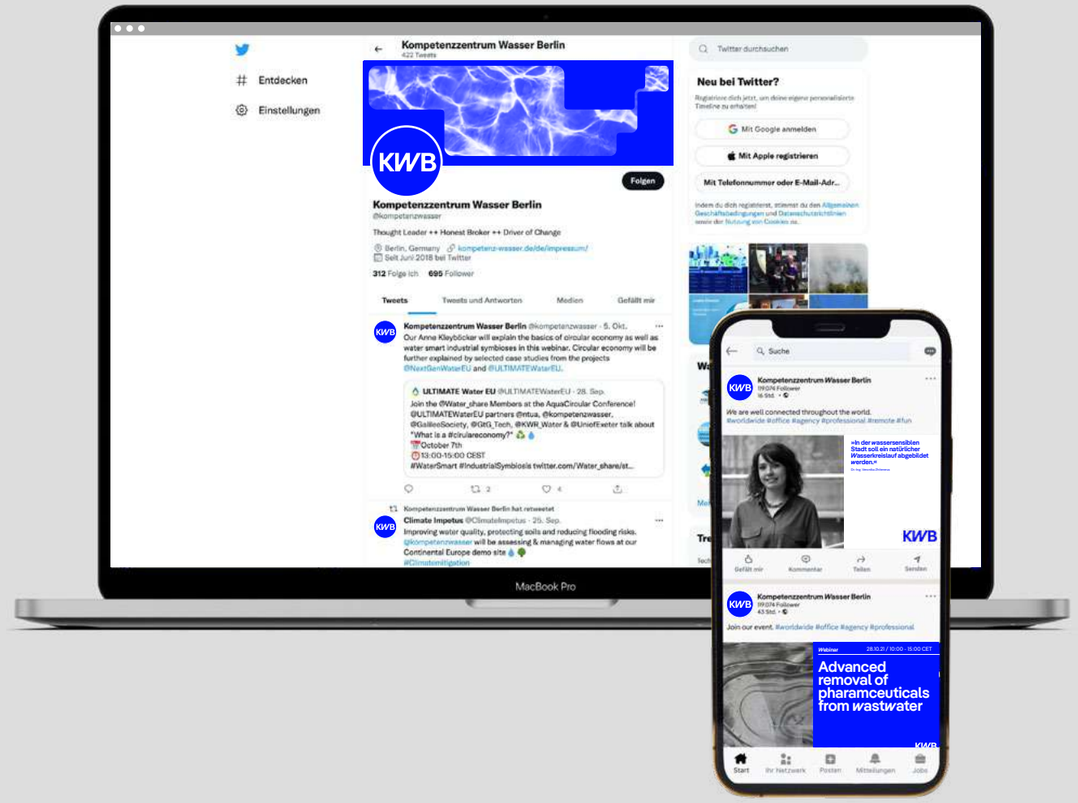

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