Research & Innovation

2019 Progress Report

waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

Research and Innovation Programme

“Water is indispensable. For us, as inhabitants, and for our companies. Water can also be a threat from which we must protect ourselves. At the same time, it is becoming increasingly clear that water can play a crucial role in tackling issues such as climate change and subsidence as well as making agriculture more sustainable.”

“We are the first generation to notice the effects of climate change and the last generation that can do something about it. If we want Amsterdam to remain in perfect condition for its 800th anniversary, we must be willing to make difficult choices now. We aim to become the green leader of the Netherlands and Europe. This requires that we opt for natural gas-free neighbourhoods, for further sustainability and energy conservation.”

The regional public water authority Amstel, Gooi en Vecht (AGV) and the City of Amsterdam have great ambitions in terms of making our area future-proof. We want to reduce greenhouse gas emissions and contribute to the energy transition by using aquathermal energy. We want to recover energy and raw materials from the water cycle and minimize waste. The challenges posed by climate change, such as flooding, water shortages, threats to drinking water resources and flood protection, are considerable. This is why Waternet, as the operational organization of the municipality and the regional public water authority, is working within this program on making our water tasks future-proof. We do not do this research on our own, because cooperating with other parties. we get more out of water. This report presents the progress of the 2019 research and innovation programme. We hope you enjoy reading it!

Peter Smit, Member of the Board of the water authority Amstel, Gooi en Vecht (AGV)
Roelof Kruize, CEO Waternet

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The UN Sustainable Development Goals symbols refer to innovation themes.

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Biodiversity (the number of species and the numbers per species) is a clear measure of the quality of our living environment. Because biodiversity is under serious threat worldwide, we are devoting a lot of attention to this. Pumping stations, purification plants and other buildings surrounded by areas, as well as dykes, inspection paths and ditches, offer good opportunities to contribute to biodiversity if we organize them in a nature-friendly way and carry out less maintenance there.

The area around the Derde Bedijking pumping station now has a wildflower meadow with a bee hotel, a kingfisher wall, swallows nest boxes and a nature-friendly bank. The lawn is also no longer mowed short. In addition, we can adapt our buildings by providing roosting facilities for bats and birds during new construction and renovation. We also want to design and manage the sites at approximately 600 pumping stations in the urban area in a nature-friendly manner.

Read more

Wet cultivation to combat subsidence

Waternet is working with a farmer to conduct a trial with wet cultivation in Ankeveen. Since further lowering of water levels in the relatively rapidly subsiding peat meadow area is no longer a realistic option, livestock farming will no longer be possible there by 2080. Other negative effects include subsidence of buildings in the area and greenhouse gas emissions. Together with the target group, we are investigating alternative agricultural earnings models.

The trial was launched in 2019 and will last for over six years. It focuses on harvesting wet crops, on what is earned from them and on their possible integration into agricultural operations. We are growing three different crops (peat moss, common reed and cattail) in different ways on six experimental fields. We are examining water use, water quality, effects on the soil and the environment, the extent to which nitrogen and phosphate are released, and the best way of managing wet crops.

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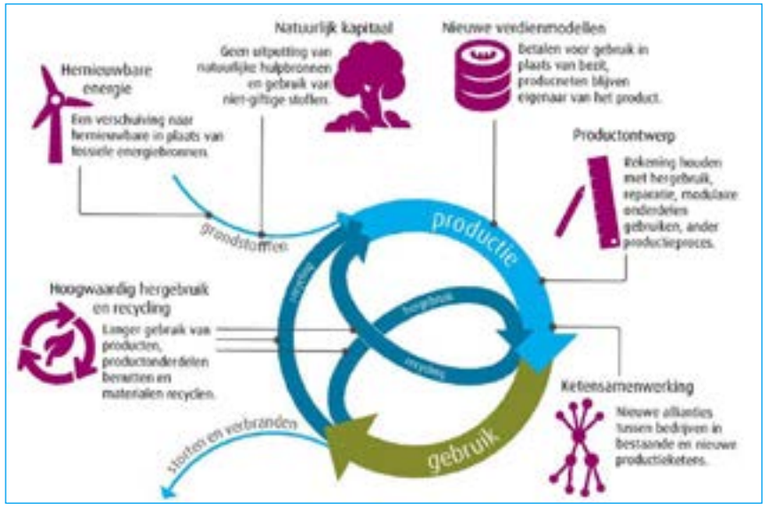
Planting cattails

Circular application of dredge spoil

The water authorities want to apply their raw materials in a fully circular manner by 2050. This includes the reuse of dredge spoil. In order to link the supply of dredge spoil to the potential demand, a social cost-benefit analysis (SCBA) was performed, focused on a circular economy. The long-term added value for each stakeholder was quantified and qualified. This shows that the reuse of dredged spoil can make an important contribution to the circularity goals of the water authorities, partly because of the large quantities involved. However, we still need to look further into existing and new ways of using dredge spoil in a circular manner.



In a second study, we will develop a quantitative tool to assess the degree of circularity of the various dredging plans and projects. By linking this to a catalogue of reuse options for clean and contaminated sediments we can gain insight into the potential contribution of dredge spoil to the circular goals.

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Research of slow sand filtration

We have been using slow sand filters for many years as the last purification step in the production of biologically stable and hygienic safe drinking water. However, the microbiological processes involved in producing this clean drinking water are still largely a mystery. Two PhD research projects will address this issue in the coming years. One study concerns the optimization of the process conditions, while the other tests a model that approaches the removal of micro-organisms. We want to design better slow sand filters with the results of these studies.

The microbiological processes occur mainly in the upper layer of the slow sand filter. This layer consists of organic material with micro-organisms such as bacteria, fungi and protozoa. By treating the layer in different ways, we can test under which conditions the filter performs best. We will also test it under different process conditions. In addition, we have a model that approaches the removal of micro-organisms. Through a research project, we want to find out whether that model works well.

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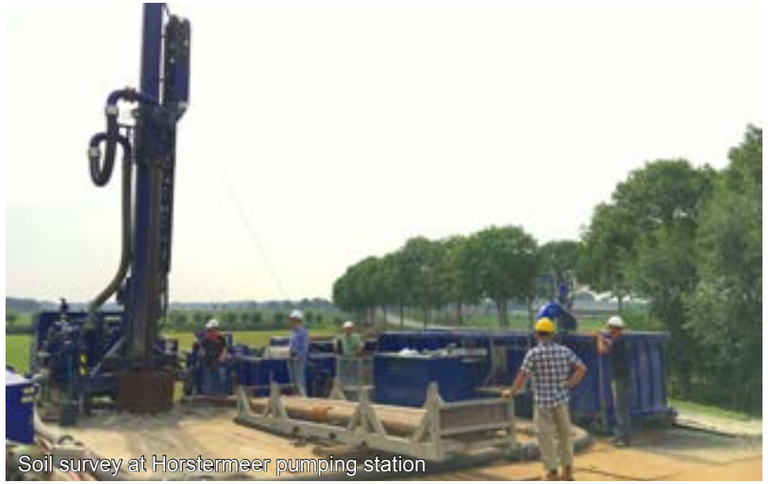
Slow sand filter at Leiduin

Controling brackish seepage


Soil survey at Horstermeer pumping station

The Horstermeer polder is a polder with brackish seepage water. At the edges of the polder, a lot of fresh water springs up from the higher surrounding area, while in the middle, brackish water rises up from great depths. Both seepage streams mix with the polder water, which is pumped to the Vecht. Because the brackish seepage water not only contains salt, but also sulphate and nutrients, it has a negative impact on the water in the polder and the surrounding area. To combat this problem, we let in fresh water from the Markermeer, but that is not inexhaustible.

We are going to investigate whether it is possible to pump up the brackish seepage water before it reaches the surface and to purify it into drinking water for the growing Amsterdam region. In 2019, we construct the pilot plant, which is expected to be operational in 2020 and 2021. If the results are good, work can start in 2022 on the construction of installations for the actual production of drinking water.

Read more

Plastic in the water cycle

Waternet manages approximately 350 kilometres of flowing polder drainage water, such as rivers and canals. Every day, our floating dirt removers remove plastic and other floating garbage from our waters, and several times a year we have clean-up days. Every year, we remove approximately 42,000 kg of plastic from the waters of Amsterdam. This is probably only a small proportion of the amount that flows into the North Sea via IJmuiden.

We are investigating the amounts of plastic in the water and in the water bottom. In a test involving the separation of plastic from dredge spoil, we brought in 1,800 m^3 of dredge spoil from the Rijpgracht canal. The storage capacity for the sieved waste was reached after screening just the first 300 m^3, which contained 20 m^3 debris – one-third of which was plastic! To combat all that plastic in the water, we also want to test an air bubble screen, designed to intercept the outflow of plastic from rivers and canals. By the end of 2019 we hope to be able to provide more information about this screen, the Great Bubble Barrier.

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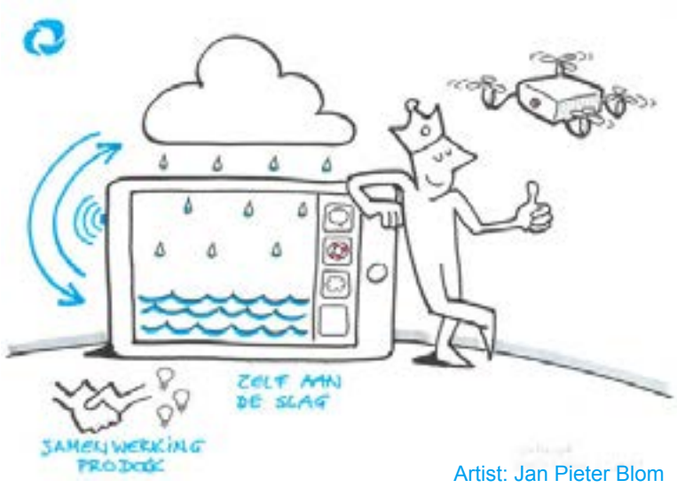
Collaboration with TU Delft



Artist: Jan Pieter Blom

Waternet works together with other partners in research and innovation projects. Waternet, Witteveen+Bos and Delft University of Technology (TU Delft), for example, are investigating whether the removal of micropollutants in wastewater treatment plants can be improved by applying ozonation prior to carbon filtration. After achieving good results in a laboratory study, we now want to conduct a pilot study at a wastewater treatment plant. We also want to explore other techniques to remove micropollutants.

TU Delft, Waternet and the Catholic University of Leuven (KU Leuven) are investigating the possible recovery of ammonium from the sludge fermentation or from the black water fermentation as fuel for a fuel cell, in order to achieve energy-neutral removal of ammonium. Other collaborations concern research into the effects of the extraction of thermal energy from drinking water on its quality and into the effects of using recycled calcite on softening reactors in the preparation of drinking water.

Read more

Collaboration with customers

Waternet wants to involve residents in policymaking and in solving problems. Whereas up to now this has mostly involved separate projects and pilots, set up in response to a need for innovation and experimentation, we now need a substantiation and a structural approach for involving the citizens and residents of Amsterdam in our work.

We are examining the following three social developments:
1) involving residents in Waternet's new and complex tasks
2) the supply of and demand for initiatives with citizen participation within and outside Waternet
3) the emergence of new technologies, data sources and (measurement) methodologies.

Because Waternet wants to increase internal support for these developments, Waag research institute is going to design a custom-made framework for the method and measurement of citizen participation.

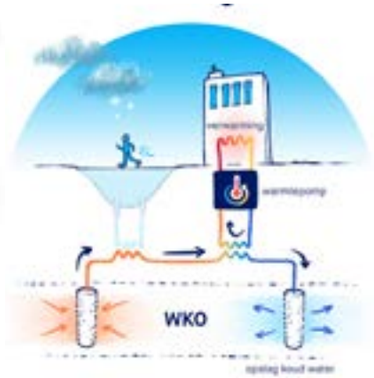
Read more

Sustainable heat supply

Waternet is involved in several projects in the area of aquathermal energy. Amsterdam wants to build 15,000 new homes each year. Some of these new residential areas have already been planned, such as Haven-Stad (the largest new housing development ever) and IJburg 2 (including Strandeiland). The new houses will meet very high sustainability and insulation standards and they will be heated by low-temperature heat. In many cases they will also require cooling. Waternet is contributing ideas about the use of aquathermal energy in these neighbourhoods and about the use of the low-temperature residual heat from data centres.

Extracting heat and cooling a building

Heating a building



For Strandeiland we want to apply new sanitation with an innovative sewerage and purification concept in which different types of waste water are collected separately in order to recover raw materials and energy (biogas and heat) from them. Within an 'innovation partnership', Waternet and Amsterdam will investigate the responsibilities and funding with selected market parties. We are also designing an 'ambient heat map' with several layers that show (among other things) the energy consumption and energy potential of Amsterdam's hydrothermal energy sources.

Read more

Monitoring tree transpiration

Trees play an important role in mitigating extreme temperatures in the city. They evaporate water through the pores in their leaves. This so called transpiration cools the surrounding area. In addition, leaves provide shade. Little is known about the absorption and evaporation of groundwater by trees. Therefore, we have launched a study with experts from Ghent University and tree experts from Amsterdam to investigate the amount of groundwater consumed by trees.

Sensors have been installed on six elms in the Stadionbuurt near the Olympic Stadium. Op 25 July (with a record high temperature of 40.7°C), the largest elm evaporated 170 litres per day. This is more than the drinking water consumption of an average Amsterdam inhabitant (140 litres per day). Amsterdam has about 300,000 trees. The evaporation varies per tree, but together they use a lot of water in the summer. The results of the study will enable us to work purposefully on a more robust design of neighbourhoods such as the Stadionbuurt, so that we can cope with more extreme weather conditions.

Read more

Processing precipitation

The green strip along Zuidelijke Wandelweg

More and more systems are being developed for ways of processing precipitation to prevent flooding and droughts. The drainage system can be modified so that precipitation can be buffered, infiltrated into the soil or used in some other way. Facilities such as bioswales are being designed for this purpose and Rockflow, drainage joints and infiltration crates are used in the public space.

We are testing these systems in practice to find out whether they work properly at the locations concerned, whether they will continue to do so and how they should be maintained. The functioning of the systems can be influenced by the groundwater level or the layout of the public space. We use a variety of test methods, such as long-term monitoring or full-scale infiltration tests. We also verify whether the systems have been installed correctly (i.e. according to the design) as this has proved to be one of the greatest challenges in practice. The results of these studies will enable us to design the public space in a future-proof manner.

Read more

Rainproof polder roofs

Blue-green roofs can absorb a lot of water, increase biodiversity and help cooling the outdoor space. Waternet and the City of Amsterdam have purchased and researched three polder roofs. These roofs can be monitored and controlled via the Internet. It is now known how this system can retain precipitation. The system is now less susceptible to malfunctions and we know which user functions are operated and which sometimes interfere with each other.

The next step is to determine the responsibilities (ownership, management and maintenance) to ensure that the roofs continue to function properly. The RESILIO project, a collaborative partnership between Amsterdam institutions, is addressing this issue. Within this project, Waternet is responsible for the development of a centralised control system using LoRa technology. We are currently working with a student to determine how blue-green roofs can be optimally coordinated at the district level.

Read more

700 m² polder roof on De Boel residential complex at De Boelelaan

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Rainproof polder roofs | The digital Vecht | Sensors in canals | eDNA and 3D-water quality | Measuring salinity with fibre glass | Waternet Datalab | Measuring temperature in ditches | Testing line wastewater treatment plant West | The use of drones | Smart water meters

The digital Vecht


Busy shipping traffic on the Vecht

The pilot project ‘The Digital Vecht’ has been launched in the service area of the regional public water authority Amstel, Gooi en Vecht (AGV). It is the first step towards a traffic model to monitor and control water traffic. For the protection of nature-friendly banks, the speed (wash) and size (draught) of vessels are also monitored. Other priorities are swimmers jumping from bridges and inexperienced skippers. The component sound has less priority.

At the Weesp support point, an all-sense camera must be installed in the 2019/2020 period, which monitors the number of ships and their sailing direction and speed, and also records sound. A digital dashboard is being designed. Digital information signs will be placed along the Vecht. Furthermore, consultations are being held with stakeholders and sector organizations about a pilot for digital vignettes.

Read more

Sensors in canals

We measure the water quality in Amsterdam’s canals with sensors at fixed locations in the city and with sensors on the nautical inspection boat Waterspreeuw. We replaced them in 2019 (after eight years). We have also temporarily installed an LED-IF sensor on the Waterspreeuw for additional water quality measurements.

Various new sensors in the city and the sensor on the Waterspreeuw continuously measure several water quality parameters, such as conductivity, oxygen concentration, temperature and chloride. The sensor on the Waterspreeuw has a large measuring range and can also measure organic matter, such as various algae species and oil residues. If this sensor continues to work properly, we would like to install similar sensors elsewhere in our area. The sensors in the canals and on the boat give us a good impression of the surface water quality in and around Amsterdam. This enables us to further improve our water quality models.

Read more


Sensors under the hatch on the Waterspreeuw

eDNA and 3D-water quality

With eDNA we can detect the presence of muskrats in a certain area through water samples. Next, we need to consider what the best sampling strategy is and how the sampling can best be done. For sampling we work together with the University of Amsterdam (UvA) and with Muskusrattenbeheer West- en Midden-Nederland (MRB-WMNL). The UvA focuses mainly on the collection of samples through existing methods and Waternet focuses mainly on the sampling by means of flying and floating drones. In this research, it is important to prevent cross-contamination between water samples.

The image is a conceptual drawing of the water sampler. This concept serves as the basis for the production of the actual water sampler. The illustration shows the protective exterior on the left and a part of the internal mechanism on the bottom right. Finally, the top view can be seen at the top right (sketch by Tim Hoevenaar).

The Tow-Fish, a measuring instrument with sonar equipment that is towed behind a vessel, can be used to visualise the water quality of a whole body of water in 3D. It contains two sensors for visualisation and one for salinity. We expect to start building the Tow-Fish in mid-2019.

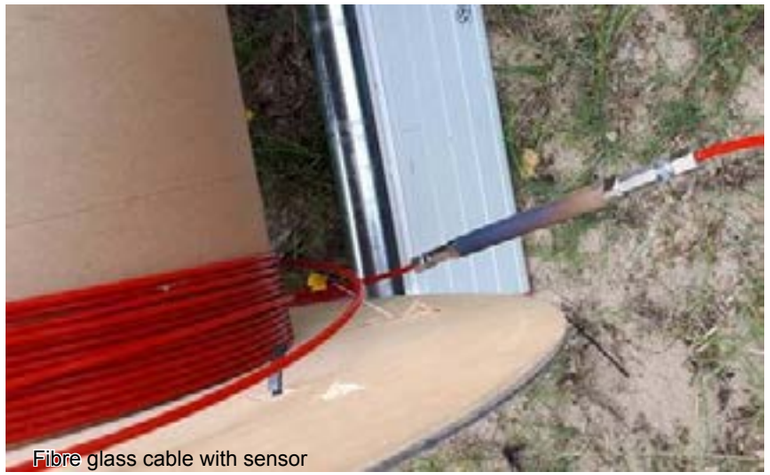
Read more

Measuring salinity with fibre glass

Waternet is testing a new type of fibre glass in collaboration with TNO and Deltares, among others. This continuously measures the salinity of the surrounding groundwater in deep boreholes (80-120 metres). This allows us to determine where the freshwater-saltwater interface lies, so that we have a better view of the supply of fresh groundwater in Amsterdam's water supply dunes.

The fibre glass measurement can perhaps be used as a replacement for the saltwater detection cables, which dune water companies have been using for decades to determine the freshwater-saltwater interface. Using this technique we expect to be able to measure much more frequently and at many more different depths than with the salt detection cables. We are testing the new fibre glass in a leaky monitoring well, which we had not yet closed for testing purposes. As we pump it out, the salinity in the well soon changes, enabling us to test the new measuring technique properly.

Read more



Fibre glass cable with sensor

Waternet Datalab

The Datalab is working on the possible applications of Artificial Intelligence (AI). Using a model, we have analysed negative (anonymous) customer reviews. This provided insight into how we can improve customer contacts. An image recognition model has also been developed so that fallow deer in the dunes can be counted automatically by means of infrared photos.

In 2019, a neural network model was built to estimate the amount of air that is transported to the aeration tanks of the Amsterdam West wastewater treatment plant. This will enable us to further optimise aeration and save energy. Other activities were data validation and the automatic generation of points in cross sections of dykes. The various applications of Artificial Intelligence have provided new insights, enabled optimisation of processes and eliminated the need for repetitive manual work.

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Measuring temperature in ditches

The quality of the surface water in the Bovenkerkerpolder is deteriorating, which is especially evident from the disappearance of the (submerged) water plants. Despite the introduction of manure-free zones, there has been no recovery. Therefore, the supply of nutrient-rich water from urban areas should also be prevented as much as possible, a good light climate should exist, and dredging should be carried out in time to reduce the supply of nutrients from the bottom sediments. If a ditch is well at depth, the temperature fluctuates less and the water does not warm up as much in the summer.

In September 2018, together with farmers and the AGV Water Authority, we hung online temperature gauges in twenty three ditches (fourteen deep ones and nine shallow ones). We also measure soil chemistry at sixteen locations in order to determine the subsequent supply from the bottom of the ditch. We review and discuss the results regularly. Farmers use the 'scan your ditch' (scan uw sloot) application to keep track of vegetation and other field parameters.

Read more

Testing one line of wastewater treatment plant West

The Amsterdam West wastewater treatment plant purifies Amsterdam's wastewater in seven treatment lines, all of which consist of an aeration tank and two post-settling tanks. We are designing one of these lines as a testing line, with extra sensors to monitor the quality of the incoming water, of the water in the aeration tank and of the outgoing water in real time. With the data this yields, we want to improve process control, so that the purification process requires less energy and produces less dinitrogen oxide (N_2O).

Artificial Intelligence (AI) will be used to identify complex patterns and relationships in order to improve control. The first AI model will determine the energy consumption in each aeration tank, and the subsequent AI models will serve to purify the water better and in a more energy-efficient manner. We are working together with KWR Water and a number of European partners in the Fiware4Water project, with a grant from the European Horizon 2020 programme. This open-source IT platform for, among others, the energy sector is now also linked to the water sector.

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The use of drones

We want to work more closely with other parties for the further implementation of drones. We have carried out a test with the City of Amsterdam to livestream drone images to crisis centres in the event of emergencies. We are also involved in Amsterdam's Urban Air Mobility Demonstrator project, a European initiative for the exploration of potential innovations using drone technology in urban areas. Other participants are the Johan Cruijff ArenA, the public transport company GVB, Amsterdam Airport Schiphol, Rabobank and the RAI Amsterdam Convention Centre.

Multispectral sensors collect light reflection data outside the normal (red, green and blue) wavelengths. This is useful for monitoring dykes (cracking, waterlogging, drying out), for detecting floating garbage and seepage, and for ecological projects. We have recently selected the best multispectral sensor. The possibilities for drones flying on hydrogen were also explored. Instead of twenty minutes, they can be kept in the air for up to two hours.

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Smart water meters

We are preparing for a large-scale replacement of water meters in our service area from 2020. We want to replace them with smart water meters, which can be read remotely and, in addition to the volume flow, also perform other measurements to optimise the invoicing and asset process. They can also alert in the event of a leak and indicate incorrect measurements. They use secure Internet of Things (IoT) technology.

Our technical and customer-related departments worked together on a business case using external expertise. We are working with various suppliers to develop the best water meter for Waternet. The communication module sends the available data from the water meter to our IoT Platform. The data are not shared with external parties, but only with the customers. The process takes place in a secure environment that is only accessible to Waternet. As a test we installed a number of smart water meters at colleagues who obtain their drinking water from Waternet.

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Colophon

Front photo:	The team that does research into the transpiration of trees
Photo on page 3:	Researcher Sarian Kosten of Radboud University performing methane measurements in a ditch near Nijmegen
Photo on page 11:	Planting in the bioswale at Harkstraat
Back photo:	Peter Smit, Member of the Board of the regional public water authority Amstel, Gooi en Vecht (AGV), Innovation portfolio manager
Text editing:	Peter Beemsterboer - Waternet
Design and layout:	Marjan Schermerhorn - Waternet
Final editing:	Alice Fermont and Hidde Schijfsma - Waternet

This is a publication of Waternet Research & Innovation