Annual Report 2021
The Meuse

Water quality under pressure due to incidents

RIWA - Vereniging van Rivierwaterbedrijven

Content

“In 2021, the water quality of the Meuse was under pressure due to incidents”

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RIWA
RIWA-Meuse

Introduction

News in this annual report

In mid-May 2022, an unknown substance was encountered in the Meuse. The contaminant could not be identified immediately, and its origin remained unknown for a long time. The incident tracking protocol developed in 2021 was put into action immediately, however drinking water company WML had to nonetheless cease the abstraction of Meuse water to produce drinking water. This happened mainly due to the declining water supply from the Meuse and the rising temperatures. Because the abstraction suspension lasted for longer than usual, on 12 July there was a switch to the backup source: deep ground-water. Situation persisted until mid-August.

Why am I starting this 2021 annual report with a new incident from 2022? Because this event is illustrative for the contents of this annual report, which is about incidents, climate change and border-spanning cooperation to be able to continue to guarantee the quality of the Meuse as a source of drinking water.

From Rain to Meuse

Before I start to consider 2021, I would like to ask for your attention for a special book that proves to be timeless. ‘Van Regen tot Maas’ (From Rain to Meuse, 2008) is about cross-border water management in dry and rainy times. In it, author Marcel de Wit describes two fictional newspaper pieces which at that time took place in the future: 12 December 2020. The author’s intention in this was to allow the reader to identify with different future scenarios for the Meuse.

RIWA-Meuse is an international cooperative association of drinking water companies in Belgium and the Netherlands that use the river Meuse as a source to produce drinking water.

The members of RIWA-Meuse are water-link, WML, Dunea, Evides, Brabant-Water and de Watergroep.

RIWA-Meuse promotes the interests of these companies, so that they can use clean water from the Meuse River to supply drinking water reliably to seven million people.

In one of the newspaper items, the writer imagines a flood, in which a churning Meuse caused widespread damage. In the other imaginary piece, the author describes the consequences of long-term drought, with a looming spectre of a dried-up bed of the river Meuse.

Marcel de Wit then made an appeal to come up with an instrument, a mathematical model, that could provide insight into how interventions in one place in the Meuse River basin would affect conditions elsewhere. Such instruments already existed then within national boundaries, but there was not yet a cross-border instrument for the entire Meuse River basin.

Climate change

What was still fiction in 2008 has become a reality. In 2021, the consequences of climate change manifested themselves as extreme weather events. Three successive years of serious drought in the Meuse River basin (2018, 2019 and 2020), were followed by a flood in the summer of 2021.

RIWA-Meuse has taken the recommendations in Marcel de Wit's book on board, and commissioned Deltares to develop a cross-border mathematical model for the entire Meuse River basin. Together with Rijkswaterstaat, the drinking water companies and Deltares, work was carried out on a water balance model, RIBASIM, which appeared in 2022. In this annual report, we describe the results from this model for a scenario with low water. For this, four locations in France, Wallonia, Germany, and the Netherlands were modelled.

High water in 2021

In practice, in 2021, we were not confronted with long-term drought, but with a flood as a result of extreme high water in the Meuse River basin. The crisis had major consequences for the drinking water companies along the Meuse. In this annual report, we focus on its consequences for the drinking water companies of WML in the Netherlands and water-link in Flanders.

Strategy RIWA-Meuse

Incidents

In 2021, the water quality of the Meuse was under pressure due to incidents, such as a long-term breach of standards for the biocide prosulfocarb from Wallonia. Besides this, water used to extinguish fires was released after incidents at a vehicle scrapping plant in Brabant, which caused problems on several occasions.

The incidents of 2021 motivated the drinking water companies to develop and implement a crisis protocol exercise in 2022. The water managers in the Dutch part of the Meuse River basin also participated. In this annual report, we describe the primary findings from the exercise.

Water quality

The core of our annual report is informed by the results from the data analysis that emerged from the monitoring program in 2021. To monitor the water quality of the Meuse, the drinking water companies work with a list of drinking water-relevant substances. This list was re-evaluated in 2021. The assessment system that forms a basis for this was also further refined. Before we present the results from the data analysis, we describe the system used to identify and develop the list of drinking water-relevant substances in this annual report.

Cooperation in the project De Schone Maaswaterketen (Clean Meuse Water Chain, SMWK)

To be able to do our work properly, we cooperate with other parties, share knowledge and information, provide data management, and coordinate the risk-based monitoring of the water quality of the Meuse.

An important cooperative arrangement within this is the project called 'De Schone Maaswaterketen' (Clean Meuse Water Chain, SMWK). In 2021, it was decided to adopt a program-based approach, so that our cooperation efforts can improve in the future. RIWA-Meuse is taking the role of programme manager for this arrangement.

Stories from practice in this annual report

The information in this annual report came into existence in collaboration with other organisations and stakeholders involved in the use and management of the Meuse River basin: the drinking water companies water-link, WML, Evides, Dunea, and Vivaqua, Rijkswaterstaat and the water boards Aa en Maas and Limburg. In addition, the water laboratories Het Waterlaboratorium and Aqualab Zuid, knowledge institute Deltares, and industries along the Meuse, such as Sitech were also involved in the creation of this annual report.

I am happy to report that several of our collaborative partners were ready to proactively elaborate on our joint efforts in 2021 for this annual report. We intend to use their stories from practice to make the facts and figures in the report more accessible to a wider group of readers.

Call for action

We wish to use the contents of this annual report to improve how social dialogue regarding the current and future quality and availability of the water in the Meuse River basin is managed. This is necessary to allow us all to engage in collaborative action more efficiently. In this context, it is preferably to act today rather than tomorrow, as the situation is urgent due to the changing climate.

Maarten van der Ploeg, Director of RIWA-Meuse

A

The Meuse as a source of drinking water

How did things go in 2021 for the Meuse as a source of drinking water?
What events affected the water quality?

1 High water in 2021

In July 2021, Limburg was afflicted by extreme high water. Heavy rainfall in the river basin caused high water levels in the Meuse as well as its tributaries and the streams in Limburg, resulting in severe flooding. According to the South-Limburg Safety Region, the areas around the Geul and Gulp Rivers in South Limburg were the most affected. The damage to infrastructure was significant. WML, the water supply company in Limburg, also suffered from due to severe weather. Nevertheless, WML succeeded in ensuring that customers could continue to have access to good drinking water. In section A1.1, WML director Joyce Nelissen illustrates how this affected their work.

The heavy rainfall in July 2021 also had major consequences in Belgium. The province of Liège was particularly affected. At that time, there was rising concern about the lock near Liège, where the Meuse and the Albert Canal come together. The drinking water company water-link extracts water from the Albert Canal to produce drinking water. In what way was water-link confronted with the high water of 2021? In section A1.2, Bert Rousseau from water-link provides a detailed account on the impact of such events. The extreme weather events of July 2021 also had major consequences in Germany. For example, 2.5 million m^3 of water ran from the Inde River into a brown coal open-cast mine. This water was pumped out of that location and was later discharged into the river Inde, which is connected to the Meuse via the Rur. The cross-border information exchange between the parties involved proceeded smoothly. More information on this matter in section A1.3.

2 Incidents in 2021

In 2021, drinking water companies along the Meuse were further confronted with high levels of the herbicide prosulfocarb, originating from Wallonia. This was not the first time; there was also an incident with the same substance in 2019. Water managers and drinking water companies acted together to get the situation under control. One of the drinking water companies that was confronted with the illegal discharge of prosulfocarb was WML in Limburg. For the then brand-new WML director Joyce Nelissen, the incident in 2019 was an immediate baptism of fire. In section A2.1, she relates how she experienced the events.

In 2021, the Netherlands also faced incidents in 2021 that caused problems on the Meuse. One specific incident was a fire at a vehicle scrapping plant (AVI) which had a major impact on the drinking water production from the Meuse. Drinking water producer Evides opted for conducting extra monitoring, and later wrote up an evaluation report of the incident. This incident was also covered by the Brabants Dagblad newspaper. André Bannink from RIWA-Meuse elaborates on the event in section A2.2.

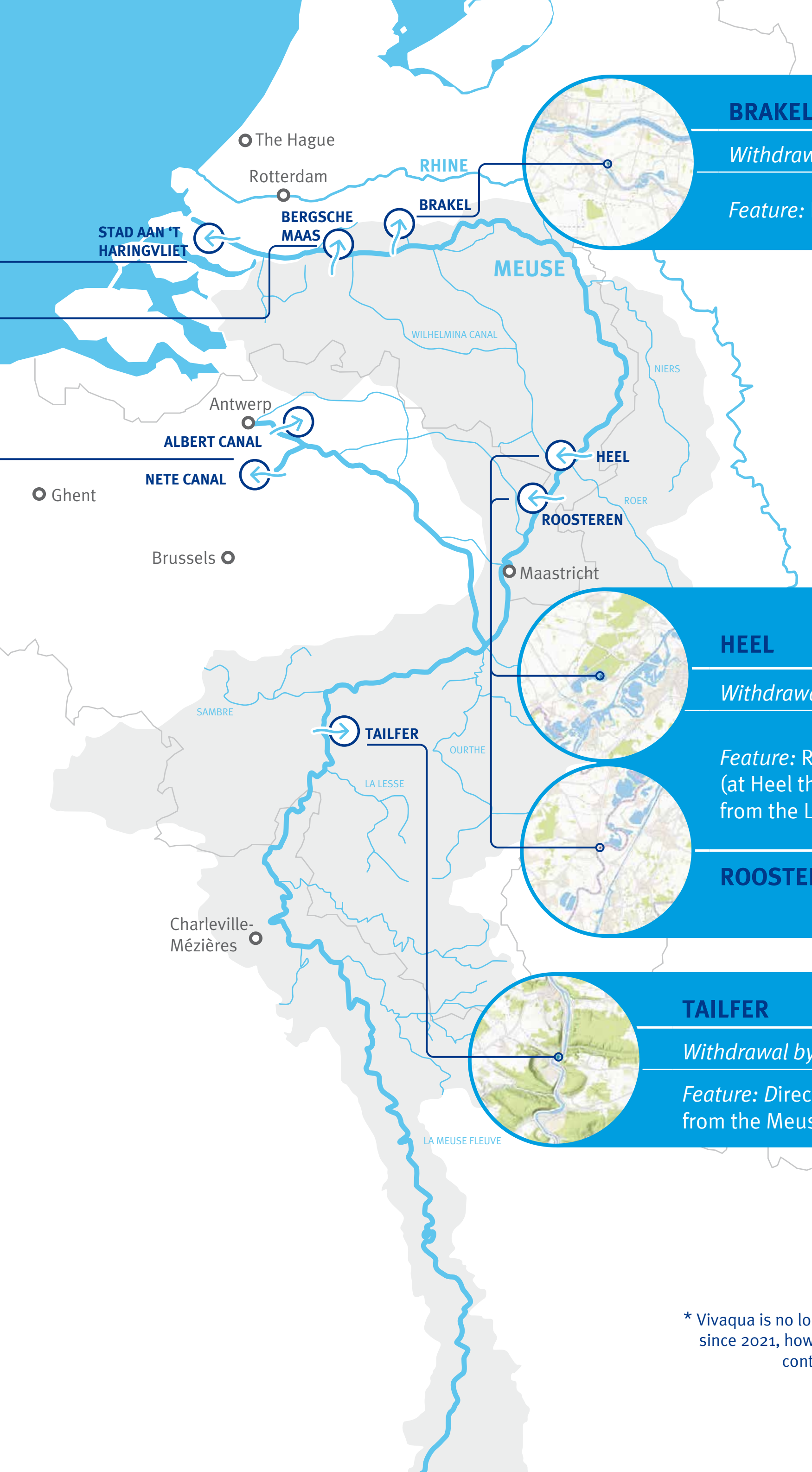
The incidents in 2021 motivated the drinking water companies along the Meuse to organise and conduct a crisis exercise protocol on 10 May 2022. More information may be found in the report on the crisis exercise in Part D (Perspective for Action) in this report.

3 Water quality in 2021

More and more chemical substances are coming on to the market which will sooner or later end up in the environment, and therefore in the Meuse. How do drinking water companies know which of all these chemical substances are problematic, and so which ones they need to keep an eye on? With these questions in mind, a list of drinking water-relevant substances is developed every three years. This list was re-evaluated in 2021. The assessment methodology that forms the basis for this was also further refined. In section A3.1, HWL expert Tineke Slootweg, reports on this collaborative project which resulted in the report: '*Drinking water relevant substances in the Meuse: An update of the lists with substances that are relevant for the production of drinking water from the river Meuse*'.

Last but not least: what surfaced from the monitoring of the Meuse water quality in 2021? The primary findings are listed in section A3.2. More information about the entire monitoring programme may be found in Part B (Monitoring and measurement results).

The Meuse as a source of drinking water



STAD AAN 'T HARINGVLIET

Withdrawal by: Evides

Feature: Dune infiltration

BERGSCHE MAAS

Withdrawal by: Evides/WBB

Feature: Reservoirs in the Biesbosch

ALBERT CANAL

Withdrawal by: water-link

Feature: Supplies 40% of Flander's drinking water as well as other drinking water supply companies (such as Watergroep, Farys and PIDPA)

NETE CANAL

BRAKEL

Withdrawal by: Dunea

Feature: Dune infiltration

HEEL

Withdrawal by: WML

Feature: Riverbank filtration (at Heel through withdrawals from the Lange Vlieter)

ROOSTEREN

TAILFER

Withdrawal by: Vivaqua*

Feature: Direct intake from the Meuse

SURFACE WATER AS DRINKING WATER SOURCE

RIWA-Meuse Member companies	*Surface water intake (%)*	*Surface water intake (10^6 m³/year)*	*Customers supplied with surface water*
Evides (+WBB)	80%	227,5	2,0 million
water-link	100%	158,8	2,5 million
Dunea	100%	74,2	1,5 million
Vivaqua*	30%	34,8	750.000
WML	25%	9,8	280.000
Total		**505,1**	**7,0 million**

* Vivaqua is no longer a member of RIWA since 2021, however water quality data continues to be exchanged.

WML

Joyce Nelissen (WML) about the impact of the high water in 2021

In July 2021, Limburg was afflicted by extreme high waters. Heavy rainfall in the river basin caused water levels to rise significantly in the Meuse, its tributaries, and the streams in Limburg resulting in severe flooding. How did WML ensure that consumers could continue to have good drinking water available during the crisis?

"It was very tense," says WML director Joyce Nelissen. As chair of the drinking water policy team in Limburg, she was the final decision-maker during the flood in 2021. "The high-water levels were very unexpected. We know of course that the climate is changing. But in each of the three years prior to 2021, we were confronted with hot and dry summers. But that it could swing round in one year to extreme rainfall, and in the middle of the summer period at that, was something new. We were indeed prepared for high water, but not in the summer".

The flow rate of the Meuse rose to 3000 m^3 per second. What were the consequences? "Because the high water was so extreme, it wouldn't have taken much more for our head office to end up underwater. The provincial government buildings were flooded. If the water had risen to the car park, this would have happened to us too. It was within three centimetres.

It would have had major consequences for our ICT facilities. Drinking water production is automated after all – ICT is crucial to this. We therefore immediately decided to evacuate and moved all our ICT facilities to a safe place".

Consequences for primary production process

What were the further consequences for WML's primary production process? "We had trouble with the high water at a couple of sites, but the most serious problem was that the production site of Roosteren was flooded.

RIWA
RIWA-Meuse

WML

The consequences were major because our clean water reservoirs were contaminated with water from the Meuse. This was able to happen because our drinking water reservoirs were indeed designed to allow excess produced water to be discharged into the Meuse, but not to keep out Meuse water from outside.

Since Meuse water ran inside, our drinking water stock became unusable due to contamination. We then diverted the supply route via some other sites in the vicinity of Roosteren. This was possible because our network has a cluster structure. We can guarantee the continuity of the water supply thanks to transport pipes between the production sites (within the clusters). I am proud and relieved to be able to say that the supply to our customers fortunately was never in danger".

Difficult decisions

"The fact that our production site was flooded is one thing, but that it happened during the summer holiday did make it extra troublesome. Due to the holiday period, we of course had to cope with lower staffing levels. On top of this, the flood also affected our staff personally, because they live and work in Limburg.

A crisis organisation was again initiated at the WML head office. In the second phase of the high-water crisis, bacterial contamination arose in the pipe network. Normally speaking, we then clean out the pipes by flushing and draining. But the contamination persisted, and on top of this it was summer.

We became concerned in case we were confronted with a high drinking water demand and high temperatures. If it became too hot, we would not be able to keep supplying all our customers. We then had to opt for chlorination in order to make the transport pipework bacteriologically reliable. After this, we could put the pipe back into use.

This was the tensest decision. Chlorination isn't something you do just like that. Our colleagues at Evides were of great help to us at that time. They moved a mobile chlorination plant to Limburg. We were able to sort it all out together, but the Roosteren site was out of operation for no less than 10 weeks".

Future-proofness

The fact that WML could continue to supply drinking water to all its customers under these circumstances is quite an achievement. Can we therefore conclude that WML is ready for the future? "After everything was finished, we had an external evaluation done by the Berenschot bureau, and it concluded that we had indeed done very well. We had only just started with our crisis organisation on 1 July 2021, and the high-water emergency happened as early as 15 July. Big compliments to the organisation; I'm a proud director of WML.

But whether we can now conclude that we're ready for the future? Naturally, we don't know that. We do know in any case that many climate developments are turning out to be more complex than was expected and happening at a faster rate. The extreme high water was a confirmation that we must continue to exercise with situations whose extremity we cannot envisage, but for which we nonetheless must be prepared. We must also consider other themes, such as cybersecurity. We therefore continue to train for all possible crisis incidents. In this way, we manage our primary drinking water process for now and for the future".

water-link

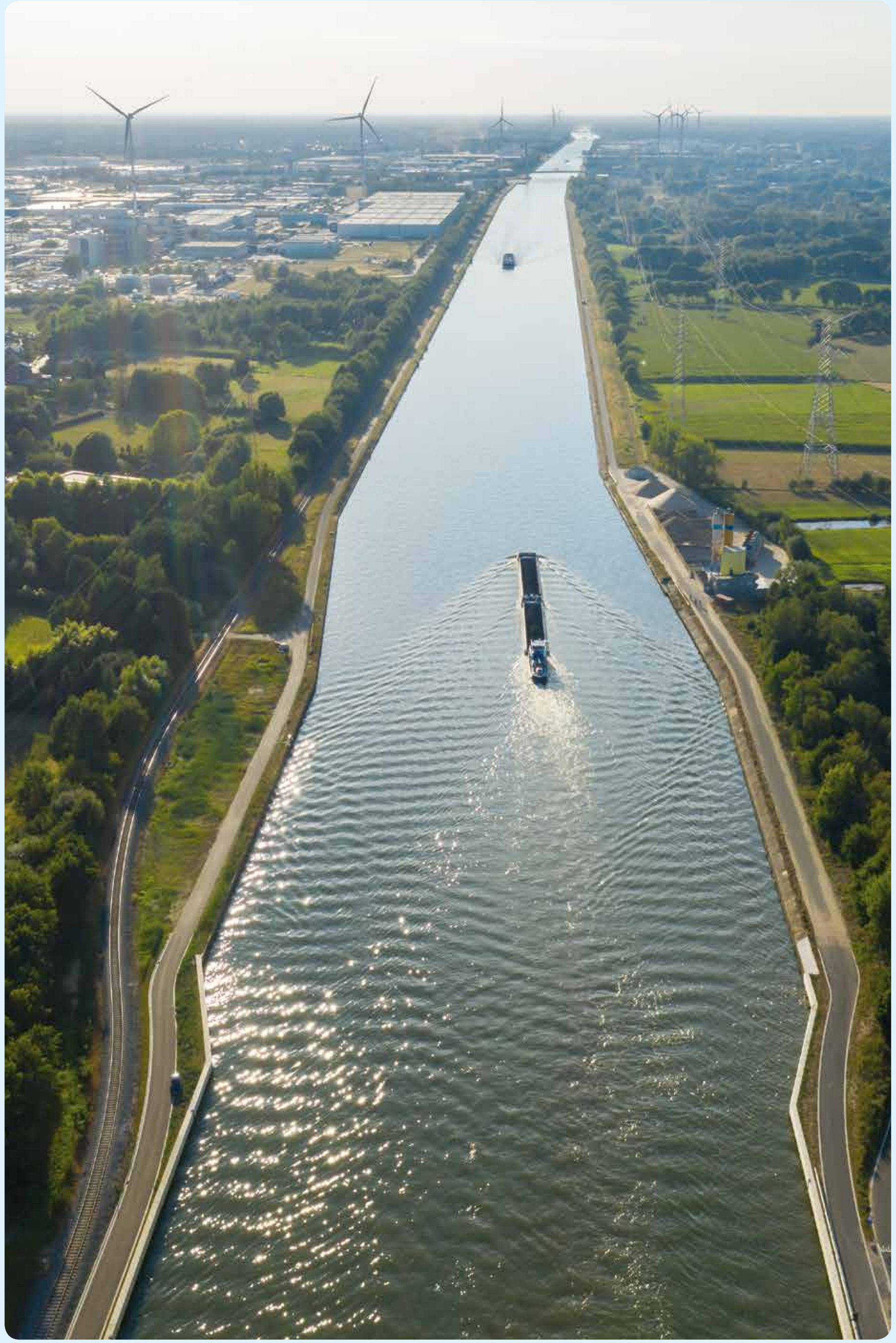
Bert Rousseau concerning the impact of the high-water levels in Belgium

The heavy weather events of July 2021 also had major consequences in Belgium. The province of Liège (Luik) was particularly affected. At that time, there was concern about the lock near Liège, where the Meuse and the Albert Canal come together. The drinking water company water-link extracts water from the Albert Canal to produce drinking water. In what way was water-link confronted with the high-water crisis of 2021?

The Albert Canal provides 40 per cent of the drinking water supply to Flanders. The canal is entirely supplied by the Meuse. This also applies to the Nete (Nèthe) Canal, a side branch of the Albert Canal.

Flanders is highly dependent on the Meuse. Not only for drinking water production, but also for various economic activities, such as businesses and shipping. The Albert Canal is in fact a major industrial axis along which major companies are situated. The water in the Albert Canal runs on into the Port of Antwerp.

In this location, around the port, freshwater mixes with the salt water in the Scheldt. Flanders is confronted with the problem of disturbed silt, particularly during dry periods when there is too little freshwater.



water-link

To keep an eye on matters, drinking water company water-link measures the conductivity. This will be further elaborated in later sections of this report.

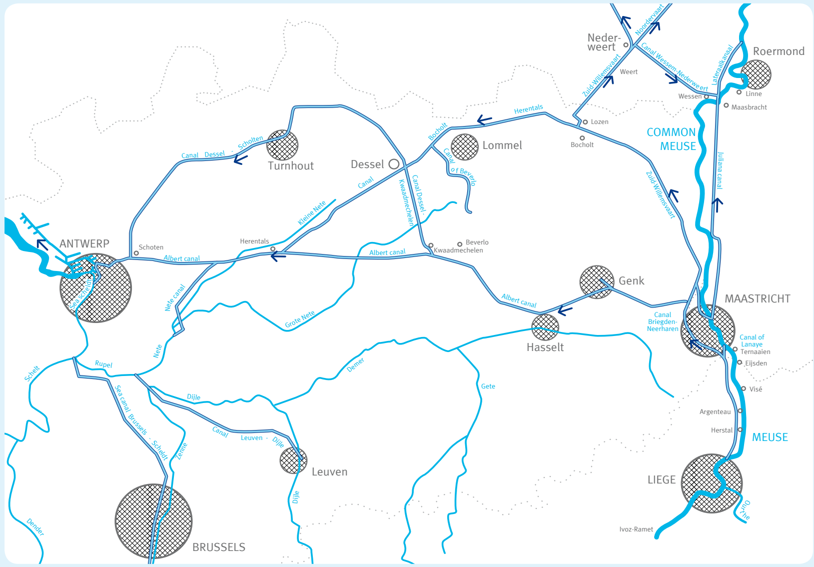


Figure 1: The Kempen canal system.

Source: De Milieuboot vzw; adapted by Studio Ilva

Water from the Albert Canal

Process technologist Bert Rousseau from water-link tells us about the impact of the high water in 2021. Bert is responsible for the monitoring of the raw water source from the Meuse, the Albert Canal, and the Kempen canals.

"We had learned from reports that the Meuse was likely to overflow its banks. We monitored the flow rates of the Meuse and saw that they were rising to previously unrecorded levels. Normally, the average flow of water via the Meuse is 250 cubic metres per second. On 15 and 16 July, the flow rate of the Meuse increased to 3,000 m^3 per second. In the past, we have sometimes measured flows between 1,000 and 2,000 m^3 per second, but never above 3,000 m^3 per second, and certainly never in the summer. It was indeed highly exceptional.

Despite these events, the Albert Canal itself maintained a slowly flowing water course. This is because high flow rates are not permitted – as these would cause the dikes to collapse. At that time, it was feared that the lock at Liège might collapse. It was under high pressure during the flood. Fortunately for the shipping sector, the lock held up".

Canal system

To provide Flanders with water, seven canals were constructed between 1827 and 1947: known as the Kempen Canals. Of all the Belgian canals, the Albert Canal is the most important, because it connects Liège and Antwerp. The canals are artificial watercourses. As Bert further elaborates: "The natural watercourses in which the rainwater ends up are separate from this canal system. The only supply the canal system has, are the locks at Liège – otherwise, very little water comes in. This means that there are never major changes in the flow rate of the Albert Canal, not even during extreme rainfall".

Measurement during the high-water peak

Coincidence or not: the day that the flow rate in the Meuse reached its highest peak was also the day that Bert had planned to do sampling, from both the Albert Canal and the Meuse. "At that time, we took samples from the turbulent

Meuse water that was rushing past. From these samples, besides the suspended matter content, we also determined pesticides and nutrients. In the Meuse, the suspended matter content was very high, because everything was being churned up. As soon as the Meuse water came into the Albert Canal, it calmed down. The flow rate reduced, the water flowed more slowly, and the suspended matter settled. This happened mainly at the start of the Albert Canal.

At our abstraction point a little further along, all the suspended matter had already settled. We continued to monitor to see whether any extra contaminants would appear. After all, we didn't know what the effect of extra water running off the fields and from wastewater treatment plants would be. But after the analyses, it emerged that the dilution effect of the enormous mass of water ensured that we had no problems with contaminants".

Dilution effect

The question that arises is: how extreme was the dilution? "To determine that, we measure the conductivity. In normal periods, the conductivity of the water we abstract from the Albert Canal is between 400 and 500 µS/cm. In 2021, due to the wet summer, the conductivity reached a maximum of 556 µS/cm. The water that we abstracted that originated from the high water measured 339 µS/cm.

As a comparison: in dry periods, the measurement values here can rise to above 800 µS/cm (the maximum value at the end of the drought in 2020 was 838 µS/cm and in 2019 865 µS/cm)".

"Never previously so clean"

What were the consequences of this dilution? "For us, the high flow rate turned out positively. To be honest, the Meuse water has never previously arrived at us so clean. Our experience therefore differs from that of our colleagues in the Netherlands and Brussels, because they abstract directly from the Meuse. Our colleagues had to shut off the water abstraction due to the turbidity of the Meuse. Our situation is different because we use the Meuse water from the Albert Canal".

Climate-proof drinking water

The high water in 2021 is an illustration of extreme weather events that can occur as a result of climate change. In preceding years, water-link was confronted with extreme drought. In 2019 therefore, a plan was initiated to make it possible to cope with the consequences of extreme weather in the future. At that time, different options were put forward to provide for a climate-proof drinking water supply. Some examples: desalination at the Oelegem site; reuse of effluent from the Antwerp sewage treatment plant (STP) as process water for industry; construction of an extra storage basin; and the linking of the water networks of water-link with those of groundwater company Pidpa.

Implementation of master plan

Where are we now with the implementation of these measures? Bert: "With the measures included the plan, we must be better prepared for extremely dry periods. We expect extreme drought to occur more often. At this point, some of the projects mentioned above have already been completed; others are still under way. Current state of affairs?

water-link

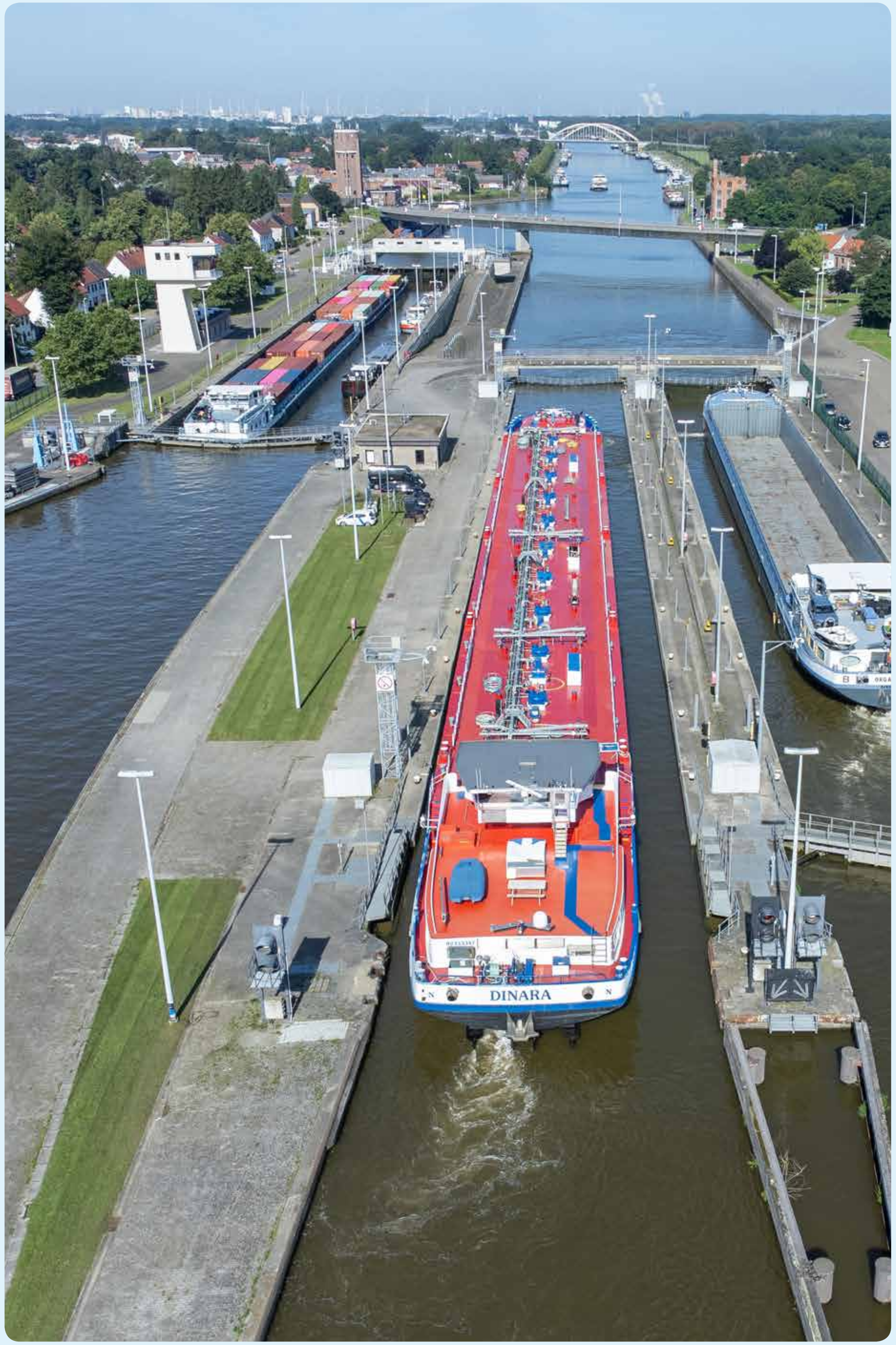
The linking of the water-link and Pidpa water networks is finished, so that we can intervene for each other in emergency; the project for the reuse of the effluent from the Antwerp STP is still underway, but there have already been pilot tests in the port of Antwerp; we've also looked at the use of a desalination plant, but we're currently reserving this option as a backup measure; the project for an extra storage basin in Oelegem, to increase the reserves, is still in full throttle; this is happening in collaboration with the government of Flanders".

Everything is about water availability

"Another example of a climate measure comes from Vlaamse Waterweg (Flemmish Waterway), the operator of the Albert Canal. Pumps are being installed at each lock, so every time the locks operate, the water can be pumped back up. This means the water availability in the canal is more reliable.

Moreover, the government of Flanders has been busy on a reactive consideration framework. Different experts have mapped out the impact of various water-saving measures and have provided the Flemish government with a toolbox based on their findings. This is the 'Reactive Consideration Framework.' When severe drought arises and the Albert Canal comes under significant pressure, the government can impose highly targeted measures, while having insight into the consequences of the measures. It goes without saying that restricting the abstraction for drinking water production will only be done as a last resort, given the major social impact it could carry".

You can read more information about drought in Flanders in the 2020 Annual Report on the Meuse from RIWA-Meuse.



A1.3 High water in Germany

The heavy weather events of July 2021 also had major consequences in Germany. For example, 2.5 million m^3 of water ran from the Inde River into a brown coal open-cast mine. This water was pumped out and was later discharged into the Inde, which is connected to the Meuse via the Rur. The border-spanning information exchange between the parties involved proceeded smoothly.

Flood at Inden brown coal opencast mine

Due to a dam collapse caused by the extreme high water in July 2021, water from the Inde river ran into the Inden brown coal open-cast mine at Lamersdorf (between Düren and Jülich). An estimated total of around 2.5 million m^3 of water ran from the Inde into the mine.

Energy company RWE, which runs the open-cast mine, had to pump it out to allow the extraction of brown coal to be resumed. A notification arrived in August via the Wasserverband Eifel Rur (WVER) that RWE was going to discharge into the Inde river, a tributary of the Rur. The water that would be pumped out of the mine would run via the Inde into the Rur and finally end up in the Meuse.

WVER informed the Dutch representatives of the water boards, Rijkswaterstaat as well as the drinking water sector. The fact that WVER contacted their Dutch neighbours, and the drinking water companies is a good example of international cooperation in the Meuse River basin.

Consequences

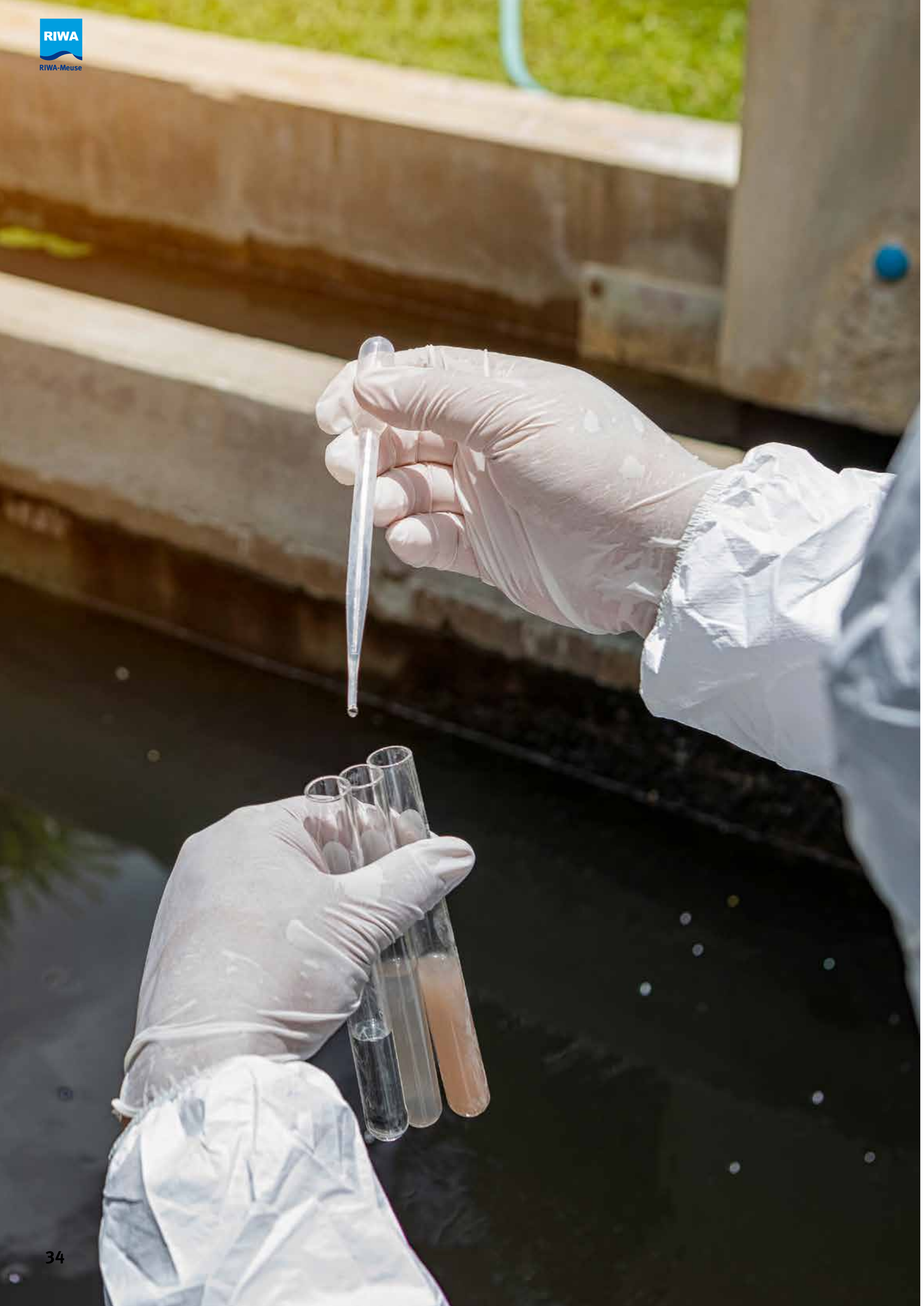
The Inde river was more polluted than usual during the high water (14-15 July 2021). It was estimated that the pumping out of the opencast mine - and therefore the discharge of the pumped out water- would last until the beginning of November 2021.

1 *A video of the flood can be seen in the following link: https://youtu.be/-qkGcW7V7ls*

Photograph 1: Screenshot taken from Marvin Schepp's video on YouTube

However, the discharges began later than planned because the turbidity of the water was too high. In fact, the permit that was granted to RWE by Bezirksregierung Arnsberg imposed limitations on the amount of suspended matter that may be discharged. This suspended matter consisted mainly of humus particles, which were not removed by the purification system in use.

Water managers in the Netherlands were concerned about the possible increase in the levels of heavy metals in the Rur, particularly the concentrations of cobalt and zinc. Dutch drinking water companies requested additional monitoring. Extra samples were taken, from which it became clear that this discharge had not led to noticeable concentrations of drinking water relevant substances or heavy metals.



A2 Incidents in 2021

Besides extreme water discharge, there were incidents that affected the quality of the Meuse water.

In 2021, drinking water companies were confronted with an incident that could be traced successfully, thanks to good cooperation across the border. Also in 2021, they had to deal with incidents in the category 'lingering burden.' This section provides a description of both types of events.

The incidents motivated the organisation of a joint crisis exercise protocol in 2022, in which the drinking water companies, Rijkswaterstaat and the water boards together tested the tracking protocol within the Netherlands part of the river basin. Part D offers a more elaborate description on these processes (Perspective for Action, section D2).

Furthermore, drinking water companies are pleased with the fact that incidents are being prevented due to efficient discharge control and monitoring embedded in updated permits. This means that unwanted discharges - which can lead to incidents - and their impacts are minimized. An example of this is the working methodology of Sitech company, which is described as an example of 'good practice' in Part D (Perspective for Action, section D3.2).

A2.1. Example of a successfully detected incident

At the end of October 2019, Dutch drinking water companies had to deal with the discharge of prosulfocarb into the Meuse, upstream of the Dutch border at Eijsden. All companies had to suspend the abstraction of water from the Meuse for a longer period as a result of this contamination (see 2019 Annual Report on the Meuse). The exact location of the origin of this contamination had not been found at that time, though it could be roughly pinpointed to a specific part of the river in Wallonia.

On 28 August and 9, 17 and 30 September 2021, prosulfocarb peaks were again observed in samples taken at the Eijsden border monitoring station. Rijkswaterstaat made fellow water administrator Service Public de Wallonie (SPW) aware of this. By conducting extra sampling in the previously identified part of the Meuse, it could be jointly established that the source should be looked for in a discharge point close to the port of Wandre. Besides prosulfocarb, propamocarb was also detected during this time using additional analysis techniques.

The source of the contamination was finally determined: Solirem, a company in Wandre that cleans and reconditions containers and drums. The company proved also to have cleaned drums with residues of plant protection products, while they had no permit for this. SPW initiated legal action against the company. Since then, prosulfocarb has not been detected again in the Meuse.

Motivated by the incident with prosulfocarb in 2019, RIWA-Meuse drafted a protocol to allow such discharges to be traced quickly in the future. Together with Rijkswaterstaat Water, Transport and Environment, Rijkswaterstaat Southern Netherlands, water laboratories and the drinking water companies, in 2020, a network of 120 measurement points were set up along the Meuse, from the French border as far as Haringvliet. The protocol has the objective to rapidly identify who is responsible for a detected contamination discharge.

(Largely based on an announcement from Rijkswaterstaat Zuid Nederland).

Postscript

André Bannink from RIWA-Meuse was closely involved in both incidents. He concludes the above message from Rijkswaterstaat with a remark. “Although it can’t be established with certainty, discharges originating from this waste-processing company might also have been responsible for the still unexplained peaks of glyphosate in the fourth quarter of 2020 (see 2020 Annual Report on the Meuse). At that time, an estimate of more than 700 kg of active substance, equivalent to almost 1,500 L of plant protection product, ended up in the Meuse.

That the autumn peaks of the herbicides prosulfocarb (2019) and glyphosate (2020) probably had nothing to do with normal agricultural use had already been noted. After all, we’re talking about large quantities of these harmful substances being detected suddenly in the Meuse, outside the usual usage seasons. This is why it’s good that we now possess a joint tracking protocol, so we can go into action more quickly from now on”.

WML

Joyce Nelissen on the prosulfocarb incident

What did the prosulfocarb incident mean for drinking water company WML? WML director Joyce Nelissen: “First, it’s important to state that if we’re talking about water quality, we see an increase of all sorts of new substances in the Meuse. This demands not only increasing alertness, but also cross-border cooperation. After all, the Meuse starts in France.

This means coordination with all our partners along the Meuse to ensure that we try to manage the quality of the Meuse as well as possible. This is problematic due to the differing interests that multiple stakeholders have and the ways in which they think they ought to use the Meuse. Prosulfocarb is an example of this. It’s a substance that you absolutely do not want to come across in your water”.

Managerial impression

In 2019, the incident with this herbicide led to major abstraction interruptions. “We had to suspend the abstraction of Meuse water for so long that we almost switched over to the abstraction of groundwater. This is a drastic measure that was avoided just in time.

If we must stop the abstraction of Meuse water, we first use water from our stock basin. Depending on the weather, we can maintain production

WML

in the summer for 1½ months and in the winter for 2½ months. But then of course the basin needs to be refilled from the Meuse.

I still remember that just a couple of days before we definitely had to switch to our groundwater wells, we heard what the issue was. There was an untraced discharge of prosulfocarb, somewhere in Wallonia. Only when it became clear where the polluter was situated, we could call a halt to it.

To this end, we contacted the Network Development Director of Rijkswaterstaat Zuid-Nederland, Karin Weustink. Because Rijkswaterstaat, the water manager of the Meuse, was facing the same problem".

Round the table with SWP

"We then went together to the offices of the Service Public de Wallonie (SPW) to raise the problem there. We sat at the table with the management team to discuss the seriousness of this case. We also expressed our desire and expectation of SPW would go into action.

To be honest, the reaction to this was disappointing. From SPW's perspective there wasn't a problem because they apply different standards from ours. In other words: the polluter was still meeting the standard there. It was also strange to consider that WML and SPW are only a few kilometres apart geographically, but nonetheless work with completely different standards and legislation. Our Walloon colleagues therefore enforce different standards from ours.

We then steered the discussion about the different standards towards making practical working agreements, and we emphasised the importance of cross-border cooperation for the future. Our response to SPW was clear: if there's no problem in Wallonia, but there is downstream, then we need to solve it together.

This was the starting point for the development of an international protocol with which cross-border incidents on the Meuse can be tracked down quicker in the future. RIWA-Meuse drafted this".

Tracking protocol proves successful

"When high concentrations of prosulfocarb were found again in the Meuse in 2021, there was no more discussion about standardisation. Thanks to the protocol and the cooperation we had built up between 2019 and 2021, we were able to track the culprit quicker. In 2021, the discharge proved to originate from a waste-processing company that processes drums with plant protection products. SPW then initiated an enforcement procedure against the company. I'm happy that we see the fruits of our cooperation in this tracking protocol".

Example of an incident in the category 'lingering burden'

Auto Verschrotings Industrie (vehicle scrapping plant, AVI) in Den Bosch
In the Netherlands there were also incidents that caused problems in 2021, particularly in Brabant. André Bannink from RIWA-Meuse witnessed this personally: "I was in a shopping centre when I got an alarm message on my phone. It was a GRIP1 notification, originating from a vehicle scrapping plant. GRIP is the Dutch acronym for Coordinated Regional Incident Control Procedure, for which coordination between different sectors is needed in phase 1. "I looked up from my phone and saw a thick black plume of smoke. It proved to be the thirteenth incident at that company in only two years".

André compares the handling of the incident with the approach to the illegal discharge of prosulfocarb in Wallonia, also in 2021. "In Wallonia, once the source of the incident had been identified, the Walloon water administrator actually wanted to shut-down the business responsible for the incident. Finally, the mayor didn't do that. So, in the Netherlands, there were thirteen incidents in a row, and enforcement took place much too late or not at all. I think this is illustrative of our administrative culture".

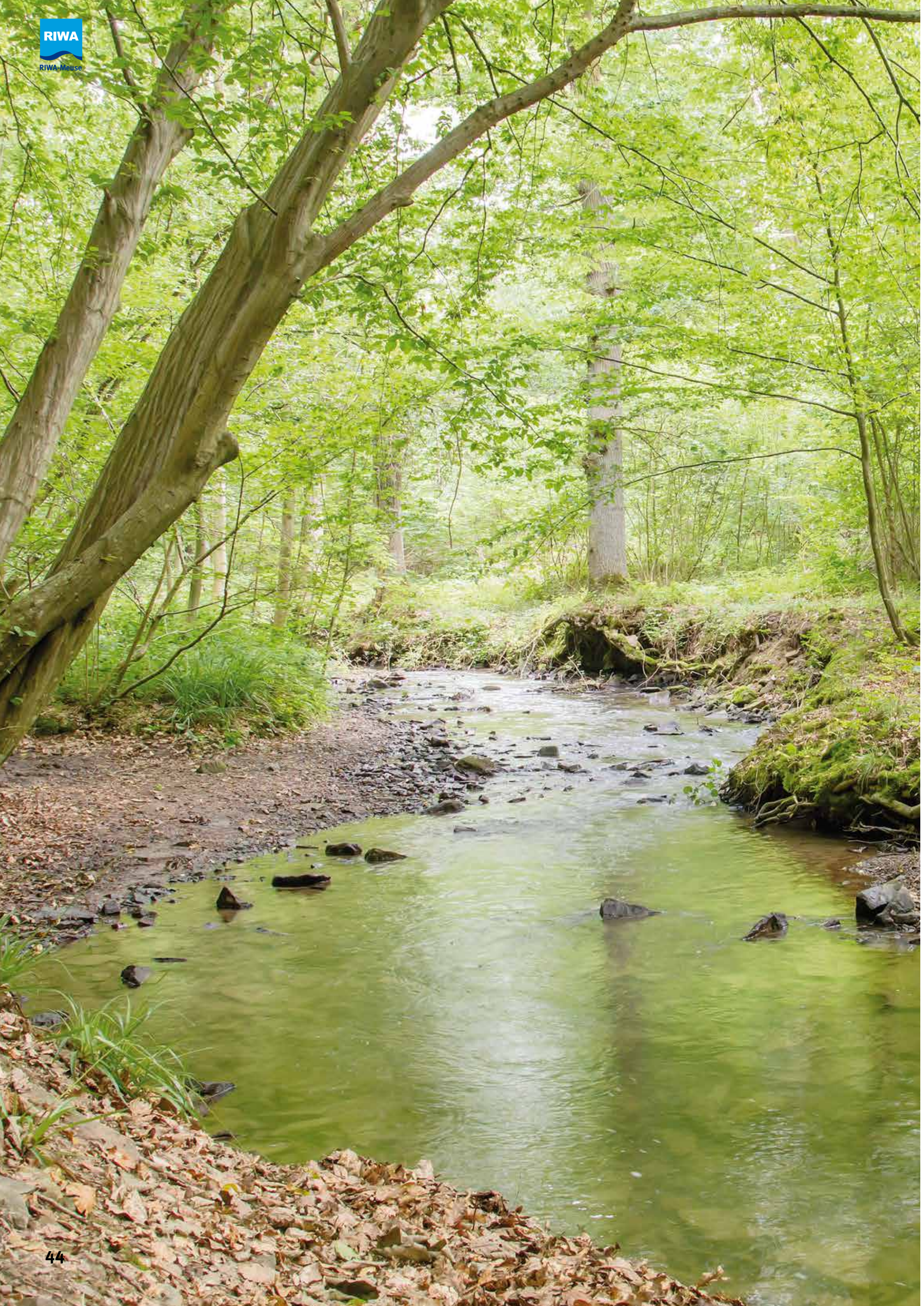
The fire at the vehicle scrapping plant had a major impact on the drinking water production from the Meuse. Drinking water producer Evides opted for extra monitoring, and later wrote up an evaluation of the incident. The Brabants Dagblad newspaper also wrote an article on the matter. The following story summarizes the incident:

'*On 9 March and 14 October, major fires took place at the AVI vehicle scrapping plant at the De Rietvelden industrial estate in Den Bosch. The most likely cause of the fire in March were lithium batteries, presumably originating from what we might call prosperity scrap (household appliances, bikes and the like). In October, a scrap car went on fire, for still unknown reasons. This was the thirteenth time in over two years that a fire broke out at AVI.*

The business is situated on the bank of the Dieze river, so that during the fires, some of the firefighting residue water ran straight into the Dieze. Part of this water also ended up in the Dieze indirectly via the Den Bosch wastewater processing plant. The competent authority, the Aa and Meuse Water Board, took various measures both times to prevent the spread of contaminants as far as possible. The Evides water company was always informed on time by Rijkswaterstaat, so that the abstraction of water from the Bergsche Meuse could be stopped, and the quality of the water in the river could be monitored more intensively.

The screening techniques for unknown components by Aqualab Zuid proved particularly relevant to distinguish the peaks after the fires from the normal situation. Further, it is striking that elevated concentrations of PFAS compounds were observed in the water that was sampled after the fires. Whether these PFAS compounds came from the extinguishing foam or from the lithium batteries (in which PFAS-containing electrolytes are sometimes used) present on the site is unclear.

Noord-Brabant Province put AVI under enhanced supervision after the major fire of 9 March. In the meantime, extra measures have been imposed that ought to prevent new fires on the site. Likewise, severe fines lurk if the company stores too much scrap. After the fire in March, the province imposed a fine of € 150,000, which is still being contested by AVI. Due to the fire in October, the province warns with new fines, which could total over € 1 million. The Brabant-Noord Environmental Agency is now checking AVI every week.'
[end of release]



A3 Water quality in 2021

High water and incidents both affected the Meuse water quality. But what was the impact exactly?

RIWA-Meuse pleads for Meuse water to be as clean as possible, so that drinking water can be made from it in a sustainable way and using natural purification techniques. This objective is also legally anchored in the Water Framework Directive. But the legal formulation is vague, and not yet specific enough to work with.

To provide more focus on this formulation, RIWA-Meuse has been working since 2007 on a priority system. This is intended to allow substances to be monitored in a more targeted way. HWL (the Water Laboratory) has been involved right from the start. The assessment system was evaluated in 2021. In the following section, Tineke Slootweg of HWL explains the way in which drinking water companies determine which substances are relevant and need to be measured in 2021.

Following this, the primary findings from the 2021 monitoring efforts are summarised. In Part B, a comprehensive description of the analysis results follows.

Het Waterlaboratorium

Tineke Slootweg concerning ‘Evaluation of drinking water-relevant substances’

Tineke Slootweg is a chemical advisor water quality at Het Waterlaboratorium. “Recently, it’s all been about the assessment of new substances that are emerging. With questions such as: what new unknown substances are we finding in the sources of drinking water; are these substances removed during purification; what is the risk of the substances to the drinking water companies for example?”

New substances, new lists

Tineke herself has been involved with this topic since 2011 and drafted an evaluation for the first time in 2015. “In the meantime, I almost know the list by heart.” In 2021, the list of drinking water-relevant substances was re-evaluated. “That was a lot of work. Particularly due to the trend of the new substances turning up. We’ve made a wide collaborative project out of it, together with Aqualab Zuid, the Belgian drinking water company water-link and RIWA-Meuse”.

Assessment system

The question is: how do you arrive at a common list of substances that the drinking water companies will monitor? According to Tineke, there is a whole system behind this, which has been gradually further refined in the course of time. She describes how it works. “We first check whether the substance arises at multiple places in the Meuse, and whether it also appears regularly. Then we check whether the substance exceeds specific target values, and whether it has already been detected recently”.

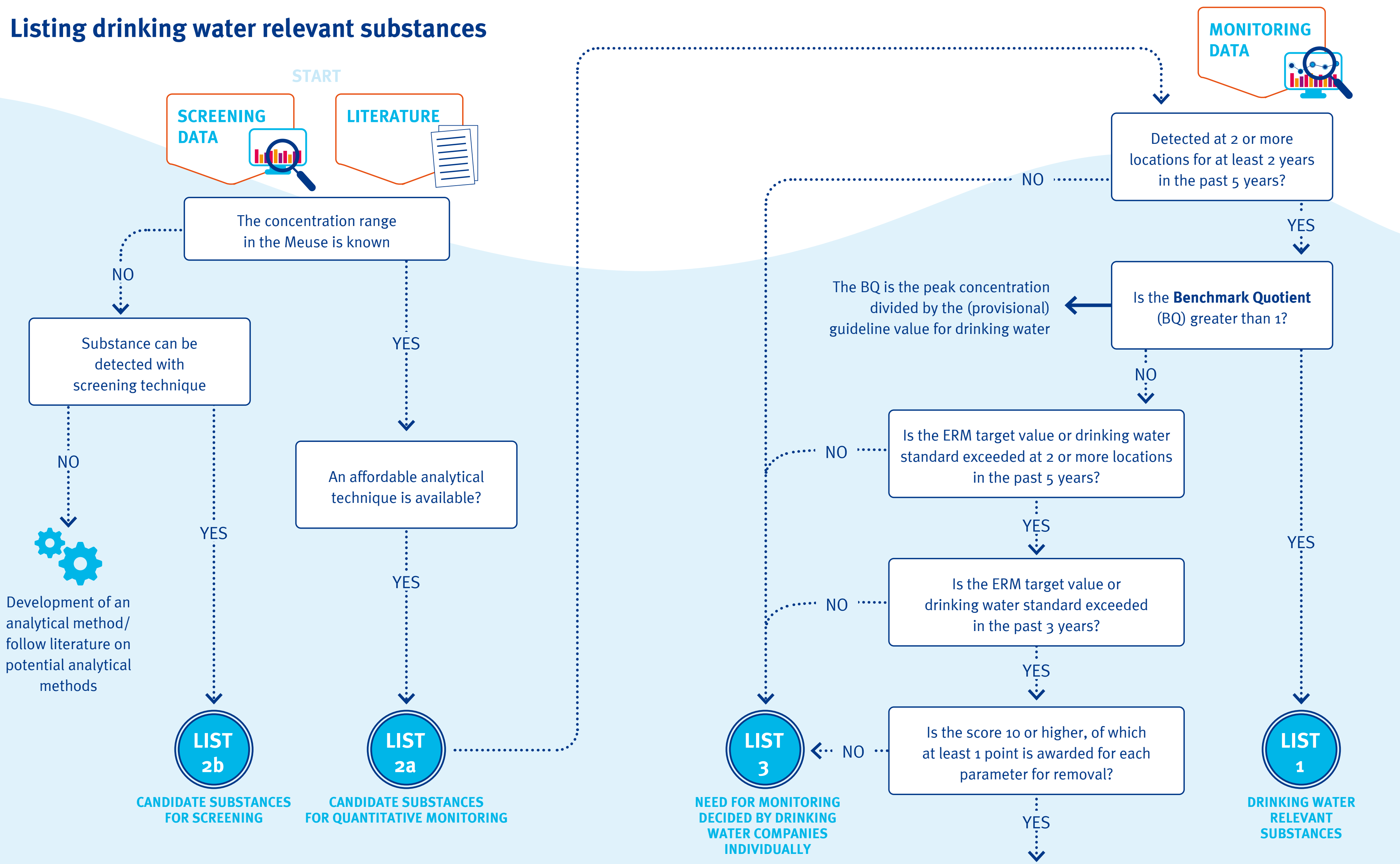
However, this is by no means the end of it. “We also define a number of properties of the substance that give an indication of whether it is possibly relevant: for example, how well it dissolves in water, and how easily it binds to active carbon. Based on this, you can make a good estimate of how a substance will behave in a drinking water purification plant. We use this to estimate how well the substance will be removed during natural purification”.

List 1

All this yields a score that determines whether the substance appears on List 1 or not. “Once they appear on List 1, the substances are monitored by all the drinking water companies along the Meuse using target analyses. This means that the concentrations are measured, and that it becomes possible to determine the risks. There are also substances that are disregarded from List 1 with the passage of time. This applies for example to prohibited pesticides that are no longer detected. For example, as pyrazole, with which the industrial sector has done a great deal to reduce its emissions. As a result, this substance has ended up below the relevant concentration. However, new substances end up on List 1 as well”.

The primary criterion for being added to List 1 is whether the substance poses risks to human health. “To this end, we look at the concentration at which we

Listing drinking water relevant substances



A schematic overview of the ranking scheme used to establish the list of drinking water relevant substances.

RIWA
RIWA-Meuse

expect no effect at all. RIVM (the Dutch National Institute for Public Health and the Environment) does this as well. For substances that are detected in the Meuse at high concentrations, we ask RIVM for advice about their risks. They then use the available data to calculate a safe concentration or standard".

Information sources

The next question that arises is: how difficult is it in fact to assess a substance? "That all depends. For biocides, it's easy to derive the risks, because legislation has been created for this that stipulates that the assessment must already have been done before the product comes on to the market. So, before these substances are even allowed to be produced, a calculation has already been done of the concentrations safe to humans. We only need to consult the dossier. We also use information from studies by the RIVM or the US EPA. For substances present in consumer products, such as in shampoo or foodstuffs, it's also easy to obtain information.

The assessment becomes harder when we're looking at industrial substances used as intermediate products or by-products, because there's often no information about them. In this case we assume a maximum permitted concentration of 0.1 micrograms per litre. This is a generally accepted toxicological threshold value: hardly a single substance still has an effect on humans below this threshold. Therefore, this also becomes the target value for surface water".

Screening and drinking water-relevant substances

In a nutshell: the assessment system works as a kind of flowchart or decision tree. Important factors are checked step by step: for example, whether a substance goes straight through the water purification plant, or whether a substance has an effect on humans at low concentrations, and naturally whether the substance is actually detected in the water.

New in this system of drinking water-relevant substances is the extra focus on the use of screening techniques. Thanks to this, many new substances can be identified quickly. How does it work? Tineke: "The starting point is a list of 2,000 known substances; the substances library. Next, water samples are analysed using liquid chromatography, in combination with high-resolution mass spectrometry.

This yields a pattern of peaks that can be compared to the peaks of the known substances in the library. This gives us an indication of the substances present without us knowing their concentrations. Using this screening method, we can look for more substances simultaneously than with target analyses".

Tineke predicts that the arrival of this screening technique will mean a lot for the monitoring of new drinking water-relevant substances. "By using screening, we can in fact also look for substances that are suspected to be relevant to the drinking water sector, but about which we still know too little, because they're not yet monitored. We add such substances to the library, and then include them in the screening.

Drinking water relevant substances

200.482 measurements

screening

1.356 substances

literature review

evaluation
+
recommendations

30 substances

selection based on

- Concentration
- Frequency of Detection
- Toxicity
- Purification Requirement
- Expert judgement

LIST 1 DRINKING WATER RELEVANT SUBSTANCES

Industrial compounds and consumer products

1,4-Dioxane
Melamine
Cyanuric acid
Diethylenetriaminepentaacetic acid (DTPA)
Ethylenediaminetetraacetic acid (EDTA)
Nitriloacetic acid (NTA)
Benzothiazole
Bromate
Di-N-butyltin
Aminomethylphosphonic acid (AMPA)
Diisopropyl ether (DIPE)
Trifluoroacetic acid
Sulfamic acid
Fluoride
PFAS*

Pharmaceuticals and endocrine disrupting chemicals (EDC's)

Valsartan
Valsartanic acid
Metformin
Guanylurea
Lamotrigine
Hydrochlorothiazide
Tramadol
N-Formyl-4-aminoantipyrine
Ketoprofen
Naproxen

Pesticides, biocides and their metabolites

Dibromoacetic acid
Metolachlor
Terbuthylazine
Monobromoacetic acid
Prosulfocarb
Glyphosate
Aminomethylphosphonic acid (AMPA)
Chloridazone-desphenyl

* PFAS is a group of substances

For the lists the following monitoring frequencies are maintained:

LIST 1 — 13x a year for 5 years

LIST 2a — 13x a year for 1 year

LIST 2b — 13x a year via targeted screening

LIST 3 — need for monitoring decided by drinking water companies individually

+

evaluated every 3 years

LIST 2a — CANDIDATE SUBSTANCES FOR QUANTITATIVE MONITORING

Industrial compounds and consumer products

- Dichloromethane sulfonic acid
- 1,2,4-Triazole
- 4-Aminophenol
- 4-Mesyl-2-nitrotoluene
- Bisphenol-F
- Methylglycindi acedic acid (α-ADA, MGDA)
- 1,3-Di-o-tolylguanidine

Pharmaceuticals and endocrine disrupting chemicals (EDC's)

- Ritalinic acid
- Candesartan
- Fluconazole
- Oxipurinol
- Fexofenadine
- N-acetyl-4-aminoantipyrine

Biocide

- Chlorate

LIST 2b — CANDIDATE SUBSTANCES FOR SCREENING

Industrial compounds and consumer products

- Cyanopropanal
- 4-Amino-3-hydroxybenzoic acid
- Ethyldimethylcarbamate
- Toluenesulfonamide (ortho)
- Kojic acid
- Adamantan-1-amine
- Toluenesulfonamide (para)
- Cyanoguanidine
- P-toluenesulfonic acid

Pharmaceuticals and endocrine disrupting chemicals (EDC's)

- Levothyroxine
- 10-Hydroxy-amitriptyline
- β-asarone
- Adamantan-1-amine
- Gliclazide

Pesticides

- Gamma-cyhalothrin
- Benzovindiflupyr
- Isofetamid
- Mefentrifluconazole
- Oxathiapiprolin
- Pyriofenone

LIST 3 — NEED FOR MONITORING DECIDED BY DRINKING WATER COMPANIES INDIVIDUALLY

Industrial compounds and consumer products

- 1,2-Benzisothiazol-3(2H)-one
- 1,3-Diphenylguanidine
- 1H-Benzotriazole
- 2,2,6,6-Tetramethyl-4-oxopiperidinonoxy
- 2,3,3,3-Tetrafluoro-2-(heptafluorpropoxy) propanoate (GenX substance)
- 2'-Aminoacetophenone
- 3,5,6-Trichloro-2-pyridinol (TCP)
- 4-Methylbenzotriazole
- 4-n-Nonyl phenol
- Acesulfame-K
- Acetone
- AHTN (6-acetyl-1,1,2,4,4,7-hexamethyltetraline)
- Benzo(a)pyrene
- Bis(2-chloroisopropyl) ether
- BPS (4,4'-sulfonyldiphenol)
- Caffeine
- Diglyme (bis(2-methoxyethyl)ether)
- Dimethyldisulfide
- ETBE (ethyl-tertiairy-butyl-ether)
- Ethyl sulphate
- Galaxolide (HHCB)
- Hexa(methoxymethyl)melamine
- Methenamine/urotropine/hexamine
- Methoxymethyltriphenylphosphonium
- MTBE (methyl-tert-butylether)
- Musk (ketone)
- Musk (xylene)
- NDMA (nitrosodimethylamine)
- O-desmethylvenlafaxine
- Phenanthrene
- Pyrazole
- Sucralose
- Surfynol 104
- TBP (tributylphosphate)
- TCEP (tris(2-chloroethyl) phosphate)
- TCPP (tri-(2-chloroisopropyl) phosphate)
- Tetrachloroethene
- Tetrahydrofuran
- Tolyltriazole
- Tribromomethane
- Trichloroacetic acid (TCA)
- Trichloroethene
- Trichloromethane
- Trifluoromethanesulfonic acid (F3-MSA)
- Triisobutyl phosphate
- Triphenylphosphine oxide (TPPO)
- Vinylchloride

Pharmaceuticals and endocrine disrupting chemicals (EDC's)

- 1,3-Diethyldiphenylurea
- 10,11-Dihydro-10,11-dihydroxycarbamazepine
- Acetaminophen (paracetamol)
- Amidotrizoic acid
- Amoxicillin
- Anti-androgenic activity (expressed in flutamide-equivalents)
- Aspirin (acetylsalicylic acid)
- Azelaic acid
- Barbital
- BBP (butylbenzylphthalate)
- Bisphenol A
- Carbamazepine
- Cetirizine
- Ciprofloxacin
- Citalopram
- Clarithromycin
- Clindamycin
- DBP (dibutyl phthalate)
- DEP (diethyl phthalate)
- DIBP (di-(2-methyl-propyl)phthalate)
- Diclofenac
- Erythromycin
- Estrogenic activity (expressed in 17β-estradiolequivalents)
- Estrone
- Gabapentin
- Glucocorticoid activity (expressed in dexamethasone-equivalents)
- Ibuprofen
- Iohexol
- Iomeprol
- Iopamidol
- Iopromide
- Ioxaglic acid
- Ioxitalamic acid
- Irbesartan
- Lincomycin
- N-butylbenzenesulphonamide
- Pentobarbital
- Phenazone
- Phenobarbital
- Salicylic Acid
- Sotalol
- Sulfamethoxazole
- Telmisartan
- Triamcinolonehexacetonide
- Venlafaxine
- Vigabatrin

Pesticides, biocides and their metabolites

- 2-(Methylthio)benzothiazole
- 2,4-D (2,4-dichlorophenoxyacetic Acid)
- BAM (2,6-dichlorobenzamide)
- Carbendazim
- Chloridazon
- Chlorotoluron
- Dimethenamid
- Diuron (DMCU)
- DMSA (N,Ndimethylaminosulfanilide)
- Isoproturon
- MCPA (4-chloro-2-methylphenoxyacetic acid)
- Mecoprop (MCPP)
- Metazachlor
- Metazachlor-ethane sulfonic acid
- Metazachlor-oxanilic acid
- Methyl-desfenylchloridazon
- Metolachlor-ethane sulfonic acid
- N,N-dimethylsulfamid (DMS)
- Nicosulfuron
- Oxadiazon
- Sebuthylazine
- Thiabendazole
- Triflusulfuron-methyl

Het Waterlaboratorium

This yields a general picture of where such substances arise, and how often. We call these substances 'candidate drinking water-relevant substances.' They end up on List 2B".

Candidate 2A status

"If we actually find the substances on List 2B in all the sources (at waterlink, WML, Evides and Dunea), the substance is shifted to List 2A in the next evaluation round. This means that we will develop a target method for it, so that we can also determine its concentrations and health risks in the future.

List 2A therefore includes substances that have emerged from the screening and are seen as important. Substances that we not only measure at many places in the Meuse, but that we also sometimes detect in the drinking water.

Moreover, List 2A also includes substances that have come up as relevant in specific monitoring programmes. For example, the KWR water research institute has recently created a method for very polar substances. If these are actually seen in the Meuse at concentrations above the 0.1 micrograms per litre, then the drinking water company also has to start to monitor it".

Monitoring

Now that the idea behind the three lists is clear, the question arises of what happens after going through the step-by-step plan? "The drinking water sector itself determines which 2A substances will be monitored using target analyses. After all, it means an expansion of the measurement package. This expansion is phased, so that the extra monitoring efforts are spread out.

In the first year for example, we're focusing on 10 new substances. We follow these for a year. The year after that, we select another 10. It's not realistic to suddenly start monitoring 40 extra substances in one year, on top of the existing monitoring programme".

Importance of the list

It is clear from Tineke's account that there is much knowledge and expertise behind the system. Why is the list so important?

"The strong point of the list of drinking water-relevant substances is that it forms a common monitoring list for all the drinking water companies. We therefore have a specific list of substances that we can use jointly, and with which RIWA-Meuse can really get started with addressing emissions. The list of drinking water-relevant substances has for example already been shared with Rijkswaterstaat, along with the request to start monitoring these substances in the Meuse. This is so that targeted actions can then be put in motion to reduce the substances in the Meuse".

Tineke also indicates the importance of the substance lists in relation to recently amended legislation. "According to the Drinking Water Directive, drinking water companies must start to use risk-based monitoring. It's then useful to be able to use this approach (determination of drinking water-relevant substances)".

Remarkable monitoring results from 2021

In 2021, the members of RIWA-Meuse and Rijkswaterstaat conducted a total of 134,343 samples of 828 parameters. These included the following substance groups:

- Industrial pollutants and consumer products;
- Pharmaceuticals and endocrine disrupting chemicals (EDC's);
- Plant protection products, biocides, and their metabolites.

To determine which potentially problematic parameters to produce drinking water, drinking water companies test the measured parameters against the European River Memorandum (ERM) target values. This is the agreed yardstick in the European River Memorandum.

The results from the entire measurement programme are described in Part B: Monitoring and sampling results. A summary can be found below.

Table 1: Overview of breaches of ERM target values by substance category

	Industrial pollutants and consumer products	Pharmaceuticals and endocrine disrupting chemicals (EDC's)	Plant protection products, biocides, and their metabolites
Permanent 100%	3 (8,6%)	0 (0%)	0 (0%)
Structural 50-99%	5 (14,3%)	1 (6,7%)	2 (13,3%)
Frequent 10-49%	12 (34,3%)	7 (46,7%)	1 (6,7%)
Incidental 0-9%	15 (42,8%)	7 (46,7%)	12 (80,0%)
Total	35 (100%)	15 (100%)	15 (100%)

What emerged from the analysis of the 2021 sampling figures?

In 2021, 69 parameters exceeded the ERM target values one or more times. 50.7% of these cases concerned industrial pollutants (35 substances). Of the 2,813 samples taken for these 35 substances, 566 (20.1%) exceeded the ERM target value.

The poly-and perfluoroalkyl substances (PFAS) also come into this category of 'Industrial pollutants and consumer products.' More information regarding PFAS is available further in this section.

Further: in the category 'Residues of pharmaceuticals and endocrine-disrupting chemicals', 15 parameters exceeded the ERM target value one or more times in 2021. Of the 848 samples taken for these 15 substances, 134 (15.8%) exceeded the ERM target value.

In the category 'Plant protection products, biocides and their metabolites', 15 parameters also exceeded the ERM target value one or more times. Of the 1,585 samples of these 15 substances, 213 (13.4%) exceeded the ERM target value.

What is notable?

It was generally the case in previous years that the category 'Pharmaceuticals and endocrine disrupting chemicals (EDC's)' contained the highest percentage of exceeding samples, but this was not the case in 2021. It is worthwhile highlighting this, however it is too early to rejoice because this was mainly caused by drinking water companies starting to apply different ERM target values in 2021.

Also notable is that the category 'General parameters and nutrients' scores high regarding number of breaches, while this category contains relatively few problematic substances. This was caused by the low ERM target values that are applied for dissolved substances (expressed as DOC and TOC).

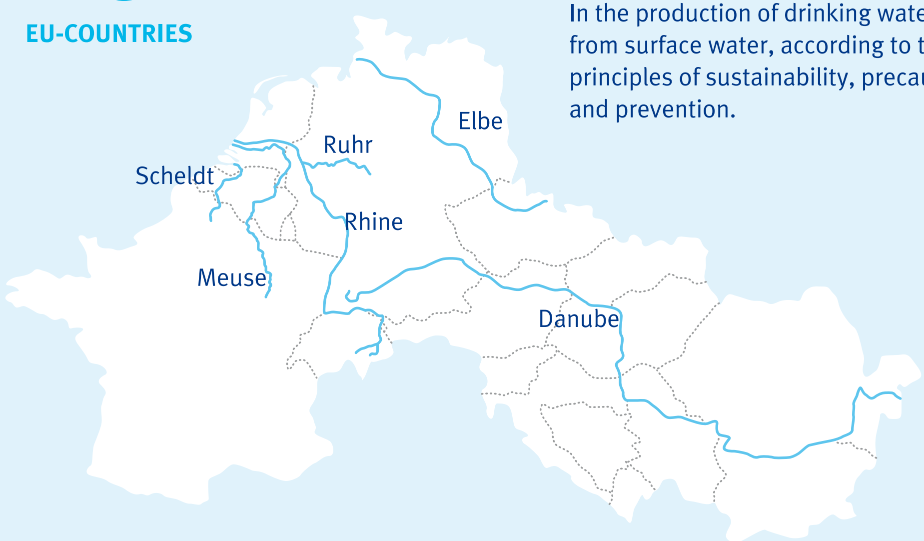
Target values of the European River Memorandum

Drinking water companies from the river basins of the Meuse, Rhine, Danube, Elbe, Ruhr and Scheldt have the European River Memorandum (ERM) drawn up in order to use surface water for the production drinking water. Surface water that meets the ERM Target Values can be used sustainably to produce drinking water, which can be prepared using natural purification methods.

EUROPEAN RIVER MEMORANDUM

18

EU-COUNTRIES

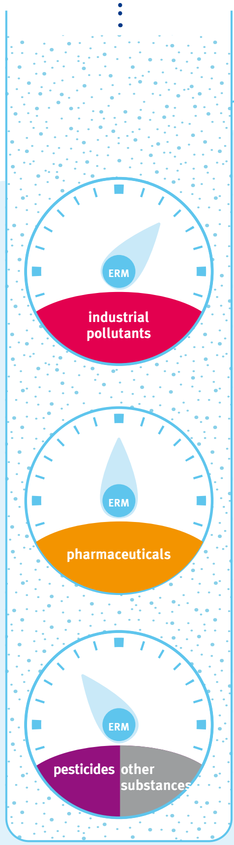


COMMON STRATEGY AND VISION

In the production of drinking water from surface water, according to the principles of sustainability, precaution, and prevention.

Important ERM principles

- Drinking water supply has a priority above other uses
- Sustainable management of water resources
- Emphasis on the prevention and protection of water bodies
- Enforcing responsibility for the discharge of substances
- Provide insight into (potentially) harmful substances



TARGET VALUES

- Anthropogenic non-natural substances
- Organic substances
- General parameters

RIWA-Meuse

WATER QUALITY ASSESSMENT

water quality indicators for

170

DRINKING WATER COMPANIES

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MILLION CUSTOMERS

Most substances that exceeded the ERM value in 2021 come into the category 'Industrial pollutants and consumer products.' Some examples of such substances: TFA, cyanuric acid and sulfamic acid. These substances permanently exceeded the ERM target value in 2021.

A 'Mugbook for substances in the Meuse' is also included in Part B of this report. To have a first-hand insight in the meantime: TFA is a solvent whose full name is trifluoroacetic acid. It is used for industrial purposes. Cyanuric acid is produced during the synthesis of melamine. Melamine is a synthetic substance mainly used in the production of plastics. Sulfamic acid is an ingredient of many acidic cleaning agents for the removal of deposits. It is also used in the synthesis of artificial sweeteners (cyclamic acid and sodium cyclamate).

Poly- and perfluoroalkyl substances (PFAS)

For drinking water companies, PFAS is a problematic substance group in the category 'Industrial pollutants and consumer products.' PFAS are also known as 'forever chemicals' because they do not degrade and are hard to remove throughout the purification process. PFAS substances prove to be harmful even at very low concentrations. What does this mean for drinking water production?

A

How do drinking water companies assess the PFAS content in the water?

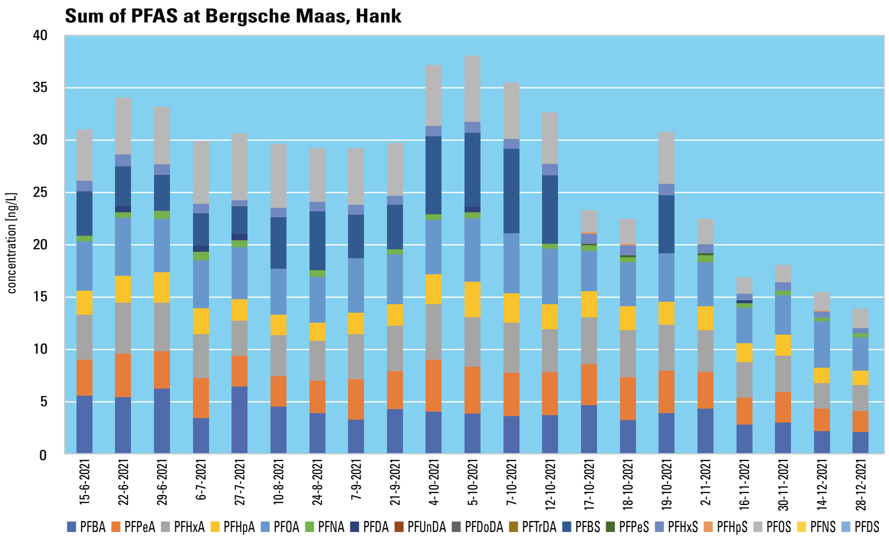
On 16 December 2020, the European Parliament formally adopted the revised Drinking Water Directive 2020/2184/EU. The Directive entered into force on 12 January 2021, and the Member States have two years from that date to transpose it into national legislation.

In the revised Drinking Water Directive, standards are included for PFAS for the first time: one standard for PFAS Total (0.5 µg/L or 500 ng/L) and one for the Sum of PFAS (0.1 µg/L or 100 ng/L). The Member States may choose which of these two standards, or both, they wish to transpose into their legislation. The Sum of PFAS includes the following 20 substances:

- Perfluorobutanoic acid (PFBA)
- Perfluorohexanoic acid (PFHxA)
- Perfluorooctanoic acid (PFOA)
- Perfluorodecanoic acid (PFDA)
- Perfluorododecanoic acid (PFDoDA)
- Perfluorobutane sulfonic acid (PFBS)
- Perfluorohexane sulfonic acid (PFHxS)
- Perfluorooctane sulfonic acid (PFOS)
- Perfluorodecane sulfonic acid (PFDS)
- Perfluorododecane sulfonic acid
- Perfluoropentanoic acid (PFPeA)
- Perfluoroheptanoic acid (PFHPA)
- Perfluorononanoic acid (PFNA)
- Perfluoroundecanoic acid (PFUnDA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluoropentane sulfonic acid (PFPeS)
- Perfluoroheptane sulfonic acid (PFHpS)
- Perfluorononane sulfonic acid (PFNS)
- Perfluoroundecane sulfonic acid
- Perfluorotridecane sulfonic acid

PFAS in the measurement programme

To calculate the Sum of PFAS, the starting point is the European Commission Directive[2], and results below the reporting limit are always set to zero. Based on this method of calculation, the status of the Sum of PFAS at Hank at the end of the Meuse River basin looks like this:



What follows from the graph?

Of the 20 EU PFAS (PFAS-20), 17 were measured at the Bergsche Maas monitoring stations (Hank) in 2021. Added together, the concentrations do not exceed 100 ng/L. This is in line with an investigation in Flanders from which it was concluded that the maximum measured concentration of PFAS-20 did not exceed 100 ng/L in water bodies used to produce drinking water (source: VMM report Perfluoro compounds in the sources to produce drinking water – 2021).

2 *Commission Directive 2009/90/EC of 31 July 2009 laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status*

Drinking water target value for PFAS

In September 2020, the European Food Safety Authority (EFSA) issued a scientific opinion about the health risks of the presence of PFAS in foodstuffs. EFSA calculated the quantity of PFAS that humans can ingest safely during their entire lives (health and hygiene limit value): the total ingestion of four PFAS ought not to exceed 4.4 ng/kg/week expressed in PFOA equivalents (PEQ).

EFSA has opted for a health and hygiene limit value for the sum of PFOS, PFOA, PFNA and PFHxS. These PFAS are assessed as a sum because EFSA assumes that these four PFAS cause the same critical effect and because these are the primary PFAS that have been detected in people's blood. The EFSA-4 are not by definition also the most relevant PFAS for other exposure routes, environmental compartments, and policy frameworks (source: Analysis of contribution of drinking water and food to exposure to EFSA-4 PFAS in the Netherlands and recommendation on drinking water target value, RIVM 2021). Based on the permissible ingestion proposed by EFSA, RIVM calculated a drinking water target value of 4.4 ng/L of PFOA equivalents (PEQ). This choice of PEQ was made because the effects in the underlying study are mainly associated with PFOA (and not with other PFAS). In the calculation, RIVM assumed relative potency factors (RPFs) so that the concentrations of PFOA counts once, PFOS twice, PFHxS 0.6 times and PFNA 10 times.

What now?

It is not yet clear what the relationship between the new Drinking Water Directive and EFSA's opinion is. The extent to which the EFSA proposal should be enacted into drinking water standards is still the subject of discussion among experts.

Since it is expected that standard levels and target values will become lower or much lower, drinking water laboratories are working on the further lowering of the lowest reporting limits. An advisory report is expected from RIVM about how to incorporate the new standards for PFAS into the Drinking Water Decree.

B

Monitoring and measurement results

B1 Measurement results from 2021

Not all substances in the Meuse are equally relevant to the drinking water sector. Along with a series of legally stipulated parameters, RIWA-Meuse has worked with a priority system since 2007. This system is intended to allow substances to be monitored in a more targeted way and to be able to take adequate advantage of new advancements.

Therefore, every three years, these ‘drinking water-relevant’ substances in the Meuse are reinvestigated. This is based on a broad monitoring programme. Another evaluation was conducted in 2021 where the method itself was also evaluated. In Part A3, there is a description of the procedure used.

Since 2015, RIWA Meuse has used a threefold substance classification for monitoring programmes:

- Drinking water-relevant substances. These are the substances on which RIWA-Meuse focuses its advocacy efforts;
- Candidate drinking water-relevant substances (substances that have not yet been measured, or not sufficiently);
- No longer drinking water-relevant substances.

The results from the joint monitoring efforts in 2021 are available in this part.

Number of samples

In 2021, the members of RIWA-Meuse and Rijkswaterstaat conducted a total of 134,343 samples of 828 parameters (see Table 1). The Evides Bergsche Maas intake station began its operations halfway through 2021 and has been added to the monitoring points. The substances measured were tested against the ERM target value, which is mainly used to test substances that are appearing that do not have (or do not yet have) a legal standard in the context of drinking water legislation.

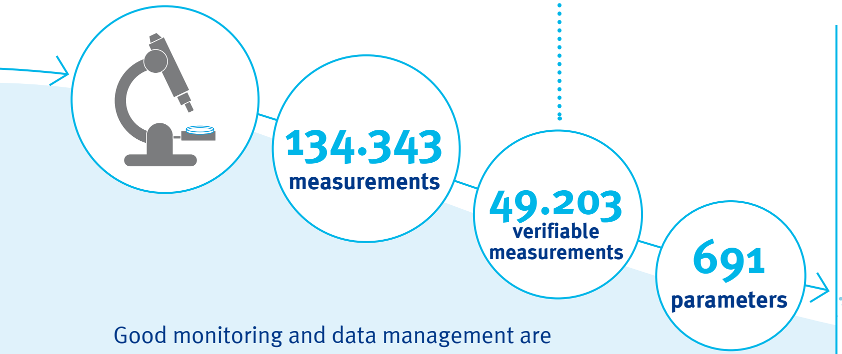
Of the 828 parameters, 691 were testable, and of these, 69 (10.0%) exceeded the ERM target value one or more times in at least one measurement point (see Appendix 1). The 137 parameters that were not testable is directly related to the fact that there is no ERM target value for these. In total, a breach of the ERM target value was observed 1,201 times; this is 2.4% of the testable samples (49,203).

Table 2: Number of water quality samples in the Meuse in 2021

Monitoring station	Number of samples	Number of parameters	Number of testable samples	Number of testable parameters
Tailfer (M520)	3,038	57	2,235	28
Namêche (M540)	4,192	92	2,610	64
Luik (M600)	6,492	113	3,365	59
Eijsden (M615)	7,138	139	2,565	74
Roosteren (M660)	6,268	141	3,027	126
Stevensweert (M675)	3,896	143	2,407	87
Heel (M690)	28,431	261	7,424	180
Brakel (M845)	14,656	239	5,219	161
Heusden (M845)	9,504	84	4,189	69
Keizersveer (M865)	13,418	282	4,953	202
Bergsche Maas (M868)	9,914	259	3,844	186
Haringvliet (M870)	27,396	268	7,365	196
Total	134,343	828	49,203	691

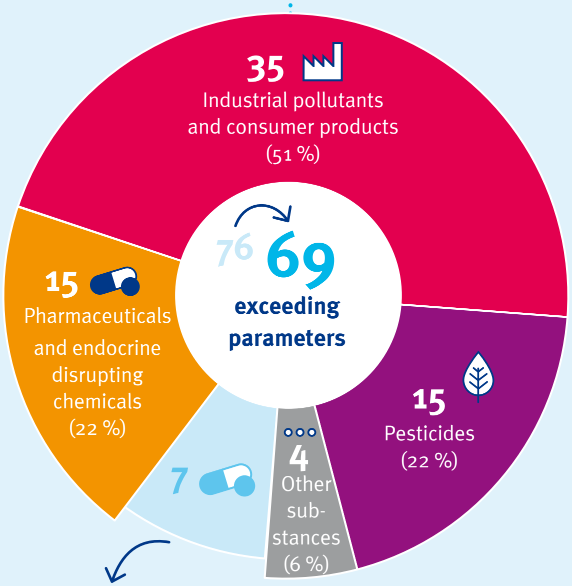
Monitoring the water quality of the Meuse

RIWA-Meuse assesses the water quality of the Meuse according to the target values of the European River Memorandum. Surface water that meets the ERM Target Values can be used sustainably for the production of drinking water, which can be prepared by using natural purification methods.

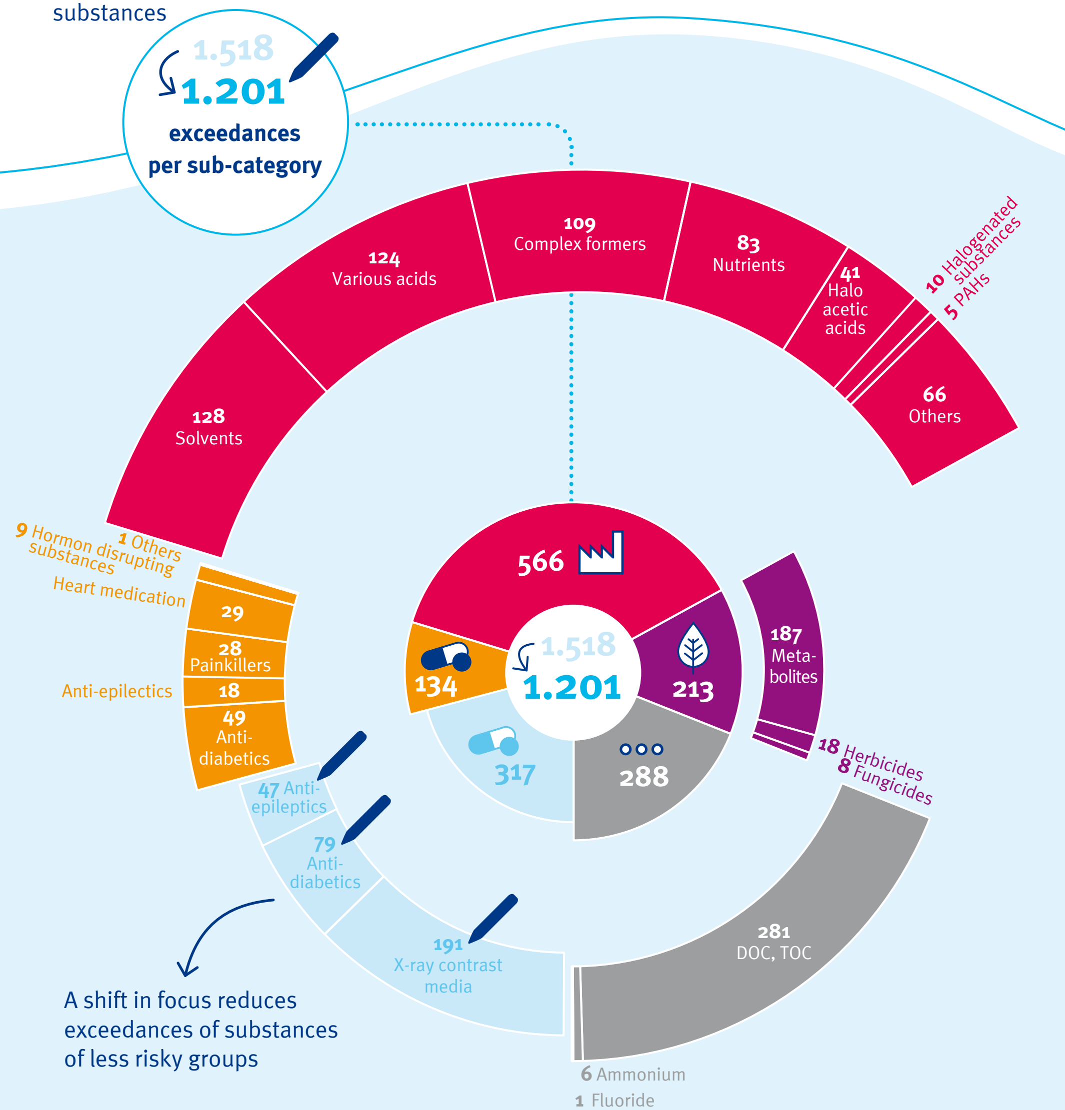


Fewer exceedances due to a stronger focus on harmful substances

Good monitoring and data management are essential to safeguard the water quality of the Meuse as a source to produce drinking water.



Fewer exceedances due to a stronger focus on harmful substances



A shift in focus reduces exceedances of substances of less risky groups

Testing against the ERM

To test the measured substances, drinking water companies use the ERM target value; the yardstick in the European River Memorandum. Drinking water companies in the river basins of the Meuse, Rhine, Danube, Elbe, Ruhr, and Scheldt drafted the European River Memorandum (ERM) for surface water. It is possible to prepare drinking water in a sustainable way with natural purification methods from water that meets the ERM target values.

Plant protection products, biocides and their metabolites are tested against the ERM target value. The ERM target value is equal to the legal standard (0.1 µg/L) for active substances and their metabolites which are toxicologically relevant to humans.

The ERM states that toxicologically 'well assessed substances' must be tested against 1 µg/L, whilst for a number of these substances testing is still done against a value of 0.1 µg/L. In 2021, the drinking water companies that use Meuse water therefore decided to use a different ERM target value for several parameters.

From now on, substances with an indicative drinking water target value over 10 µg/L will in practice be tested against 1 µg/L. This concerns the substances listed in Appendix 3.

PFOA is also tested against an even lower ERM target value than 0.1 µg/L. The reason for this is that the indicative drinking water target value for PFOA is extremely low: 87.5 ng/L. In order to avoid misinterpretation: in this report's section on PFAS, the indicative standard of 4.4 ng/L is mentioned. However, the drinking water sector has decided to not yet test against this EFSA recommendation. Therefore, the standard of 87.5 ng/L is maintained in this report.

Result: number of ERM breaches

In 2021, TFA, cyanuric acid, and sulfamic acid continuously exceeded the ERM target value. In 2020, EDTA, cyanuric acid and sulfamic acid continually exceeded the standard, while in 2019, EDTA and TFA exceeded it persistently. Note that cyanuric acid and sulfamic acid have only been monitored since 2020.

Table 3: Overview of breaches of ERM target values by substance category

	Industrial pollutants and consumer products	Residues of pharmaceuticals and Endocrine-Disrupting Chemicals (EDCs)	Plant Protection Products, Biocides, and their metabolites
Permanent 100%	3 (8,6%)	0 (0%)	0 (0%)
Structural 50-99%	5 (14,3%)	1 (6,7%)	2 (13,3%)
Frequent 10-49%	12 (34,3%)	7 (46,7%)	1 (6,7%)
Incidental 0-9%	15 (42,8%)	7 (46,7%)	12 (80,0%)
Total	35 (100%)	15 (100%)	15 (100%)

Not every breach of the ERM is equally relevant. Broadly, there are three types of breach:

- Structural breaches: substances that breach the ERM target value at least once again every year;
- 'Flashing light' breaches: substances that breach the ERM target value one year and not the next year;
- New breaches concern substances that we now see for the first time because new methods for analysis are available.

An overview of the number of breaching substances since 2015 is presented in Figure 2

Given that different substance categories were used in previous reports, the breaches were determined again based on the selection made in 2020 and 2021. Therefore, the results presented here may on some occasions sometimes deviate from what was stated in previous reports. It may also concern new substances compared to before. This is due to the assignment of ERM target values to substances that were not included in the past testing, as they already had a (legal) drinking water standard.

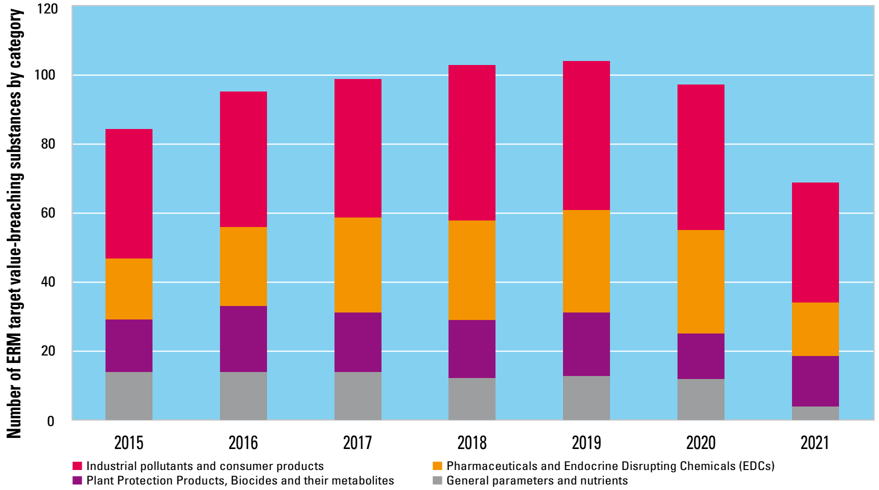


Figure 2: Number of ERM target value-breaching substances by category, 2015-2021

After assessing the results against the ERM values, it became clear that the number of breaching substances in the category 'Industrial compounds' is always the highest. The number of breaching substances in the category 'Pharmaceuticals and endocrine disrupting chemicals (EDC's)' proves to have reduced sharply in 2021. This is related with the previously described decision to test substances with an indicative drinking water target value over 10 µg/L against an ERM target value of 1 µg/L from now on, rather than 0.1 µg/L.

Moreover, it is evident that the number of breaching substances in the categories 'Plant protection products, biocides, and their metabolites' and 'General parameters and nutrients' is relatively small.

Analysis: Seriousness of breach

Besides the number and the type of breaches of the ERM, it is relevant to examine how far above the ERM target value drinking water-relevant substances are. To this end, the percentage of breaches has been determined in Figure 4. As previously mentioned, drinking water-relevant substances are the ones on which RIWA-Meuse focuses its advocacy efforts.

Figure 3 shows a summary of the breach percentages of the ERM target value within the substance categories since 2015.

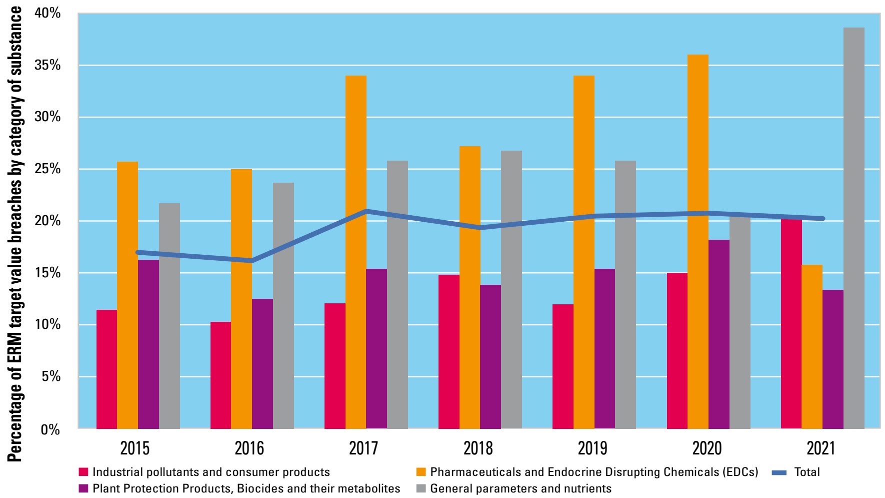


Figure 3: Percentage of ERM target value breaches by category of substance 2015-2021

What is remarkable from the assessment carried out for this report is that the percentage of breaching samples is no longer the highest in the category 'Pharmaceuticals and endocrine disrupting chemicals (EDC's).' This was mainly caused by the choice of a different ERM target value.

Likewise, it is also worth highlighting that the percentage of breaching samples in the category 'General parameters and nutrients' is high, while this category contains relatively few breaching substances. This was mainly caused by the low ERM target values for DOC (2021: 73.9% of breaches) and TOC (2021: 55.6% of breaches).

It is also possible to observe that the category 'Plant protection products, biocides and their metabolites' indeed contains more breaching substances in 2021 than in 2020, however the breach percentage is in fact lower.

B

B2 'Mugbook' for substances in the Meuse

An abundance of anthropogenic pollutants was detected in the Meuse's water. In 2021, 69 substances exceeded the ERM target value. This happened 1,201 times in 5,992 samples: therefore in 20% of the cases. Some substances remain anonymous; others are identified. Anonymous substances are not taken further into account. To gain an impression of the types of substance that drinking water companies had to deal with in 2021, a 'Mugbook' for substances in the Meuse is presented below.

These concerns the following substance groups:
- Industrial pollutants and consumer products;
- Pharmaceuticals and endocrine disrupting chemicals (EDC's);
- Plant protection products, biocides, and their metabolites;

Table 4: Industrial pollutants and consumer products that exceeded the ERM target value in 2021 (maximum concentrations)

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Industrial pollutants and consumer products																566	2813	20,1%
cyanuric acid	108-80-5	0,1	µg/L					1,7		2,3	1,1		0,96	2,7	2,3	46	46	100,0%
sulfamic acid	5329-14-6	0,1	µg/L					15		23	31		38	41	77	46	46	100,0%
Trifluoroacetic acid (TFA)	76-05-1	0,1	µg/L								1,1		1,2	1,1	1,3	39	39	100,0%
Ethylenediaminetetraacetic acid (EDTA)	60-00-4	1	µg/L		5,3	7,6	7,6	8,7		11	27		16	30	13	85	86	98,8%
Sucralose	56038-13-2	1	µg/L								2,5	3	3,9	3,2	1,8	34	43	79,1%
Trichloroacetic acid (TCA)	76-03-9	0,1	µg/L								0,24	1,2	0,24	0,4	0,19	40	52	76,9%
dichloromethane sulfonic acid	53638-45-2	0,1	µg/L					0,44		0,29	0,16		0,24	0,35	0,23	32	46	69,6%
methenamine	100-97-0	1	µg/L		3,67	6,11		2,8		2	1,5		1,7	1,2	1,8	49	89	55,1%
1,2-Dimethoxyethane	110-71-4	0,1	µg/L				<0.05		<0.05	<0.05	<0.05		<0.05		1	17	35	48,6%
8-Hydroxypenillic acid	3053-85-8	0,1	µg/L										0,43	0,54	0,11	11	26	42,3%
1,4-Dioxane	123-91-1	0,1	µg/L				0,5	<0.2		<0.2	0,2	0,24	0,22	0,2	0,62	29	88	33,0%
Di-iso-propylether	108-20-3	1	µg/L		<0.1	14,04	10	6,2	1,1	1,5	0,02	2,4	0,39	0,4	0,26	31	149	20,8%
Trifluoromethanesulfonic acid	1493-13-6	0,1	µg/L					0,41		0,4	0,12		0,34	0,04	0,06	9	46	19,6%
1,3,5-triazine-2,4,6-triamine (melamin)	108-78-1	1	µg/L		0,453	0,637		1,1		1,4	2,2	4,5	2,3	3,3	1,7	38	238	16,0%
Nitrilotriacetic acid (NTA)	139-13-9	1	µg/L		<1	<1	7,4	<1		<1	<1		<1	<1	<1	13	86	15,1%
Tetrahydrofuran (THF)	109-99-9	0,1	µg/L					0,2		0,083			0,25	0,28	0,16	8	55	14,5%
Diethylenetriaminepentaacetic acid (DTPA)	67-43-6	1	µg/L		<1	<1	<1	<1		1,1	10		3,7	2,6	1,3	11	86	12,8%
nonionic detergents		0,001	mg/L										0,1	<0.1	<0.1	1	8	12,5%
Tributylphosphate (TBP)	126-73-8	1	µg/L		0,022	9,047	3,42		0,154	0,249	0,13	0,27	0,307		0,196	4	39	10,3%
PAHs, sum 16 of EPA		0,1	µg/L		0,185	0,074										2	20	10,0%
sum of trihalomethanes		0,1	µg/L			0,16		0,13		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5	99	5,1%
1,3-Diphenylguanidine	102-06-7	0,1	µg/L					0,1		0,055			0,059	0,08	<0.05	1	44	2,3%
ethyl sulfate	540-82-9	0,1	µg/L					0,1		<0.1	<0.1		<0.1	<0.1	<0.1	1	46	2,2%
benzotriazole	95-14-7	1	µg/L		0,84	1,286		0,9		0,58	0,62	0,95	0,55	0,6	0,61	2	95	2,1%
PAHS, sum of 10		0,1	µg/L					0,036		0,033	0,02	0,12	0,082			1	53	1,9%
Diacetone acrylamide	2873-97-4	0,1	µg/L										0,26	<0.05	<0.05	1	65	1,5%
Dichloroacetic acid	79-43-6	0,1	µg/L					<0.1		<0.1	0,04	0,13	0,04	0,04	0,05	1	66	1,5%
Chloroethene	75-01-4	0,1	µg/L	<0.1	0,12	<0.1	0,13	0,053	<0.045	<0.045	<0.045	<0.05	<0.045	<0.045	<0.045	2	148	1,4%
Pyrazole	288-13-1	1	µg/L				<0.5	<0.5		<0.5	0,45	0,36	<0.5	<0.5	1,3	1	75	1,3%
tetra- and trichloroethene (sum)		0,1	µg/L		0,11			<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1	78	1,3%
Phenanthrene	85-01-8	0,1	µg/L	0,008	0,0197	0,0257	0,279	0,0058	0,0582	0,00857	0,00881	0,01	0,03	0,0101	0,00812	1	133	0,8%
Fluoranthene	206-44-0	0,1	µg/L	0,013	0,0415	0,0232	0,694	0,0071	0,0934	0,0251	0,00933	0,02	0,0576	0,0163	0,0145	1	133	0,8%
Pyrene	129-00-0	0,1	µg/L	0,007	0,0272	0,0186	0,475	0,0065	0,0671	0,0232	0,00942	0,02	0,0467	0,0135	0,0169	1	133	0,8%
1,2-Dichloroethane	107-06-2	0,1	µg/L	<0.1	0,11	<0.1	<0.1	<0.05	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	1	161	0,6%
Tetrachloroethene	127-18-4	0,1	µg/L	<0.2	0,11	<0.1	0,058	<0.05	<0.019	0,02	<0.019	0,05	0,031	0,035	<0.019	1	161	0,6%

ERM-sw = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Luik, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, HEU = Heusden, BRA = Brakel, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.
In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of samples.

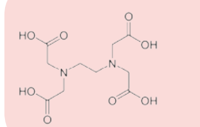
Industrial pollutants and consumer products.

In 2021, 69 parameters exceeded the ERM target values one or more times. 50.7% of these cases concerned industrial pollutants (35). Out of the 2,813 samples that were taken for these 35 substances, 566 (20.1%) exceeded the ERM target value.

Complex formers

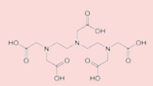
Complex formers (chelates) are chemical substances that form complex, soluble molecules with certain metal irons, thanks to which these metal irons are inactivated such that they cannot react in a normal way with other elements or ions to form a precipitate or deposit. They are used as ingredients in cleaning agents such as limescale removers and strippers and as stabilisers in bleaches and soap products.

EDTA



Application: EDTA is a complex former which is used in detergents and in medicine to trap and remove calcium and other metals, including heavy metals such as arsenic, copper and mercury.
Origin: this substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: EDTA (ethylenediaminetetraacetic acid) was detected at far above the ERM target value 1 µg/L in all but one of all samples at all points where it was measured at the measurement points Namêche, Luik (Liège), Eijsden, Roosteren,

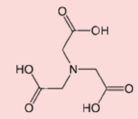
Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. The indicative drinking water target value for EDTA is 600 µg/L.
Noteworthy: Since 1990, this substance has been detected at concentrations between 0 and 30 µg/L in drinking and surface water. EDTA is a compound only slightly toxic to humans, but it has the property of releasing heavy metals from silt and keeping them dissolved in water.



DTPA

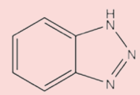
Application: From the 1960s onwards, DTPA (pentetic acid or diethylenetriamine pentaacetic acid) has been used to combat internal contamination with radioactive material. DTPA and its derivatives are used to form complexes with gadolinium, which in turn are used as contrast agents in MRI[3] scans. DTPA is also used in the extraction of soil samples.
Origin: this substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: DTPA was detected above the ERM target value at Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. DTPA is on the Netherlands list of potential substances of very high concern under REACH [source: RIVM]. The indicative drinking water target value for DTPA is 700 µg/L.
Noteworthy: In the past (2018), Dunea and Evides had an exemption to allow them to continue to use surface water with DTPA at Brakel and Keizersveer (Gat van de Kerksloot) to produce drinking water. Like EDTA, DTPA forms stable complexes with many metals.

3 *Magnetic Resonance Imaging*



NTA

Application: NTA (nitrilotriacetic acid) is suitable for softening water and for preventing or removing limescale deposits. It is therefore frequently added to water in boilers. NTA was used increasingly from the late 1960s as a replacement for phosphates in detergents.
Origin: This substance mainly ends up in surface water via cooling water discharges and wastewater treatment plants.
Distribution of contamination: NTA was detected at above the ERM target value in 13 samples taken at Eijsden. The indicative drinking water target value for NTA is 400 µg/L.
Noteworthy: NTA is biologically degradable, better than the similar EDTA. It is mainly the water-soluble trisodium salt of NTA that is used in soaps and detergents. The WHO IARC considers NTA as possibly carcinogenic to humans (IARC class 2B).

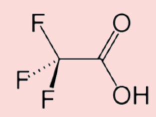


Benzotriazole

Application: Benzotriazole is chelating agent[4] that has applications including corrosion inhibitor in cooling water, antifreeze/anti-icing agent (including de-icing aircraft) and as a protective agent for silverware in washing-up liquid. Benzotriazole is for example a constituent of the cooling water additive Nalco 3D TRASAR 3DT151, a copper corrosion inhibitor.
Origin: this substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: Benzotriazole was detected above the ERM target value at Luik (Liège). The indicative drinking water target value for benzotriazole is 700 µg/L.
Noteworthy: In the past, WML (2018) and Evides (2019) had an exemption to allow them to continue to use surface water with benzotriazole from the Meuse to produce drinking water.

4 *From a chemical standpoint, chelation is the same as complex formation, with the understanding that, in chemistry, the concept complex formation is applied to mono-, di- and polydentate ligands, while chelation explicitly excludes the monodentate ligands (source: Wikipedia).*

Solvents



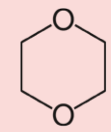
Trifluoroacetic acid (TFA)

Application: Trifluoroacetic acid (TFA) is used in the production of trifluoroacetic fluoride and 2,2,2-trifluoroethanol. The acid is added to some HPLC analyses in the mobile phase to reduce the occurrence of ‘tailing’. The acid is also frequently used as a building block in the synthesis of pharmaceutical substances and agricultural chemicals and as a catalyst in polymerisations and condensation reactions. On the boundary between organic chemistry and biochemistry, trifluoroacetic acid is used during in vitro peptide synthesis to remove the protective tert-butoxycarbonyl group from amino groups. TFA is used in the form of its salts (trifluoroacetates) in the production of ceramic materials. TFA is a much-used solvent in NMR spectroscopy, and it is used in mass spectrometry to calibrate the equipment [source: Wikipedia]. TFA is also a breakdown product of hydrofluorocarbons or HFCs that are used in applications including air conditioners, foam blowing agents and propellant gases in aerosols (source: UBA report FB000452/ENG). TFA may also be a metabolite of plant protection products based on flurtamone, fluopyram, tembotrione and flufenacet and of the substances fluoxetine, sitagliptin and 4:2 fluorotelomer sulfonate (source: https://www.ncbi.nlm.nih.gov/pubmed/28992593).

Origin: this substance mainly ends up in surface water via industrial wastewater treatment plants. TFA has also been detected in rainwater.

Distribution of contamination: TFA was detected above the ERM target value at Brakel, Keizersveer, Bergsche Maas and Haringvliet.

Noteworthy: In September 2016, at the LUBW (Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg), there were indications of an industrial contamination of the Neckar tributary with TFA. For this reason, monitoring was started. In the Neckar, high concentrations above 10 μg/L were detected; in the Dutch part of the Rhine, the concentrations in the surface water are around 1.5 μg/L (source: fact sheet from Het Waterlaboratorium).



1,4-Dioxane

Application: 1,4-Dioxane is an ether that is mainly used as a solvent in the paper, cotton and textile industry, in vehicle coolants, as initial substance for the synthesis of other substances, as foaming agent in the polymer industry, and in the production of cosmetics and shampoos. On 12 July 2021, 1,4-dioxane was added to the candidate list for REACH Annex XIV (Substance of Very High Concern, SVHC). In the Netherlands, the substance was added to the list of Very Concerning Substances (ZZS).

1,4-Dioxane may be formed in the production and processing of ethylene oxide, a major raw material in the chemicals industry. Two cases are known in which the production of ethylene oxide led to emissions of 1,4-dioxane: at INEOS in Dormagen (Rhine) and at KLK Kolb Specialties in Delden (Twente Canal). Ethylene oxide is used as an intermediate product in processes including the production of ethylene glycols. It is also used as a disinfectant for heat-sensitive materials in hospitals. The substance is highly soluble in water and is gaseous under atmospheric conditions. As a gas, ethylene oxide is heavier than air and presents an extreme explosion hazard.

Origin: It emerges from the REACH dossier that at least one ethylene oxide factory is situated on the Meuse [source: ECHA]. There are also at least two manufacturers on the Albert Canal.

Distribution of contamination: 1,4-Dioxane was detected above the ERM target value at Eijsden, Brakel, Heusden, Keizersveer, Bergsche Maas and Haringvliet. The indicative drinking water target value for 1,4-dioxane is 3 μg/L.

Noteworthy: Because the WHO IARC states that this ether could possibly be carcinogenic to humans (IARC class 2B), 0.1 µg/L is kept to as ERM target value.

Tetrahydrofuran (THF)

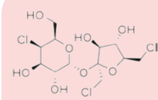
Application: Tetrahydrofuran (THF) is a solvent that is used in the chemicals industry. It can be polymerised by strong acids or electrophiles (such as trityl tetrafluoroborate) into a linear polymer, poly(tetramethylene ether) glycol or PTMEG (also known as poly (tetramethylene) glycol or polytetramethylene oxide). This glycol is mainly used to produce elastomer polyurethanes, in particular polyurethane fibres such as elastane (Spandex, Lycra).
Origin: this substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: THF was detected above the ERM target value at Roosteren, Keizersveer, Bergsche Maas and Haringvliet.
Noteworthy: no clear trend is observable.

1,2-Dimethoxyethane (DME)

Application: 1,2-Dimethoxyethane, often abbreviated to DME or EGDME, also known under the names glyme and ethylene glycol dimethyl ether, is a solvent. It is often used in chemical reactions in which an aprotic, coordinating solvent is needed. Examples of this are organometallic reactions or reductions with hydrides. It can also act as a ligand in metal complexes (source: Wikipedia). DME is a highly concerning substance (https://rvszoeksysteem.rivm.nl/stof/detail/1418): on 15 July 2012, DME was added to the candidate list for REACH Annex XIV (Substance of Very High Concern, SVHC).

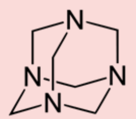
Distribution of contamination/**origin:** DMA was only detected above the ERM target value in the Haringvliet. The water in the Haringvliet mainly originates from the Rhine River basin, from where the discharges of this substance presumably also come.

Foodstuffs



Sucralose (E955)

Application: Sucralose (E955) is an artificial sweetener that is used as a sugar replacement in various foodstuff products and soft drinks.
Origin: this substance mainly ends up in surface water via sewage treatment plants.
Distribution of contamination: Sucralose was detected at concentrations above the ERM target value at Heusden, Brakel, Keizersveer, Bergsche Maas and Haringvliet. It is stable and is not broken down or absorbed in the body. This property means that it is also not (well) broken down in the environment, a wastewater purification plant or a simple drinking water purification plant. The indicative drinking water target value for sucralose is 5000 µg/L.
Noteworthy: Sucralose is in Annex III of the REACH Regulation due to the suspicion of carcinogenicity, hazard to the aquatic living environment, mutagenicity, and persistence [source: ECHA].



Methenamine (E239)

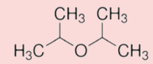
Application: Methenamine (urotropine, hexamine) is one of the trivial names for a compound that is much used in phenol resin and many other industrial applications, as well as a as a preservative against mould (E239 in products including caviar, rollmop herring, tinned fish and pickled herring). Methenamine is also the main constituent of solid fuel tablets, known by the name Esbit, much used for example in stoves for campers, mountain climbers and the military, and in miniature steam engines. Methenamine may also be used as a corrosion inhibitor and antibiotic.

Origin: this substance mainly ends up in surface water via wastewater treatment plants.

Distribution of contamination: Methenamine was detected above the ERM target value at Namêche, Luik (Liège), Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. The indicative drinking water target value for methenamine is 500 µg/L.

Noteworthy: Since 2010, methenamine has been measured in the water abstracted at Brakel and it is also detected regularly at over the ERM target value. From 2012 this substance has also been detected systematically at Keizersveer and Haringvliet at above the ERM target value.

Substances that are used in the Prayon process



DIPE; tributyl phosphate; fluoride

Application: There is a known industrial discharge in the Walloon part of the river basin that for decades has been responsible for the presence of the substances: fluoride, DIPE and tributyl phosphate in the Meuse. The company Société de Prayon developed and patented an extraction process that uses the solvents di-isopropyl ether (DIPE, 85-95%) and tributyl phosphate (5-15%) with which technical grade phosphoric acid can be upgraded to phosphoric acid of food quality [Gilmour, 2013]. Since 1983, this process has been used in the factory at Engis and there is presently a plant with which 120,000 tonnes per year (expressed as P2O5) can be processed according to the Prayon process as it is known.

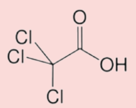
In the first step of the pre-treatment in the Prayon process, the impurities sulphate and fluoride in technical grade phosphoric acid are reduced to 0.3% and 0.1% respectively. Part of the fluoride is recovered from the process and sold in the form of hexafluorosilicic acid (H2SiF6).

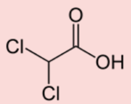
Origin: Société de Prayon in Engis.

Distribution of contamination: DIPE was detected above the ERM target value at Luik (Liège), Eijsden, Roosteren, Stevensweert, Heel and Heusden. Tributyl phosphate was detected above the ERM target value at Luik (Liège) and Eijsden. Fluoride slightly exceeded the ERM target value once at Luik (Liège). The indicative drinking water target value for tributyl phosphate is 350 µg/L. The indicative drinking water target value for DIPE is 1400 µg/L.

Noteworthy: Société de Prayon has further optimised the fluoride recovery process in their factory at Engis by installing a vapour separator and air scrubber in October 2014. This ought to deliver an extra yield of around 250 tonnes of fluoride per year, which would no longer be discharged. In the past year, a single breach of fluoride arose; the last time fluoride regularly exceeded the ERM target value was in 2011: then, 34% of the samples taken at Liège were in breach. The drinking water companies are delighted that the contaminations have been reduced, partly through reuse of the substances. They hope that this positive trend continues and that all emissions finally come under the ERM target value. In the future, the company plans to reduce the discharges of DIPE and TBP by means of an additional purification step (Prayon announcement).

Halogenated acetic acids (HAA)

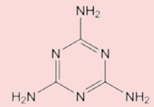


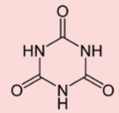


Trichloroacetic acid (TCA); dichloroacetic acid (DCA)

Application: These substances are known by-products that arise from the chlorination of water. TCA has many applications, including solvent in the plastics industry, production of sodium trichloroacetic acid (an herbicide), etchant in metal processing, additive in mineral lubricant oils and catalyst for polymerisation reactions [source: Wikipedia]. In biochemistry, TCA is used to precipitate out proteins and other macromolecules. Other applications are to be found in the medical (treatment of skin conditions and removal of warts) and cosmetic spheres (chemical peeling). TCA has been detected in the Meuse since 1986 [Versteegh, J.F.M., Peters, R.J.B. & De Leer, E.W.B. (1990)].
Origin: Chlorination of water in industrial processes is probably the source of HAA in the Meuse.
Distribution of contamination: TCA was detected above the ERM target value at Heusden, Brakel, Keizersveer, Bergsche Maas and Haringvliet. DCA was detected above the ERM target value at Heusden.
Noteworthy: TCA has been detected above the reporting limit for years in Meuse water at Heusden and Brakel.

Other industrial substances and consumer products





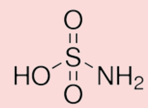
Melamine and cyanuric acid

Application: Melamine is a synthetic substance mainly used in the production of plastics [source: RIVM]. Under high pressure (>7 MPa) and a temperature over 370°C, isocyanic acid is formed, leading to cyanuric acid via an exothermic reaction. The cyanuric acid condenses with ammonia into melamine and water. Finally, the liquid melamine cools into the intended end product: a white crystalline powder.
Melamine is formed from urea, with ammonia and carbon dioxide as by-products [source: Melamine and cyanuric acid. Potential commercial discharges in the Netherlands, Arcadis 2019]. Melamine plastics are strong, hard, light and resistant to strong acids among other things. Consumer products into which melamine is processed include plastic plates, cups, dishes and cutlery, and also the miracle sponges as they are known. The Netherlands Food and Consumer Product Safety Authority (NVWA) recommends no longer using crockery made from bamboo with melamine plastic, such as coffee cups and bowls (source: NOS).
Origin: In 1964, DSM built the first melamine factory on the site that is now known as Chemelot, a large industrial complex for the chemicals industry between Stein and Geleen, in the Netherlands province of Limburg. OCI Nitrogen has a melamine factory on the Chemelot Industrial Park. It is the only production location of melamine in the Netherlands, and it makes products with names such as MelaminebyOCI™ and Melafine®. OCI Nitrogen is by far the largest production site for melamine in the world, with 60% more production than the next largest site.
Distribution of contamination: Melamine was detected above the ERM target value at Roosteren, Heel, Brakel, Heusden, Keizersveer,

Bergsche Maas and Haringvliet. Cyanuric acid was detected above the ERM target value at Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. Melamine has an indicative drinking water target value of 0.28 μM. This value applies to the sum of melamine, melem and melam. This value takes account of the simultaneous presence of cyanuric acid. If it has been demonstrated that the concentration of cyanuric acid is below 10 μg/L (0.08 μM), a drinking water target value of 2.0 μM applies for the sum of melamine, melem and melam. The value stated only apply if the concentration of cyanuric acid is lower than the sum of melamine, melem and melam.

Noteworthy: To apparently elevate the protein percentage, melamine was added to milk products in China, which attracted much media attention in 2008. The milk products were diluted with water; this can be masked by adding melamine. After ingestion into the body, melamine can be converted to compounds including isocyanic acid via hydrolysis. Melamine and isocyanic acid can then form insoluble complexes, leading to the formation of crystals and finally kidney stones, possible obstruction and damage to the renal tissue as a result. Kidney problems arose in the cases of illness in China, probably due to the formation of kidney stones.

Sulfamic acid

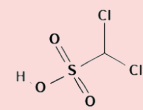


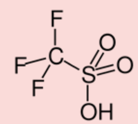
Application: Sulfamic acid is an ingredient of many acidic cleaning agents for the removal of deposits: limescale deposit in coffee machines and on chrome or stainless steel in places such as milking sheds and breweries, in steam boilers, cement residue on tiles and urine stains on sanitary ware. Sulfamic acid is also used in the synthesis of artificial sweeteners (cyclamic acid and sodium cyclamate).

Origin: The use of cleaning agents in both industry and households probably leads to the concentrations observed.

Distribution of contamination: Sulfamic acid was detected far above the ERM target value in all samples taken at Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet.

Dichloromethane sulfonic acid, trifluoromethane sulfonic acid

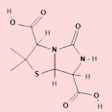




Application: Trifluoromethane sulfonic acid is mainly applied in chemical reactions due to its acid strength, as a catalyst or a source for the triflate group.

Origin: Halomethane sulfonic acids (HMSAs) such as dichloromethane sulfonic acid are recently discovered polar disinfection byproducts. Trifluoromethane sulfonic acid is one of the strongest known acids and is therefore counted as a super acid as they are known.

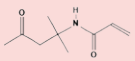
Distribution of contamination: Dichloromethane sulfonic acid was detected above the ERM target value at Roosteren, Heel, Keizersveer, Bergsche Maas and Haringvliet. Trifluoromethane sulfonic acid was detected at concentrations above the ERM target value at Roosteren, Heel, Brakel and Keizersveer..



8-Hydroxypenillic acid

Application/origin: 8-Hydroxypenillic acid was used in the past as an additive in the purification process of Sitech's I-WWTP in Sittard/Geleen (source: RIVM-VSP advisory report 14623A00).

Distribution of contamination: 8-Hydroxypenillic acid was detected above the ERM target value at Keizersveer, Bergsche Maas, and Haringvliet. The indicative drinking water target value for this substance is 10 µg/L.

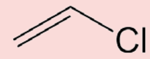


Diacetone acrylamide (DAAM)

Application: DAAM is the monomer of various types of polyacrylate. Polyacrylate is a polymer with a superabsorbent capacity. When a liquid is added to this substance, the polymer can absorb to 1000 times its own volume of pure water. A jellylike solid mass is produced with a much higher density than the added liquid. The best-known application of polyacrylate is the filling of nappies and sanitary pads as retainer for the urine or blood; the substance is also used in applications including potting compost, cosmetic products, cable sleeves, shoes, water-based coatings, binder for 'latex' interior and exterior household paints, acrylic resin as pressure-sensitive adhesive, PlexiglasPlexiglas, and film former in cosmetic products.

Origin: unknown

Distribution of contamination: DAAM exceeded the ERM target value once at Keizersveer.



Chloroethylene (vinyl chloride)

Application: Vinyl chloride is the monomer of polyvinyl chloride (PVC), a widely used thermoplastic polymer.

Origin: unknown

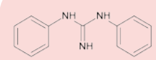
Distribution of contamination: Vinyl chloride was detected above the ERM target value at Namêche and Eijsden.

Non-ionic detergents

Application: Non-ionic detergents, or non-ionogenic surfactants, are present in washing and cleaning agents, such as washing up liquid, dishwasher tablets, washing powder, bleach and drain unclogger.

Origin: Non-ionic detergents were detected at the ERM target value at Keizersveer.

Distribution of contamination: Non-ionic detergents probably end up in the surface water via sewerage systems.

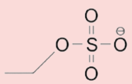


1,3-Diphenylguanidine (DPG)

Application: DPG is used as primary and secondary catalyst in the vulcanisation of rubber. It also serves as catalyst in the synthesis of sulphur-containing compounds, such as thiols, thiazoles, sulphonamides and thiurams.

Origin: unknown

Distribution of contamination: DPG was detected at the ERM target value at Roosteren.



Ethyl sulphate

Application: Ethyl sulphate, also known as sulfovinic acid and ethyl hydrogen sulphate, is an organic chemical compound that is used as intermediate product in the production of ethanol from ethylene. It is the ethyl ester of sulphuric acid.

Origin: unknown

Distribution of contamination: Ethyl sulphate was detected at a concentration equal to the ERM target value at Roosteren.

Substances with a drinking water standard

There are several substances that have an ERM target value as well as a drinking water standard. In the past, we did not report about these substances, given that the ERM target value is intended for substances without a drinking water standard. One exception is the category Plant protection products, biocides and their metabolites: these are tested against the ERM target value, which is equal to the standard for drinking water (and in the Netherlands also equal to the standard for surface water from which drinking water is made). From now on, all substances will be tested against their ERM target value, even if they have a drinking water standard. In 2021, breaches of the ERM target values took place for:

- chlorinated hydrocarbons: 1,2-dichloroethane, tetrachloroethene (PERC), sum of tetra- and trichloroethene
- sum of trihalomethanes
- polycyclic aromatic hydrocarbons (PAH): fluoroanthene, phenanthrene, pyrene, PAH (sum of 16 from EPA), PAH (sum of 10).

Pharmaceuticals and endocrine disrupting chemicals (EDC's)

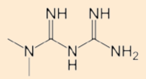
In 2021, 69 parameters exceeded the ERM target values one or more times. 21.7% of the cases concerned pharmaceuticals and endocrine-disrupting chemicals (15). Of the 848 samples that were taken for these 15 substances, 134 (15.8%) exceeded the ERM target value.

Table 5: Residues of drugs and endocrine-disrupting substances that exceeded the ERM target value in 2021 (maximum concentrations)

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Pharmaceuticals and Endocrine Disrupting Chemicals (EDCs)																134	848	15,8%
Diaminomethylideneurea	141-83-3	1	µg/L					1,5	1,3	0,59		1,5	1,7	1,8		24	39	61,5%
Vigabatrin	60643-86-9	0,1	µg/L					0,55		0,81			0,57	0,68	0,55	14	44	31,8%
valsartan acid	164265-78-5	0,1	µg/L					0,085		0,084			0,15	0,18	0,23	14	44	31,8%
Metformin	657-24-9	1	µg/L		2,26	2,21		1,6		1,1	0,85		0,86	0,95	0,75	25	94	26,6%
N-formyl-4-aminoantipyrine (FAA)	1672-58-8	0,1	µg/L					0,01		0,011	0,074		0,097	0,071	0,23	12	57	21,1%
Theobromine	83-67-0	0,1	µg/L					0,12		0,26			0,1	0,11	0,1	9	44	20,5%
N-acetyl-4-aminoantipyrine (AAA)	83-15-8	0,1	µg/L					0,022		0,025	0,074		0,061	0,049	0,16	11	57	19,3%
ER-Calux in 17beta-estradiol equivalents		0,25	ng/L		0,27	0,39		0,17		0,34	0,122	0,171	0,27	0,28	0,19	8	63	12,7%
paracetamol	103-90-2	0,1	µg/L					0,16		0,3			0,1	<0.02	0,061	4	44	9,1%
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	0,1	µg/L				<1		<1	<1	<0.5		1,2		<1	1	12	8,3%
candesartan	139481-59-7	0,1	µg/L					0,016		0,012	0,084		0,059	0,062	0,13	3	57	5,3%
Lamotrigine	84057-84-1	0,1	µg/L		0,0636	0,0655		0,079		0,087	0,077		0,1	0,1	0,1	4	83	4,8%
valsartan	137862-53-4	0,1	µg/L		0,0957	0,088		0,052		0,068	0,052		0,097	0,047	0,12	3	83	3,6%
Amantadine	768-94-5	0,1	µg/L					<0.005		<0.005			0,005	0,007	0,11	1	44	2,3%
Tramadol	27203-92-5	0,1	µg/L		0,092	0,1039		0,087		0,084	0,061		0,067	0,073	0,044	1	83	1,2%

ERM-sw = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Luik, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, HEU = Heusden, BRA = Brakel, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.
In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of samples.

Antidiabetic drugs



Metformin

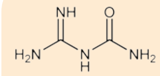
Application: Metformin is an antidiabetic drug, a medication to lower the blood sugar. It belongs to the most-produced drugs in the world as regards production volume [Scheurer et al., 2009]. Doctors prescribe metformin not only for diabetes mellitus but sometimes also for reduced fertility caused by a deformity of the ovaries (Polycystic Ovary Syndrome, PCOS). In Belgium, 258 medications with this active substance are approved [source: fagg-afmps.be]. In 2020, metformin, with a total of 155,175,400 DDD[5] (Glucient®), stood in the 11th place of most-prescribed medications in the Netherlands [source: gipdatabank.nl]. Metformin is not available over the counter. Metformin is also present in position 341 (Janumet®, 1,525,900 DDD) and 374 (Eucreas®, 1,151,400 DDD).

Origin: As medication, the substance finds its way into the surface water via the sewerage systems, as a result of human excretion.

Distribution of contamination: Metformin was detected above the ERM target value in 2021 at the measurement points Namêche, Luik (Liège), Roosteren and Heel. The indicative drinking water target value for metformin is 196 µg/L.

Noteworthy: The primary breakdown product of metformin is guanyl urea, which is not broken down further by bacteria or under the influence of light in aerobic conditions [Trautwein and Kümmerer, 2011 in Derksen and Ter Laak, 2013].

5 *Defined daily dose*



Guanyl urea

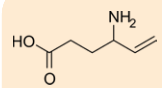
Application: None. Guanyl urea is a breakdown product of metformin.

Origin: In surface water, introduced metformin breaks down into guanyl urea, after which no further breakdown happens. Guanyl urea is indeed well broken down by passage through soil.

Distribution of contamination: Guanyl urea was detected above the ERM target value in 2021 at the measurement points Roosteren, Stevensweert, Heusden, Keizersveer and Bergsche Maas. Guanyl urea has an indicative drinking water target value of 22.5 µg/L.

Noteworthy: The breakdown product guanyl urea has a lower indicative drinking water target value than the parent substance metformin.

Medications for epilepsy and depression

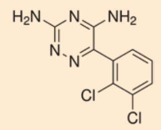


Vigabitrin

Application: Vigabitrin is a substance that brings overstimulated nerves in the brain to rest in epilepsy. It is one of the last therapeutic options, because it is less safe and is less well tolerated than other antiepileptic drugs (source: Farmacotherapeutisch Kompas).

Origin: After administration, this substance is excreted by the body, and finds its way into the surface water via sewerage systems.

Distribution of contamination: Vigabitrin was detected above the ERM target value at Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet.



Lamotrigine

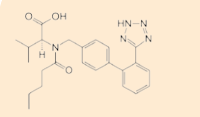
Application: Lamotrigine is a substance that brings overstimulated nerves in the brain to rest in epilepsy and manic depression (bipolar disorder). Sometimes also in nerve pain, in post-traumatic stress disorder (PTSD), in complex regional pain syndrome (CPRS, also called post-traumatic dystrophy), singultus (hiccups), muscle cramps and in the treatment of breast cancer to combat hot flushes.

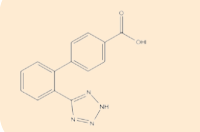
Origin: After administration, this substance is excreted by the body and finds its way into the surface water via sewerage systems. In 2020, Lamotrigine was at position 188 in the top 500 of the most prescribed medications in the Netherlands with 6,007,500 DDD.

Distribution of contamination: Lamotrigine was detected at the ERM target value at Keizersveer and Haringvliet.

Noteworthy: no clear trend is observable.

Medications for cardiovascular diseases





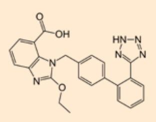
Valsartan and valsartan acid

Application: Valsartan is a medication in the category angiotensin II receptor antagonists (AIIRAs). It lowers the blood pressure and improves the pumping force of the heart and is prescribed for high blood pressure, heart failure and after a cardiac infarct. In 2020, valsartan was in positions 79 (Diovan®, 23,169,600 DDD), 185 (Codiovan®, 6,078,800 DDD), 220 (Entresto®, 4,440,400 DDD), 283 (Exforge®, 2,627,300 DDD) and 290 (Exforge HCT®, 2,467,800 DDD) in the top 500 of the most-prescribed medications in the Netherlands [source: gipdatabank.nl].

Origin: After administration, this substance is excreted by the body and finds its way into the surface water via sewerage systems.

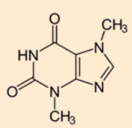
Distribution of contamination: Valsartan exceeded the ERM target value in samples taken at Haringvliet. The breakdown product valsartan acid exceeded the ERM target value in samples taken at Keizersveer, Bergsche Maas and Haringvliet.

Noteworthy: Valsartan was in the news in 2017 and 2018 thanks to large-scale recalls of medication by pharmacists worldwide. Blood pressure lowering drugs in the sartans group contain elevated concentrations of carcinogenic nitrosamines, including N-Nitroso-dimethylamine (NDMA) and N-Nitrosodiethylamine (NDEA). After the discovery, a study was initiated immediately to investigate the cause of the presence of this contaminant. This study led to the recommendation to permit no measurable quantity of nitrosamines in sartans.



Candesartan

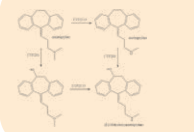
Application: Candesartan belongs to the angiotensin II antagonists (AIIRAs). It lowers the blood pressure. Doctors prescribe it for high blood pressure and for heart failure. In 2020, candesartan appeared twice in the top 500 of the most prescribed medications in the Netherlands: at number 30 with 64,390,100 (Atacand ®) and at number 209 with 4,953,000 DDD (Atacand plus ®).
Origin: After administration, this substance is excreted by the body, and finds its way into the surface water via sewerage systems.
Distribution of contamination: Candesartan was detected at levels above the ERM target value at Haringvliet.



Theobromine

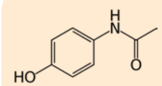
Application: Theobromine has a stimulating effect on the nervous system and heart muscle; it causes relaxation of the smooth muscles; it dilates blood vessels and promotes the excretion of urine. It is the substance that gives pure chocolate its bitter taste. Theobromine is poisonous to dogs.
Origin: unknown
Distribution of contamination: Theobromine was detected at levels above the ERM target value at Roosteren, Heel, Keizersveer, Bergsche Maas and Haringvliet.

Analgesics



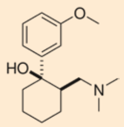
N-formyl-4-aminoantipyrine (FAA), N-acetyl-4-aminoantipyrine (AAA)

Application: N-formyl-4-aminoantipyrine (FAA) and N-acetyl-4-aminoantipyrine (AAA) are metabolites of antipyrene, a medication with analgesic and antipyretic effects, also known as phenazone.
Origin: Phenazone was synthesised for the first time by Ludwig Knorr in 1887 and was in use before 1911 as an animal genetic and fever-reducing medication. The dose was 5-20 g, but due to its depressive action on the heart and the toxic effects it gave rise to occasionally, it was replaced.
Distribution of contamination: FFA and AAA exceeded the ERM target value in samples taken at Haringvliet. AAA has an indicative drinking water target value of 10 µg/L.



Paracetamol

Application: Paracetamol is an over-the-counter analgesic and antipyretic drug. The name paracetamol is derived from the chemical name para-acetyl aminophenol.
Origin: After administration, this substance is excreted by the body and finds its way into the surface water via sewerage systems.
Distribution of contamination: Paracetamol exceeded or equalled the ERM target value in samples taken at Roosteren, Heel and Keizersveer.



Tramadol

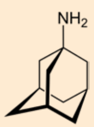
Application: Tramadol is a medium to strong analgesic that is prescribed for sudden or long-term severe pain, such as after injury, surgery or due to cancer, and for nerve pain and joint pain caused by osteoarthritis. It can also help in premature ejaculation if other medicines do not work [source: apotheek.nl]. Tramadol is a morphine-like synthetic opioid but does not come under the Opium Act.

Origin: After administration, this substance is excreted by the body and finds its way into the surface water via sewerage systems. In 2020, tramadol appeared twice in the top 200 of the most prescribed medications in the Netherlands: at number 132 with 11,249,200 DDD (Tramagetic®) and at number 170 with 7,275,700 DDD (Zaldiar®).

Distribution of contamination: Tramadol exceeded the ERM target value at Luik (Liège).

Noteworthy: In recent years, the substance has appeared with some regularity in the sports news, and then mainly in connection with its large-scale use in competitive cycling.

Medication for Parkinson's disease



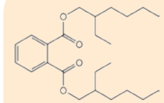
Amantadine

Application: Doctors prescribe amantadine for Parkinson's disease and for movement disorders caused by medication.

Origin: After administration, this substance is excreted by the body and finds its way into the surface water via sewerage systems.

Distribution of contamination: Amantadine exceeded the ERM target value at Haringvliet.

Endocrine-disrupting chemicals



Bis(2-ethylhexyl) phthalate

Application: Bis(2-ethylhexyl) phthalate, (also called di(2-ethylhexyl) phthalate or DEHP) is used as plasticiser in the production of PVC, as hydraulic fluid, as dielectric in capacitors and as a solvent in organic chemistry. Plastics contain an average of around 1 to 40% of DEHP.

Origin: use of plasticisers in plastic, adhesive, ink, hydraulic fluid etc.

Distribution of contamination: DEHP exceeded the ERM target value in samples taken at Keizersveer, just as in 2020 and 2019. DEHP was detected above the ERM target value at Brakel in 2017 and in 2011 to 2014.

Noteworthy: DEHP is a priority hazardous substance in European water policy (Directive 2013/39/EU). In July 2017, DEHP was designated by the European Commission as an endocrine-disrupting chemical (EDC) and identified as a substance of very high concern (SVHC) according to Article 57(f) of REACH. On 17 December 2018, the European Commission decided that an end must come to the use of and trade in products with DEHP, dibutyl phthalate (DBP), benzyl butyl phthalate (BBP) and di-isobutyl phthalate (DIBP) in the European Union (EU Regulation No 2018/2005).

ER-CALUX®

Application: none (effect measurement).

Origin: CALUX® assays form a family of bioassays that make use of human or mammalian cells. They are genetically modified such that they produce light as a reaction to exposure to substances that induce a specific effect. A reporter gene (luciferase) is then transcribed into the cell nucleus and translated into an enzyme that produces light after administration of its substrate, luciferin. The amount of light produced is proportional to the activity of the substances to which the cells have been exposed and it is quantified in a luminometer.

Distribution of contamination: ER-CALUX® exceeded the ERM target value in samples taken at Namêche, Luik, Heel, Keizersveer and Bergsche Maas.

Noteworthy: The ERM target value for ER-CALUX® is very low, because the reference substance oestradiol (E2) already has endocrine-disrupting effects in the body at very low concentrations.

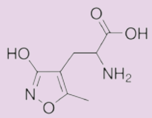
Plant protection products, biocides, and their metabolites

In 2021, 69 parameters exceeded the ERM target values one or more times. 21.7% (15) of the cases concerned plant protection products, biocides, and their metabolites. Of the 1,585 samples that were taken for these 15 substances, 213 (13.4%) exceeded the ERM target value.

Table 6: Plant protection products, biocides and their metabolites that exceeded the ERM target values in 2021 (maximum concentrations)

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Plant Protection Products, Biocides and their metabolites																213	1585	13,4%
Aminomethylphosphonic acid (AMPA)	1066-51-9	0,1	µg/L	0,163	0,382	0,41	0,526	2,2	1,93	1,9	1,09	1,58	1,1	1,2	0,5	113	126	89,7%
Chloridazon-desphenyl	6339-19-1	0,1	µg/L		0,173	0,178		0,19		0,27	0,18		0,25	0,24	0,25	66	82	80,5%
metolachloro-S-metabolite	171118-09-5	0,1	µg/L		0,091	0,101					0,11					7	37	18,9%
Propamocarb	24579-73-5	0,1	µg/L								0,069	0,36	0,069	0,13	0,064	7	91	7,7%
Glyphosate	1071-83-6	0,1	µg/L	<0.05	0,063	0,078	0,161	0,14	0,188	0,095	0,045	0,11	0,084	0,086	0,041	7	126	5,6%
metazachloro-S-metabolite	172960-62-2	0,1	µg/L		0,06	0,065					0,05		0,099	0,054	0,13	1	61	1,6%
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	0,1	µg/L	<0.01	<0.03	<0.03	0,01	0,024	0,18	0,14	0,03	0,03	<0.05	<0.02	<0.02	2	136	1,5%
Ethofumesat	26225-79-6	0,1	µg/L		0,171	<0.02		<0.02		0,043	0,03	0,06	0,045	<0.02	<0.02	1	78	1,3%
Metolachlor	51218-45-2	0,1	µg/L	0,034	0,134	0,073	0,047	0,087	0,0626	0,113	0,0311	0,03	0,0568	0,0139	0,0381	2	161	1,2%
Terbutylazine	5915-41-3	0,1	µg/L	0,02	0,111	0,053	0,0427	0,11	0,0552	0,039	0,0443	0,04	0,0498	0,0163	0,0565	2	161	1,2%
Propiconazole	60207-90-1	0,1	µg/L				0,175		0,0824	0,035	0,00993		0,0308	0,0277	0,0117	1	82	1,2%
Dimethenamid	87674-68-8	0,1	µg/L	0,068	0,112	0,084					0,045	0,046				1	88	1,1%
Prosulfocarb	52888-80-9	0,1	µg/L								0,05	0,23	<0.05	0,084	<0.05	1	91	1,1%
Nicosulfuron	111991-09-4	0,1	µg/L	0,406	<0.03	<0.03		<0.02		0,022	<0.05	<0.05	<0.02	0,022	0,02	1	132	0,8%
Metamitron	41394-05-2	0,1	µg/L	<0.015	0,115	<0.025		<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1	133	0,8%

ERM-sw = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Luik, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, HEU = Heusden, BRA = Brakel, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.
In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of samples.



Aminomethylphosphonic acid (AMPA)

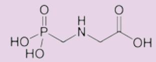
Application: none (metabolite).

Origin: The substance is a metabolite of glyphosate. In a measurement programme in 2010, a major source of AMPA was discovered that did not have its source in the use of glyphosate. High concentrations of AMPA were measured in the Ur side branch, which flows into the Grensmaas (Border Meuse) at Stein. The AMPA in the water of the Ur side branch is a breakdown product of ATMP (aminotrismethylenephosphonic acid) which is added to cooling water somewhere on the nearby Chemelot chemistry industrial estate. The majority of the AMPA burden increase between Eijsden and Keizersveer in 2010 could however be explained by the use of glyphosate and mainly outside agriculture.

Distribution of contamination: Aminomethylphosphonic acid (AMPA) was detected at above the ERM-target value at all measuring points. The Netherlands government considers AMPA to be a metabolite of a crop protection agent toxicologically irrelevant to humans. Since 2011, the Netherlands government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material to produce drinking water [Dutch Drinking Water Regulation 2011]. Since April 2020, a list of metabolites of plant protection products toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was exceeded in 2021 at the measurement points Roosteren, Stevensweert, Heel, Heusden, Brakel and Keizersveer.

Noteworthy: On average in 2010, the Ur side branch accounted for 34% of the AMPA burden increase between Eijsden and Keizersveer [Volz, 2011]. An exemption was temporarily granted to WML (2017), Evides (2017) and Dunea (2018) to allow them to continue to use surface water containing AMPA at Heel, Brakel and Keizersveer (Gat van de Kerksloot) to produce drinking water.

Glyphosate



Application: Glyphosate is an herbicide.

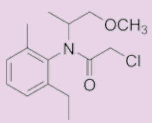
Origin: Although most of the quantities sold are applied in agriculture, we know from practical investigations and measurement programmes in the past that emissions of glyphosate into the Meuse mainly originate from sources outside agriculture. This was confirmed by calculations of burdens of emissions that were conducted in 2010 for the Netherlands part of the Meuse river bed: 1.5% of the burden comes from agricultural use and 98.5% via rainwater drains, overflows and effluents from sewage treatment plants (STPs) [source: Klein et al., 2013].

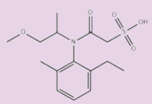
Distribution of contamination: The ERM target value for glyphosate was exceeded at measurement points Eijsden, Roosteren, Stevensweert and Heusden.

Noteworthy: In 1994, the drinking water companies demonstrated the presence of the herbicide glyphosate in the Netherlands section of the Meuse for the first time, and from 1996, the ERM target value was exceeded every year. Particularly in the period 2002-2005, the average concentration of glyphosate in the Meuse Rose to above 0.1 µg/L. In 2021, the ERM target value – also the quality requirement in the Netherlands Drinking Water Regulation and the Decree on Quality Requirements and Monitoring Water (BKMW) – was exceeded in 7 of the 126 samples(5.6%) at the monitoring points along the Meuse. The ERM target value has not been exceeded at Tailfer for years, which means that very little glyphosate from France ends up in the Meuse. In 2018, an exemption was granted to WML and Evides to allow them to continue to use surface water containing glyphosate at Heel and Keizersveer (Gat van de Kerksloot) to produce drinking water.

Desphenyl chloridazon

Application: none (metabolite).
Origin: metabolite of chloridazon (herbicide).
Distribution of contamination: The metabolite desphenyl chloridazon was detected above the ERM target value at Namêche, Luik (Liège), Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. The Netherlands government considers desphenyl chloridazon to be a metabolite of a crop protection agent toxicologically irrelevant to humans. Since 2011, the Netherlands government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material for the production of drinking water [Dutch Drinking Water Regulation 2011]. Since April 2020, a list of metabolites of plant protection products toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was not exceeded.
Noteworthy: Desphenyl chloridazon is detected in groundwater in many North European countries.



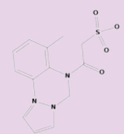


Metolachlor; metolachlor-ESA (metabolite)

Application: In the Netherlands, S-metolachlor is approved as an herbicide in the cultivation of various fruit and vegetables. It is the active substance in the plant protection products Camix (NL, BE), CODAL (BE), Dual Gold 960 EC (NL, BE), EFICA 960 EC (NL, BE), Gardo Gold (NL, BE), GARDOPRIM (BE), LECAR (BE) and PRIMAGRAM GOLD (BE) (source: Ctgb.nl, Fytoweb.be).
Origin: The drinking water companies' laboratory analysis methods present metolachlor as the racemic mixture of the R- and S-isomers[6].

6 The designations R- and S- are abbreviations of the Latin words rectus (right) and sinister (left).

Distribution of contamination: Metolachlor was detected above the ERM target value at Namêche and Heel. The concentration of the metabolite metolachlor-ESA exceeded the ERM target value at Luik and Brakel. The Netherlands government considers metolachlor-ESA to be toxicologically irrelevant to humans. Since 2011, the Netherlands government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material to produce drinking water [Dutch Drinking Water Regulation 2011]. Since April 2020, a list of metabolites of plant protection products toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was not exceeded.
Noteworthy: As of 30 November 2002, the racemic mixture of R-and S-isomers of metolachlor is no longer approved in the European Union (Regulation No 2002/2076/EC). The active substance S-metolachlor[7] was added on 1 October 2005 to Annex I of Directive 91/414/EEC pursuant to Directive 2005/5/EC. The active substance was then approved in accordance with Regulation (EC) No 1107/2009 by Implementing Regulation (EU) 540/2011. The term of the approval of the substance was extended until 31 July 2020 by Implementing Regulation (EU) 2019/707.

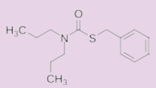


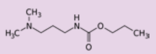
Metazachlor-S-metabolite

Application: none (metabolite).
Origin: The parent substance metazachlor is approved in the Netherlands as an herbicide in the plant protection products Butisan S, Imex-Metazachloor-500, Springbok and Sultan 500 SC [source: Ctgb.nl]. In Belgium, there are approvals for the following plant protection products based on metazachlor: BUTISAN GOLD, BUTISAN PLUS, BUTISAN S, FUEGO, METAROCK, RAPSAN 500 SC, RAPSAN TDI, RAPSAN TURBO, SPRINGBOK, SULTAN 500 SC, SULTAN TOP and TORSO.

7 the mixture of 80-100% S-metolachlor and 0-20% R-metolachlor

Distribution of contamination: Metazachlor-S-metabolite was detected over the ERM target value at measuring point Haringvliet (and at Keizersveer, just under that value). The Netherlands government considers this metabolite to be toxicologically irrelevant to humans. Since 2011, the Netherlands government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material to produce drinking water [Dutch Drinking Water Regulation 2011]. Since April 2020, a list of metabolites of plant protection products toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was not exceeded.





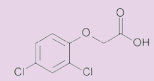
Prosulfocarb; propamocarb

Application: Prosulfocarb is the active substance in some herbicides. In the Netherlands, agents based on prosulfocarb are no longer approved, but in the past, the herbicide Boxer, with prosulfocarb as active substance, was approved for winter wheat and barley. In Belgium, herbicides based on prosulfocarb are approved under brand names such as ADELFO, DEFI, FIDOX, FIDOX EC, JURA, ROXY 800 EC, ROXY EC and SPOW (source: Fytoweb.be). Propramocarb is a fungicide that is used in agriculture in the cultivation of various vegetables, types of lettuce, tomatoes, potatoes, and house plants, to combat false mildew, phytophthora and pythium. In Belgium, many plant protection products based on the active substance propamocarb are approved: AXIDOR, BORESO FLEX, CUROMIL 450 SC, DIPROSPERO, EDIPRO, INFINITO, MATIX, OMIX (DUO), POTAGOLD 687.5 SC, PREVICUR ENERGY, PROFO ENERGY, PROPLANT, PROXANIL (GARDEN), PROXSTORM, RIVAL (DUO), VSM FINITO and WOPRO ENERGY. In the Netherlands, only Budget Propamocarb-Fosetyl is approved.

Origin: see Part A2.1. Example of incident with successful tracking

Distribution of contamination: Propamocarb exceeded the ERM target value at Heusden and Bergsche Maas. Prosulfocarb exceeded the ERM target value at Heusden.

Noteworthy: see Part A2.1. Example of incident with successful tracking



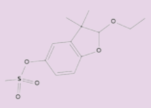
2,4-Dichlorophenoxyacetic acid (2,4-D)

Application: 2,4-Dichlorophenoxyacetic acid (2,4-D) is the active substance in an herbicide that was discovered in 1942 and came on to the market in 1944 (source: Wikipedia). The active substance 2,4-D was extended as of 1 January 2016 pursuant to Regulation (EC) No 1107/2009 (Implementing Regulation (EU) 2015/2033 dated 13 November 2015). The approval of the active substance expires on 31 December 2030. In Belgium, 2,4-D is approved as herbicide in the plant protection products CIRRAN, CIRRAN EXTRA, DAMEX FORTE SUPER, DICOTEX, FLORANID TURF + HERBICIDE, GENOXONE, KYLEO, LANDSCAPER PRO WEED CONTROL + FERTILIZER, TRIBEL XXL and U-46-D-500 (source: Fytoweb.be]

Origin: 2,4-D is mainly used to control broad-leaved weeds in grain crops (such as barley and maize) and on grass fields and lawns.

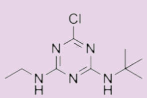
Distribution of contamination: 2,4-D was detected over the ERM target value once at Stevensweert and Heel.

Noteworthy: 2,4-D was detected over the ERM target value once in 2019 at Luik (Liège). In 2012, 2,4-D was detected above the ERM target value (once) at Keizersveer. Before that, the last time that 2,4-D exceeded the ERM target value was in 2008, when this happened three times at Keizersveer.



Ethofumesate

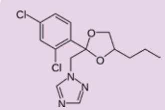
Application: Ethofumesate is an herbicide that is used in the cultivation of vegetables and grasses. In the Netherlands, BETANAL Tandem, Ethofol 200 EC, Goltix Super, Metafol Super, Oblix 500 SC, Powertwin and Tramat (200, 500), all based on ethofumesate, are approved. In Belgium, various plant protection products with ethofumesate are approved: BELVEDERE DUO, BETANAL TANDEM, BURAK 500 SC, CRISTOBAL 500, ETHOFOL 200 EC, ETHOMAT 500, ETHOSIN FORTE SC, KEMIRON SC, METAFOL SUPER, MURENA 500, OBLIX 500 SC, POWER TWIN, TORERO and TRIADE TWIN. These agents have applications in the cultivation of chicory, English ryegrass, green-harvested peas, Italian ryegrass, red beet, soya/edamame, spinach, common beans, sugar beet, tobacco, Timothy grass, feed beet and chard.
Origin: Emissions during/after use of this substance in agriculture (field wash off, drift etc.)
Distribution of contamination: Ethofumesate was detected above the ERM target value once at Namêche.



Terbuthylazine

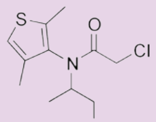
Application: The approvals of terbuthylazine in the Netherlands are all in combination with other active substances (mesotrione, s-metolachlor and sulcotrione): these are used as herbicide in the cultivation of grain maize, corn silage, corncob silage and corncob mix [source: Ctgb.nl]. It is contained in the plant protection products Calaris, Callistar, CLICK PREMIUM, Click Pro, Gardo Gold and Sulcotrek. In Belgium, agents based on this substance are also approved in maize cultivation, sometimes in combination with S-metolachlor or flufenacet also in elephant grass [source: Fytoweb.be]. It is contained in the plant protection products AKRIS, ANDES, ASPECT T, CALARIS, CALLISTAR, CLICK PREMIUM, CLICK PRO, GARDO GOLD, GARDOPRIM, PRIMAGRAM GOLD and PROMESS.
Origin: Emissions during/after use of this substance in agriculture (field wash off, drift etc.)
Distribution of contamination: Terbuthylazine was detected at concentrations above the ERM target value at Namêche and Roosteren.
Noteworthy: Terbuthylazine was previously detected above the ERM target value:

- in 2020 at Roosteren
- in 2019 at Luik, Brakel and Keizersveer
- in 2018 at Keizersveer
- in 2016 at Heel and Keizersveer
- in 2014 at Namêche, Luik, Heel and Heusden
- in 2013 at Brakel and Keizersveer
- in 2012 at Luik, Heel, Brakel, Heusden, and Keizersveer.



Propiconazole

Application/origin: Propiconazole is a fungicide that was used in agriculture and horticulture in the cultivation of grain crops and grass seed, to combat yellow or brown rust and true mildew. In Belgium, there are no authorisations in agriculture or horticulture. In the Netherlands, there are presently only authorisations as biocide in fungicidal paints and immersion baths.
Origin: Emissions during/after use of this substance in agriculture (field wash off, drift etc.)
Distribution of contamination: Propiconazole was detected just over the ERM target value once at Eijsden.



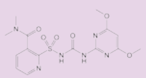
Dimethenamide

Application: Dimethenamide (CASRN 87674-68-8) is an herbicide.

Origin: Based on Implementing Regulation (EU) 2019/1137, dimethenamide-P will remain on the list of approved active substances until 31 August 2034. In Belgium, the following plant protection products based on dimethenamide-P (CASRN 163515-14-8) are approved: Akris, Arundo, Butisan Gold, Frontier Elite, Grometa, Springbok and Tanaris [source: Fytoweb.be]. In the Netherlands, the following plant protection products based on dimethenamide-P are approved: Frontier Optima, Spectrum, Springbok, Tanaris, Wing P and WOPRO Ui-schoon [source: Ctgb.nl]. These plant protection products may be applied to many arable crops (vegetables, fruit etc,) and in floriculture in both countries. In the Netherlands, Frontier Optima may also be used on field verges and on temporarily uncultivated land.

Distribution of contamination: Dimethenamide was detected above the ERM target value once at Namêche.

Noteworthy: The drinking water companies' laboratory analysis methods usually present dimethenamide as a mix of isomers; the S-isomer dimethenamide-P was reported only once.

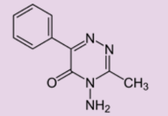


Nicosulfuron

Application: Nicosulfuron is an herbicide that is used in the cultivation of maize. In Belgium, various plant protection products containing nicosulfuron are approved: ACCENT, CHORISTE, COYOTE, DINIRO, DUCEL, ELUMIS, FORNET (40 OD, EXTRA 60 OD), IKANOS, NIC-4, NICOGAN 40 SC, NICOSH, NICOSTORM 40 OD, NISHA, SAMSON (40 OD, EXTRA 60 OD), SPANDIS, STRETCH, TALISMAN 40 OD and VICTUS OD. In the Netherlands, the following plant protection products based on this active substance are approved: ACCENT, ACCENT 40 OD, Diniro, Elumis, Ikanos, Milagro, MILAGRO (40, EXTRA 60D), Nicosh 4%SC, SAMSON (4SC, Extra 6% OD), Spandis and Victus OD.

Origin: Emissions during/after use of this substance in agriculture (field wash off, drift etc.)

Distribution of contamination: Nicosulfuron was detected well above the ERM target value once at Tailfer.



Metamitron

Application: Metamitron is an herbicide that is used in sugar beet and feed beet cultivation and in the cultivation of flower bulbs and bulb flowers (tulips, narcissi, irises, and lilies), or as a growth regulator in fruit cultivation. In the Netherlands, the following products based on metamitron are approved: AAKO (Goltix 70 WG, GOLTIX 700 SC), BEAVER 15 SG, BETTIX SC, Brevis, GLOTRON 700 SC, Goltix Queen, Goltix SC, Goltix Super, Goltix WG, KEZURO, Metafol Super, NYMEO and REVENGE. In Belgium, only Brevis is approved as a growth regulator.

Origin: Emissions during/after use of this substance in agriculture (field wash off, drift etc.)

Distribution of contamination: Metamitron was detected above the ERM target value once at Namêche.

C

Climate change and water availability

The water quality of the Meuse is associated with the water availability. How is the flow rate in the Meuse affected by climate change and extreme weather?

The four consecutive dry years (2017 to 2020) raised concerns among the drinking water companies along the Meuse. Earlier climate projections indicated that the low flow rate in the Meuse could be reduced by around 40% by 2040[8], and that the fact that such low flow rates would last for longer should be taken more into account[9].

IPCC report

This bleak picture was recently confirmed by the UN climate panel IPCC, which reports on climate change once every seven years. The second report in a series of three publications was recently published. In this, it is concluded that weather extremes will happen more often, and that the consequences of these extremes will be more serious to both humans and the environment than what was previously assumed. Additionally, the IPCC also states that risks related to a changing climate are expected to be even greater than what was previously anticipated[10].

Water balance

In 2021, Deltares developed a water balance model, based on the computer program RIBASIM to investigate how the flow rate in the Meuse will be affected by climate change. This was at the request of RIWA-Meuse in collaboration with Dunea, Evides, WML and Rijkswaterstaat Zuid-Nederland. In section C1, RIWA director Maarten van der Ploeg highlights the results of the project.

Use of the water balance

Section C2 offers an interview about the application of the water balance model with the Chair of the National Coordination Committee on Water Distribution (LCW), Harold van Waveren of Rijkswaterstaat.

8 *Report can be found in the following link: Deltares-wat-betekenen-de-nieuwe-klimaatscenario's-Voor de rivierafvoeren-van-Rijn-en-Maas?.("What do the new climate scenarios mean to the river flow rates of the Rhine and Meuse?")*
9 *Transboundary Water Management in a Changing Climate: Dewals, Benjamin (Proceedings of the Amice Final Conference, Sedan, France, 13-15 March 2013)*
10 *Kamerbrief-IPCC-rapport (Parliamentary letter on IPCC report)*

C1 Water balance model for 2021

Water balance model for insight, dialogue, and cooperation

Explanation by Maarten van der Ploeg: "The climate is changing; the situation is urgent. The question is: what does this actually mean for the Meuse? Will sufficient water of good quality remain available in the future to meet the rising water demand?

The drinking water sector wants more insight into the future water supply and into the use of Meuse water, especially during periods of drought and low water. The central question is, will we be able to continue to use the river into the future as a raw source for drinking water for the over 7 million people in the Netherlands and Belgium who are dependent on the Meuse for this?"

According to Maarten van der Ploeg, drinking water companies need to know exactly what is happening in order to be able to properly anticipate future changes in the Meuse River basin. The need for information is great. "We need to know about the water supply: how much water flows in the river, and how much water ends up in the Meuse via all the tributaries?

The same applies to the underlying drainage. We need to know what happens to groundwater after long periods of drought. What is the situation with the storage of the tributaries? We also need to know much more about water abstraction and the water usage in the Meuse basin. After all, these insights determine how much Meuse water will finally continue to flow".

Research

These questions were translated into a research commission to Deltares to develop an international water balance model: RIBASIM. This stands for River Basin Simulation Model. The research was largely conducted in 2021.

According to Maarten van der Ploeg, this model is an excellent tool to improve and drive dialogue amongst different stakeholders. "The discussion started even before the model was operational because we coordinated the points of departure with our colleagues in Flanders and the KU Leuven. The water balance provides insight and stimulates the dialogue and cooperation along the Meuse River basin. Even if you have different interests, you can still exchange information about shared subjects".

Explanation of the model

The water balance model for the Meuse consists of two components: on the one hand, water availability (based on historical flow data from nine different locations during the last 40 years), and on the other the water usage (information about water abstraction). What picture emerges from this analysis?

Maarten van der Ploeg: "The hydrological model shows that for almost all climate scenarios the situation is becoming more critical compared to the last 40 years. Deltares has made climate change calculations for four important locations: Chooz in France on the border with Wallonia; Monsin near Luik/Liège; the Dutch part of the basin around Borgharen between Maastricht and Roermond; and Megen that lies between Gelderland and Noord-Brabant. At all four of the selected locations, we see a declining trend, with longer periods of lower flow rates during summer periods. The extent to which this will happen depends on the scenario chosen: the more extreme the scenario, the lower the flow rate becomes, and the more long-lasting the period of low flow rates is".

He continues: "An important insight from the research is that the situation in the entire river basin will become more extreme than was expected. A clear picture emerges which shows that between one to two months, problems can arise with water supply for energy generation, shipping, agriculture, industry as well as drinking water supply. Given that water quality can deteriorate at lower flow rates, drinking water production from the Meuse as source is particularly vulnerable. Discharged wastewater streams are therefore less diluted, and pollution due to incidents remains present in the river water for longer periods of time. All this is amplified as a function of climate change".

Zooming in on four locations along the Meuse

In order to gain more insights into what low water could mean in the future, Deltares calculated average values for low and very low summer flow rates of the Meuse at four locations in France, Wallonia, Germany, and the Netherlands. This was based on the flow rate data for the river measured over 40 years.

These flow rate values were then combined with moderate, hot, and very dry climate scenarios[11] from the KNMI (Royal Netherlands Metrological Institute) for the years 2050 and 2085. These scenarios were based on the previous IPCC report from 2014. In 2023, new IPCC insights will be published (third report). It is expected that the scenarios will turn out even more extreme.

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The results from the water balance model then yield a picture of the possible impact of the different climate scenarios at four different locations along the international river basin of the Meuse.

1. France: situation at Chooz

Chooz lies on the boundary between France and Wallonia, where there is an EDF nuclear power station with two reactors, each of 1,500 MW. Water from the Meuse is used for cooling these reactors., International agreements[12] have stipulated that in order to protect the nature in the vicinity, power stations must stop the abstraction of cooling water at a long-term flow rate of 20 m^3 per second or less.

The shutting down of one or two reactors in the dry periods has already happened before. In 2020, the shutdown of the reactors lasted for 34 and 41 days respectively[13]. This had an immediate impact on the electricity supply in the region during that period.

11 KNMI scenarios

12 http://www.meuse-maas.be/CIM/media/Etiages-exc/Plan d%27approche dec 2020/Plan_approche_Mregie_19_21def_n.pdfPlan van Aanpak beheersing uitzonderlijk laagwater situaties Maas IMC (Plan of approach to manage exceptionally low water situations in the Meuse)

13 Source: EDF 2021

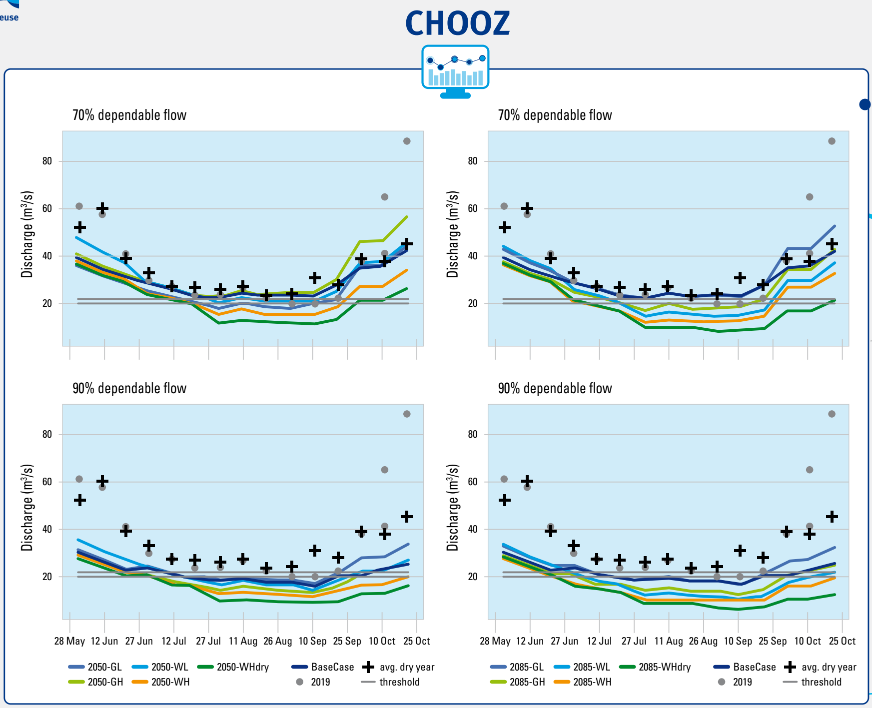
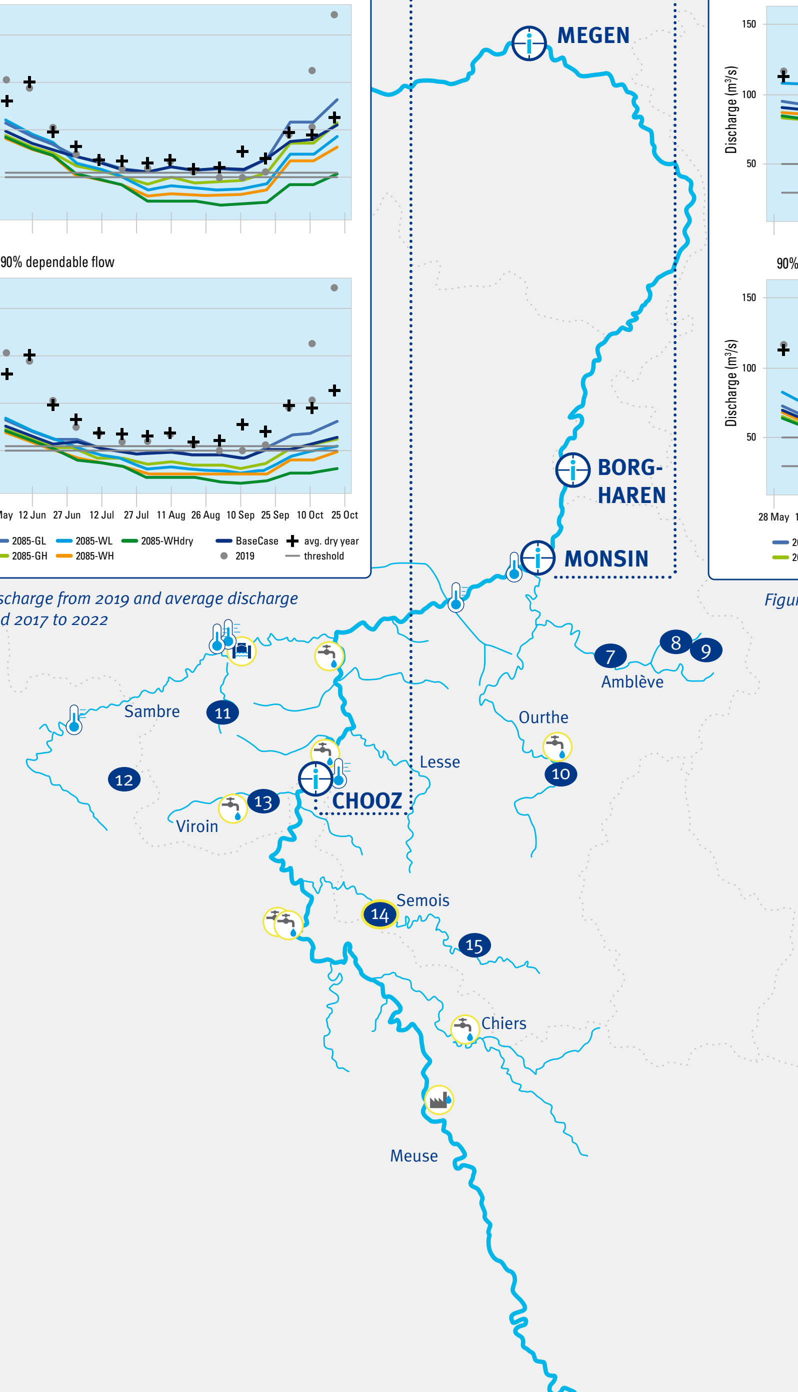


Figure 4 Dependable flow at Chooz for different scenarios, discharge from 2019 and average discharge of the drought years 2003, 2011 and 2017 to 2022



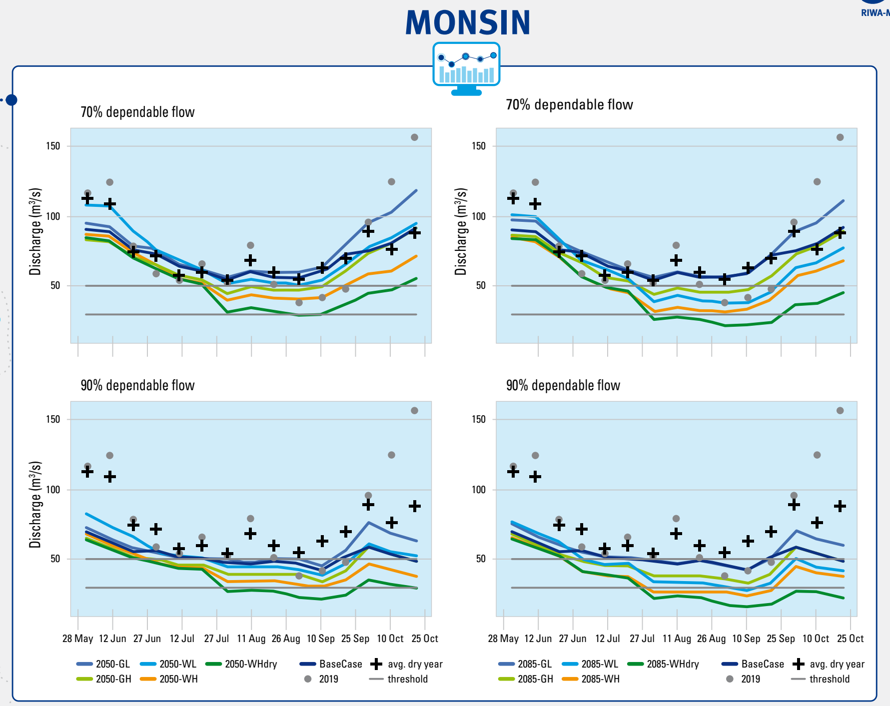


Figure 5 Dependable flow at Monsin for different scenarios, discharge from 2019 and average discharge of the drought years 2003, 2011 and 2017 to 2022

In the future, the suspension of the energy production could possibly increase from a few weeks to some months.

2. Belgium: situation at Monsin

Monsin in Liège is situated in Wallonia, at the point where the Meuse is connected to Antwerp via the Albert Canal. The Albert Canal is the source of 40 per cent of the drinking water that is supplied in Flanders. For low river flow rates, the Netherlands and Flanders have regulated agreements regarding the sharing of the Meuse water in the Maas-afvoerverdrag (Meuse Flow Rate Treaty). Problems with water availability arise when the flow rate drops to 50 m³ per second.

In the modelled scenarios, the problems with water availability could persist for a month or longer, and this would lead to water shortages for users of Meuse water in both Flanders and the Netherlands.

3. The Netherlands: situation at Borgharen

The area between Maastricht and Roermond is heavily dependent on the supply of water that is divided up at Monsin. Near Maastricht, the water of the Meuse flows into the Grensmaas (Border Meuse), the Juliana Canal and the Zuid-Willemsvaart. To the south of Roermond, drinking water company WML abstracts water to produce drinking water for around 280,000 people in Limburg.

A restricted supply of water results immediately in a deterioration in the quality of water. Due to this, WML is regularly obliged to stop the abstraction of Meuse water. In case of a long-term suspension of abstraction, it is necessary to switch to groundwater. This source is also under pressure.

Furthermore, this part of the river basin is intensively used by shipping, the Grensmaas has an important recreational and ecological role. Likewise, much industrial activities are concentrated in this area, including the Chemelot industrial estate at Sittard-Geleen.

14 Plan van Aanpak beheersing uitzonderlijk laagwater situaties Maas IMC (IMC Plan of approach to manage exceptionally low water situations in the Meuse)

RIWA
RIWA-Meuse

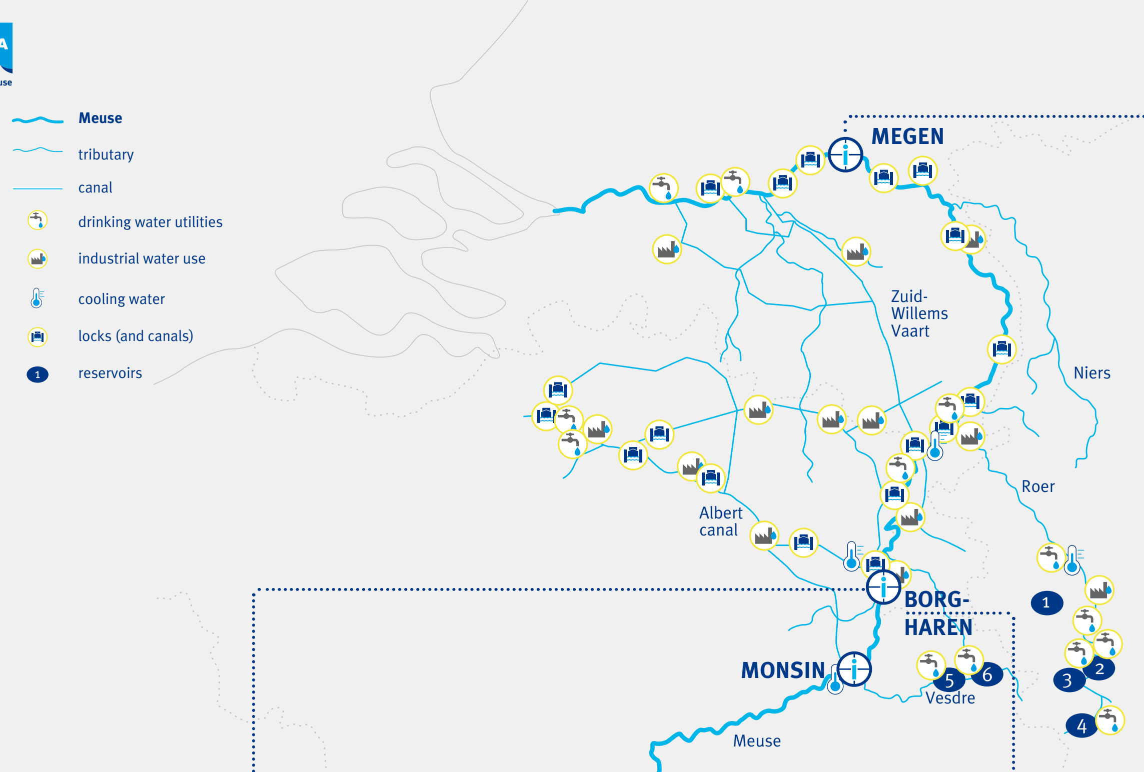
The multiplicity of functions and sectors that rely on the Meuse makes this area extra vulnerable to long periods of drought and low flow rates. Apart from the most moderate scenario, all the other scenarios reveal low to very low flow rates during periods between one to two months.

4. The Netherlands: situation at Megen

Megen lies between Noord-Brabant and Gelderland. From Roermond, the water of the Meuse is supplemented with water from the Rur, the Swalm and the Niers from Germany. During drought, the Rur makes a significant contribution to the Meuse's water in the Netherlands via storage reservoirs in the Eiffel. Climate change is causing a shift in the management of the storage reservoirs, which result in a reduction of flow rate in the Rur in the summer.

This is important for drinking water companies Dunea and Evides, who supply over 3.5 million people with drinking water prepared from Meuse water. In order to maintain the quality of drinking water, drinking water companies stop the abstraction of Meuse water in case of water quality deterioration resulting from incidents, low water or other causes. Depending on the water demand and the water reserves that are available, drinking water companies can tide over a period of four to six weeks while abstraction is on halt.

The elaboration of the climate scenarios for Megen, except for the most moderate scenario, reveals a declining trend for the river flow rate. With a rising water demand from various sectors, and a reducing supply from the Meuse and the Rur, the question is whether all water needs can be met in the future. The vulnerability of the drinking water supply increases due to the deterioration of the water quality as a result of low flow rates.



MEGEN

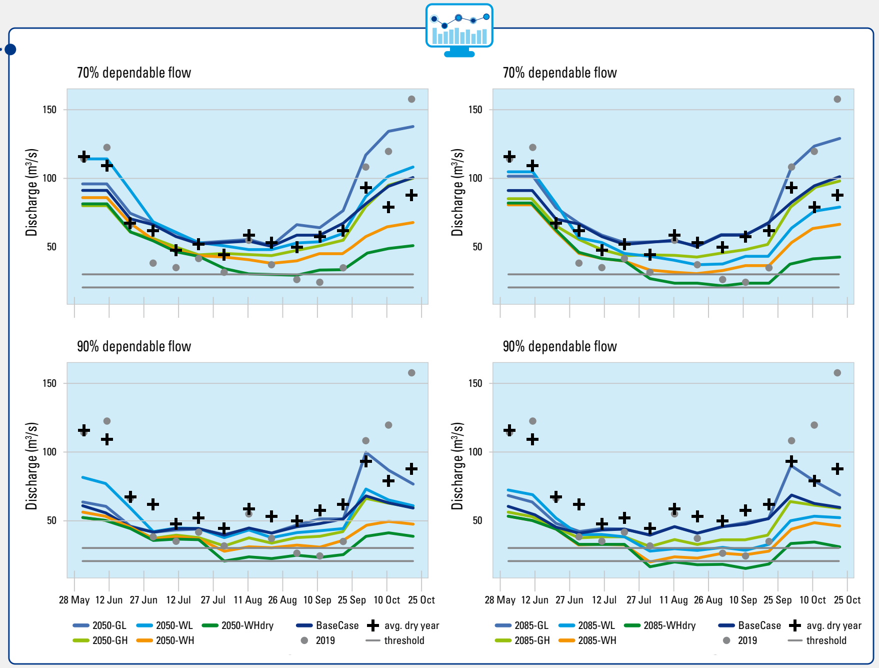


Figure 8 Dependable flow at Megen for different scenarios, discharge from 2019 and average discharge of the drought years 2003, 2011 and 2017 to 2022

BORGHAREN [COMMON MEUSE]

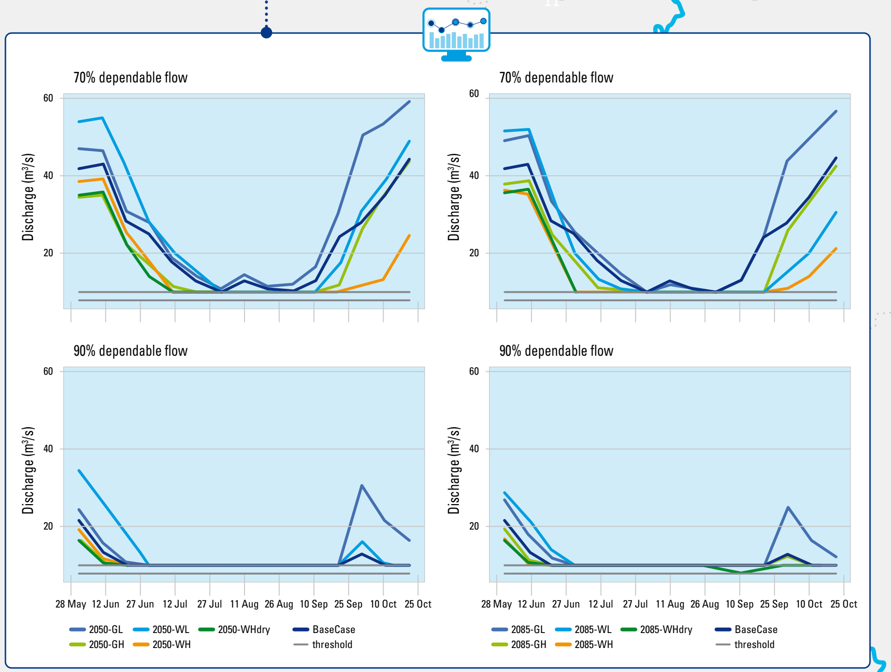


Figure 6 Dependable flow at Borgharen (Common Meuse) for different scenarios

BORGHAREN [JULIANA CANAL]

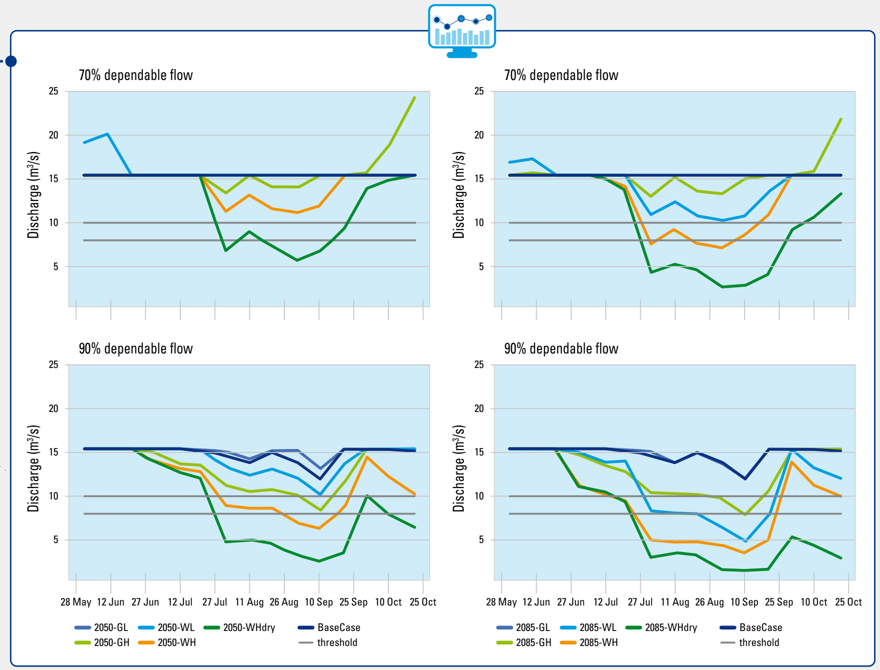


Figure 7 Dependable flow at Borgharen (Common Meuse and Juliana Canal) for different scenarios

Study of Meuse in relation to neighbouring countries

There is intensive study of the effects of climate change on water availability across the border too, although they use different mathematical models for it. Maarten van der Ploeg: “In Germany, France and Belgium, work is being done with different climate scenarios and local hydrological models elaborated in more detail. The intention behind the commission to Deltares was not to investigate which hydrological model or which climate scenario might scientifically be the most applicable in the context of the Meuse River basin. It was rather to allow a more general picture of the availability of water to be sketched out, as well as the future trends in the international river basin of the Meuse”.

Van der Ploeg states that: “To be able to deal actively with the politically sensitive subject of water availability and allocation, the model can also be employed to stimulate the dialogue with our neighbouring countries. For the coming years, significant financial investments are planned along the Meuse River basin, to safeguard the drinking water supply in times of water scarcity. When costly measures are implemented in various countries and in different sectors, it is sensible to know which measures are the most efficient, and how these measures possibly affect one another”.

Such an exercise demands an international scope. The water balance model can help to bring the border-spanning cooperation into action. For example, by conducting shared simulations with several extreme flow rate scenarios, in order to gain insights as to where the problems arise. It is then possible to consider jointly with what allocation, will the least problems arise taking into account the entire river basin”.

C2 Water balance in practice - Interview

Rijkswaterstaat

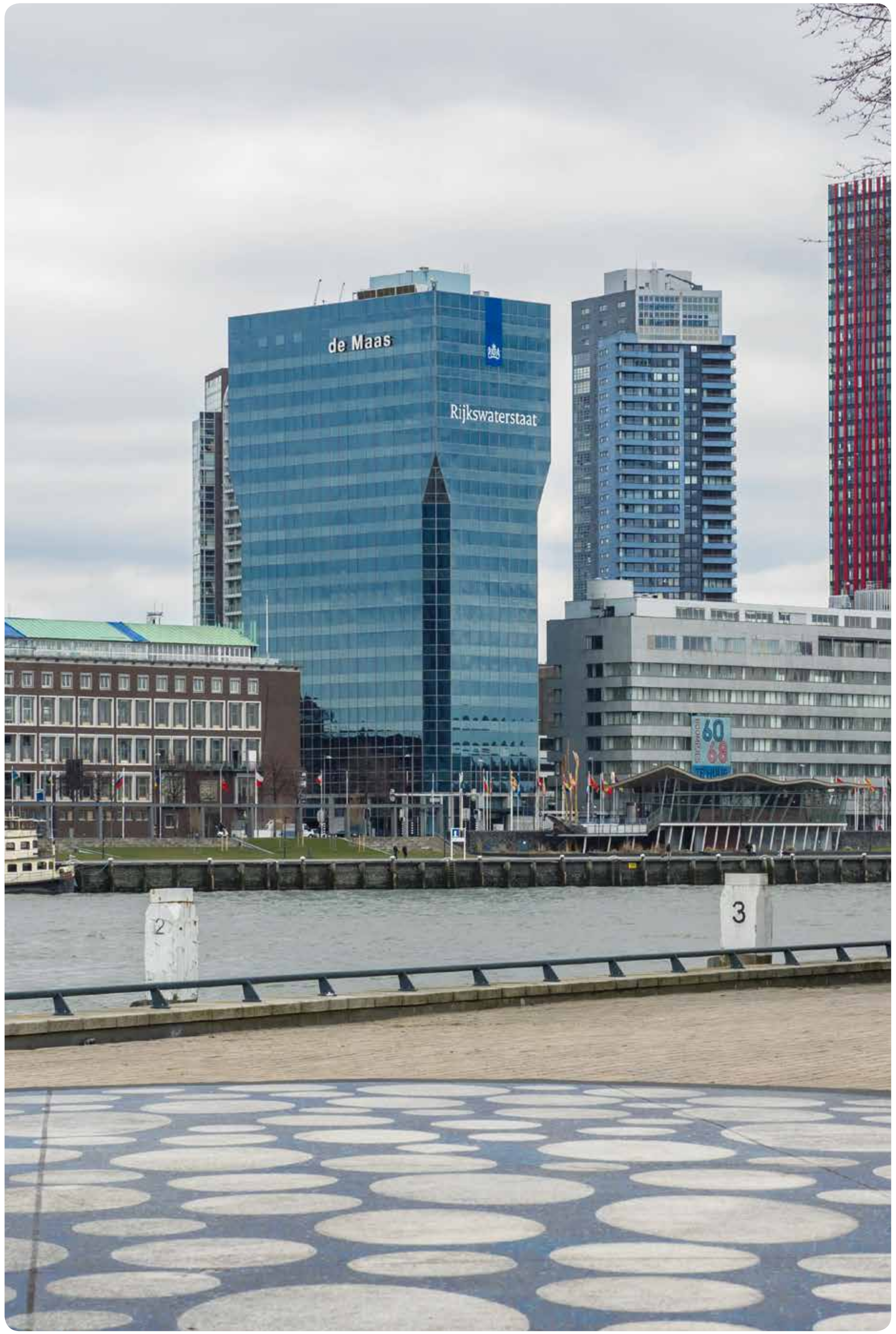
Harold van Waveren (LCW) on the international application of the RIBASIM water balance model

The climate is changing, and this impacts the flow rate in the Meuse. In 2021, the water balance model RIBASIM was developed for the international Meuse River basin. "By using this tool, we are better able to drive the discussion on the approach needed for action," contemplates Harold van Waveren of Rijkswaterstaat. "But first there has to be sufficient support for the use of the model".

Low water discharge

Rijkswaterstaat senior advisor Harold van Waveren is one of the five chairs of the National Coordination Committee on Water Allocation (LCW), part of the Netherlands Water Management Centre. It is a cooperative arrangement among Rijkswaterstaat, the Water Boards, the Ministries of Defence and of Infrastructure and Water Management, representatives of the provinces and of certain regional cooperative arrangements.

"There are five chairpersons because we work with an on-call service. Normally speaking, we don't have much to do, until extreme circumstances arise. These could be related to too much water or conversely



a water shortage, or an environmental incident." In the Netherlands, a water report is drawn up every day. "This is a core task of the Water Management Centre. In crisis situations, this work is scaled up".

The LCW is a crisis advice group for water shortages. When is this the case? "This is the case when the demand for water (use for drinking water, agriculture, shipping and nature) is greater and the supply (precipitation and the supply via the rivers). The LCW is already active when a water shortage is threatened, so that preparations can be made in good time in case real water shortages arise".

High water discharge

Harold is not only Chair of the LCW, but also of the National Coordination Committee for Flood Threats (LCO). The LCO was founded to inform the Minister and network partners to warn them in case of extreme situations in good time, when floods may possibly occur. The LCO also works with national water reports. Harold was actively involved with the highwater situation in the Meuse in 2021, and so already knows a lot about the consequences of extreme weather. "They say that the weather is becoming ever more extreme, but I say that we are confronted with it already".

According to Harold, climate change is not something that will happen tomorrow, we are already in the middle of it. "Compared to 1950, year-averaged, 20 per cent more precipitation is falling in the Netherlands. Let's do something beneficial with it. We need to look for a new balance between too much and too little water. If you do this together with your partners right from the start, you can also arrive at solutions".

Climate change

Do you notice that the LCW and LCO must go into action more due to climate change?

"This changes from year to year. At the LCW there's indeed action every year if the weather is nice for longer. We then often go into action for threatened water shortages. If you're talking about actual water shortages at a national scale, this luckily doesn't happen very often. The last time this happened was in 2018, and before that in 2011 and 2003.

At regional scale, a water shortage can indeed arise more rapidly. Particularly on the high sandy soils where we can't supply any water. There we're completely dependent on precipitation. In these areas, we've seen that in the three dry summers in a row (2018, 2019 and 2020), water shortages arose quickly. The spring of 2022 was also very dry.

We can clearly notice that something's going on with the climate. This is also substantiated by figures from the KNMI (Royal Netherlands Metrological Institute). The change in spring and summer is not so much in the shifting of precipitation, but rather in the shifting of evaporation. Particularly inland, where this has increased significantly in the last 50 years. Finally, the point is the difference between precipitation and evaporation because this determines whether there is a precipitation shortage.

The precipitation pattern itself is also peculiar because the annual average precipitation is increasing. Warm air can after all contain more water. But precipitation is not equally divided through the year. In summer, we see that precipitation reduces or conversely falls in extreme downpours, so that it does

RIWA
RIWA-Meuse

not end up in the groundwater but runs away over the surface. Due to this, shortages can therefore arise more often".

Water balance models

Water balance models are crucial to allow the dialogue regarding water availability in relation to climate change to be conducted. One example is the RIBASIM model for the Meuse. Were you involved in its development, and in what role?

"I had a fairly modest advisory role. The real work was done by RIWA-Meuse together with Rijkswaterstaat Zuid-Nederland, and Deltares who conducted the work. It's important that such models become available. In the book 'Van Regen tot Maas' (From Rain to Meuse), Marcel de Wit recommended that a cross-border instrument was needed to calculate the effects of climate change and to be able to discuss them.

The question of climate change in relation to the flow rates of the rivers, and what this means for our drinking water is an important subject. This theme must be discussed nationally and internationally, and then preferably based on fact-based policy. In other words, factually substantiated administration and management is needed so that you conduct the discussion based on the same facts. For this, computer models, such as the water balance model for the Meuse, are very important".

Aleksandra Jaskula from Rijkswaterstaat Zuid-Nederland was also closely involved in the development of the water balance model. She adds to Harold's remarks: "Fact-based policy is indeed an important departure point, but it's not the start of cross-border cooperation. First, parties must mutually agree on the input to the model. This means particularly that the climate scenarios used must be accepted. In practice, each country works with its own climate scenarios. Until now, there was no inclination to agree to make use of another country's scenarios. This is therefore an important point for follow-up actions".

Harold concludes: "Once you finally reach an agreement about the facts, you can then start to discuss their meaning. And what we can do. For example, how we can best invest to reduce water scarcity and preferably prevent it".

New insights

The study regarding the water balance for the Meuse River basin was conducted in 2021. If we consider the conclusions and recommendations, what's the most relevant outcome that has stayed with you most?

"I've been working on the dossier for a while, so the conclusions weren't new. But the most important thing for me remains the fact that in all the climate scenarios that were analysed, water availability becomes less. The trend is clear: the flow rate of the Meuse is decreasing. In all cases, even for the most optimistic scenario. This is unusual. The situation on the Rhine is different. There we see the water level increasing a little in the coming years in some scenarios due to the melting of the glaciers.

It is important to consider that the water in the Meuse will, because we already have water shortages now. Hence, this future scenario is coming on top of that. In other words: if you know that there are already regular water shortages now and that we must work hard together to deal with this situation, and you also then see that in all scenarios there is a falling trend on top of this, it's clear that we must seriously consider how we're going to deal with this and what we can do.

This set of measures could for example concern water quantity. If you could ensure that you retain more of the water flow, that would be good. Such a set could also consider water usage; we could after all use it more sparingly.

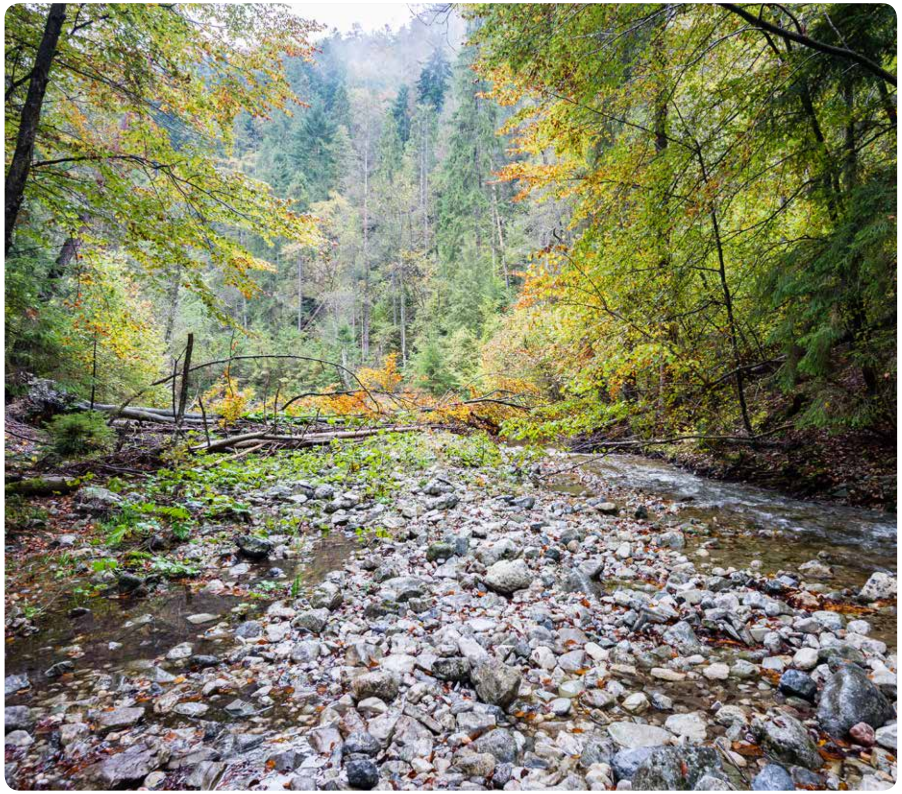
But it could also concern the impact of water shortages on water quality. Chemical substances are now discharged with the idea that they are sufficiently diluted. But this assumption disappears now that the climate is changing. In other words: we ought to have to consider whether the way in which we now have the water system set up needs to be altered".

Perspective for Action

Is the water balance model for the Meuse (RIBASIM) the suitable instrument for this, or more needs to be done?

"There are still a couple of steps needed. You can't drop this model into the international discussions just like that. The crucial thing is that we create support, together with international counterparts, about the importance of this type of model.

Once we have support from the neighbouring countries, it's then important to dive into the content. We need to jointly ask the question of whether the quality of the model is sufficient for the type of issues that we want to analyse together. I am optimistic about this. It would be nice to be able to add water quality to the model as well as water quantity. Because, with drinking water, it's always about the question of whether there is sufficient water of the right quality. In the coming time, we all just need to get on with it. In my view, if there are still question marks, these are in fact opportunities to further develop the model – together with other parties. For example, in the context of European climate research programmes for which there are also subsidies".



D

Perspective for Action

How can we ensure that Meuse water remains suitable as a source to produce drinking water? What is the approach for action?

According to RIWA-Meuse, it is always possible to think of solutions to problems, also to problems related to water quality and water availability. As Maarten van der Ploeg suggests: “If parties cooperate together, such solutions can actually be materialised. The important thing is that we don’t just wait on each other. Each party must do what they can. The National Government needs to arrange transparency for this: in other words, clear frameworks and consistent enforcement of agreements made”.

D1 De Schone Maaswaterketen (Clean Meuse Water Chain, SMWK)

Explanation of a programme-based approach

To ensure there is sufficient approach for action for the changing Meuse, it is important that the parties involved know how to find one another. For the Meuse, this is provided for in the De Schone Maaswaterketen (Clean Meuse Water Chain, SMWK) cooperative arrangement. Since 2016, various organisations in the water sector have been working together in this arrangement: Water Boards, Rijkswaterstaat, the drinking water companies and RIWA-Meuse.

In 2021, it was decided to switch to a programme-based approach to implement targeted actions. RIWA-Meuse is supplying the programme manager for this. The parties in the SMWK have developed a programme to this end, which will be implemented in the coming five years (2022-2027).

Action Plan

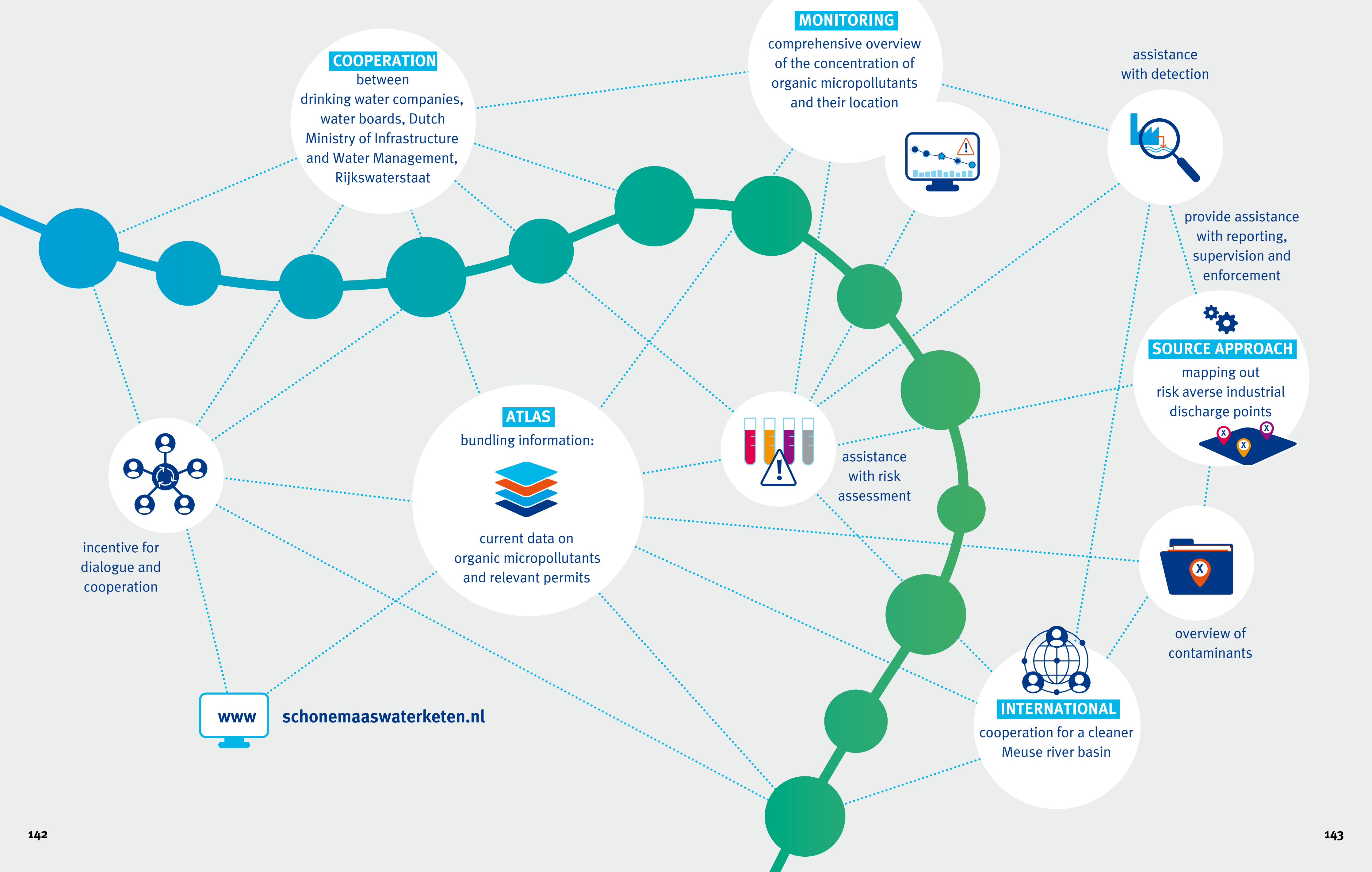
Programme manager Maarten van der Ploeg informs that: “The first step in the implementation of the programme was to define a plan of action. This covers matters including the coordination of our monitoring efforts. The result is that a common measurement programme is starting in 2022. In this way, information from the Water Boards and Rijkswaterstaat is combined with that from the drinking water companies. Moreover, the joint action plan helps to map out efforts and measures being implemented to improve the quality in the Meuse River basin”.

He continues: “Thanks to the SMWK, improved knowledge exchange and collaboration is being achieved between the various parties in the water sector. A practical example of this is a joint crisis exercise that was organised in 2022 in which the ‘Protocol for tracking the source of incidents’ was tested by the parties in the SMWK. Mika den Hollander expands on this matter in section C2.2”.

Permits

André Bannink from RIWA-Meuse: “Besides monitoring, the SMWK’s action plan also covers permits. Rijkswaterstaat is already busy on checking and revising permits for discharges into the Meuse. Rijkswaterstaat fulfils moreover the role of Ambassador in the water sector for indirect discharges, these concern the wastewater discharges into the sewerage system. With the knowledge we have gained, we now also want to bring up existing permits of the Water Boards in the Meuse River to the light. To this end, we also exchange information with the environmental agencies. The question is: how can we also derive more insight into direct and indirect discharges into the regional waters, and how we can best exchange knowledge and experience”.

Working together for a cleaner Meuse



An example of the work being done by SMWK is described in section D3.1, where Gabriël Zwart from the Limburg Water Board reports on how the Water Board has been making use of a new screening technique since 2021. Through this, more insight is gained into the composition of the effluent from sewage treatment plants (RWZIs). The Water Board also looks at some drinking water-relevant substances here.

Source of discharge? Approach by companies

To improve the water quality of the Meuse, parties in the SMWK have adopted the source of discharge approach. André Bannink explains: “Within the SMWK, we investigate how we can ensure that a discharge practice that arises is not only good for the business and/or industries that discharges wastewater, but also for water managers and drinking water companies. In the SMWK, we intend to add more meaning to this source approach in 2022”.

André continues: “When considering the source approach, it’s interesting to not only look at the permits dimension, but also at knowledge exchange with companies. For example, with Sitech who purifies wastewater from the chemistry industrial estate Chemelot. The company has recently received a new Water Act permit. We call it a ‘template permit’, because it can serve as an example for many other businesses.” In section D3.2, Hans Geijselaers of Sitech reports on the way in which the company actually implements the source of discharge approach.

International focus

The next point in the SMWK’s action plan is the international focus. Maarten van der Ploeg: “Water management demands an approach from the entire river basin, such that you consider the Meuse in its entirety. In practice, it’s clear that everyone works from the viewpoint of their own region or country. The question is, how can Germany, Flanders, Wallonia, and France act more cooperatively?

Management approach

for the sustainable protection of the Meuse as a source of drinking water for 7 million people

Overarching

- *De Schone Maaswaterketen* (Clean Meuse Water Chain) reflects the added value of working together to protect the water quality of the Meuse; together you can achieve more than alone!

Protection of rivers integrated in policy

- Additional effort is needed to achieve the goals of the Water Framework Directive (WFD) for 2027.
- It is important not to lose sight of Article 7 of the WFD, so that the quality of the source for drinking water improves whilst reducing the required purification level.

Drought and water shortage challenges

- Governments, water authorities, research institutes and water users must initiate a dialogue at national and international levels to arrive at comprehensive and stricter agreements about the management of the Meuse and its tributaries.

Micropollutants

- A total ban on PFAS is necessary to protect (the sources of) drinking water.

Permits, supervision and enforcement (PSE)

- Provide insight into all industrial discharges that directly or indirectly end up in the (tributary waters of the) Meuse. Permits for these discharges must be complete and up-to-date and the substances that can harm drinking water production must be reduced as much as possible.
- This information and the active supervision and enforcement contribute to the faster detection of contamination.

To this end, in the SMWK, we have identified various activities to reinforce the Meuse network, and to ensure that good practices and knowledge (or data) are shared. An example is the further development of the Atlas for a Clean Meuse (Atlas voor een schone Maas)".

Atlas for a Clean Meuse

In 2019, a first step was made on the development of the Atlas for a Clean Meuse, in which relevant information about the Meuse is put on the map. According to Maarten van der Ploeg: "The Atlas for a Clean Meuse is a great example of the efforts that we jointly make as the SMWK. The Atlas was delivered in January 2021 and has had another facelift since then. Some applications have been somewhat expanded. For example, drinking water-relevant substances are now integrated in the atlas.

The intention now is that the monitoring data, which we as SMWK jointly collect and measure, also gets a place there. Likewise, the Atlas will be expanded with information about permits, including those of our neighbours across the border. By shedding light on the permits from abroad, the importance of this cooperation becomes evident.

For the development of the Atlas for a Clean Meuse, we've also let ourselves be inspired by the Atlas of permits from Wallonia. We've not yet achieved actual cooperation with our Walloon colleagues from the Geoportal; up to now, the Atlas for a Clean Meuse is a Dutch project.

However, in the next phase of the Atlas and once we start to focus on permits as well as on the information about where the substances come from exactly, we'll certainly start to widen our international scope. Then we'll investigate how we can make the connection with the Geoportal in Wallonia. Maybe something similar also exists in Germany (NRW) and in Flanders (at the VMM)".

RIWA
RIWA-Meuse

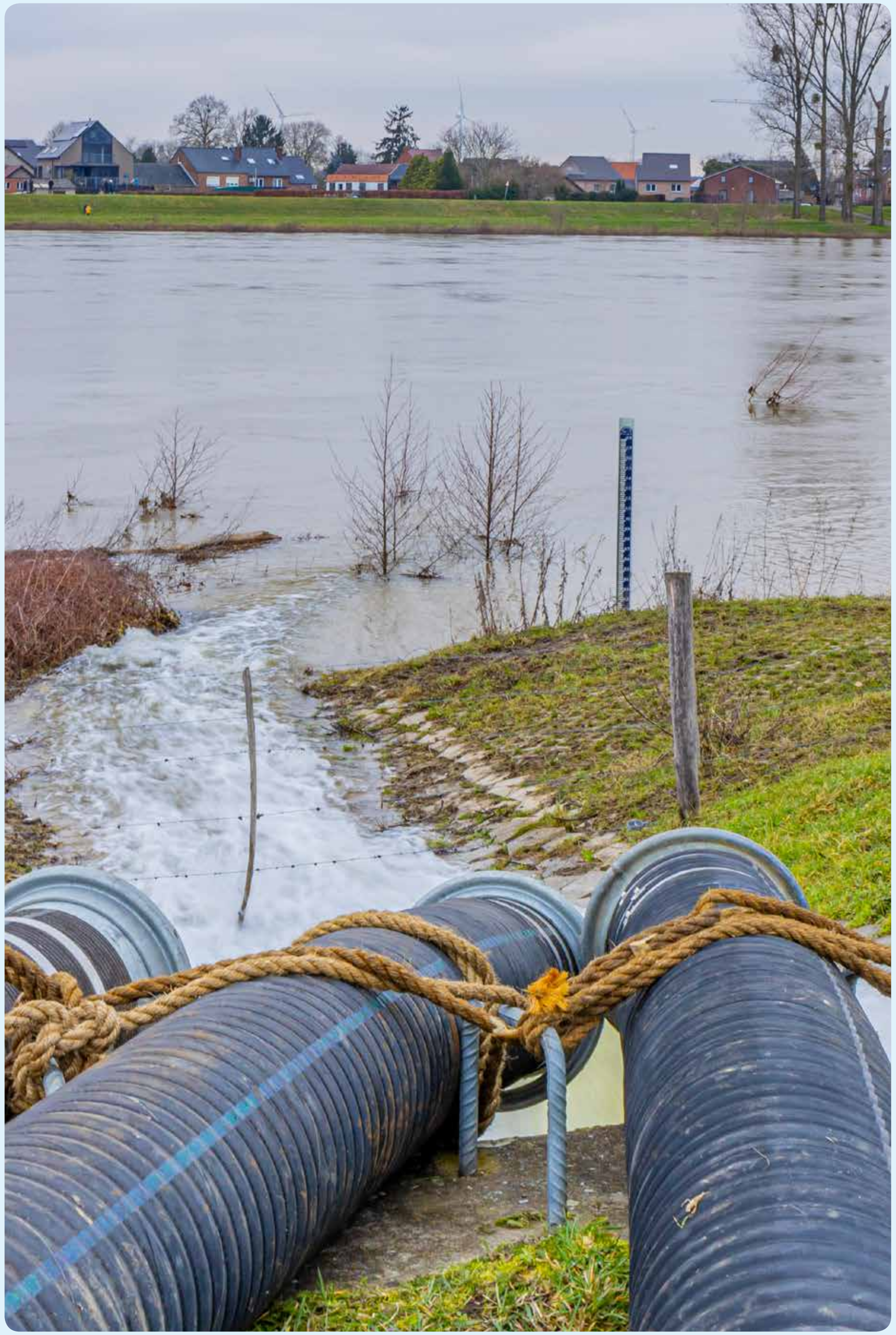
D2 Crisis exercise in the Meuse - interview

Rotterdam University of Applied Sciences

Mika den Hollander on a crisis simulation exercise with an unknown discharge in the Meuse

To allow the source of an undesirable discharge in the Meuse riverbed to be traced as quickly as possible, it is important that the parties involved know exactly what they must do. Practice makes perfect is applicable in this context. A crisis exercise was therefore organised on May 10, 2022, to allow the 'Protocol for Source Tracking in the Meuse' from the drinking water companies to be tested in practice. What happened? From now on, the involved parties intend to coordinate their crisis management more efficiently.

The crisis exercise was prepared by the special working group called 'Crisis Scenario Inspiration Group', which Evides, RIWA-Meuse, Dunea, Rijkswaterstaat and the Aa and Meuse Water Board participated. Mika den Hollander, Water Management student at the Rotterdam University of Applied Sciences, was closely involved in organizing this exercise. Mika was the primary contact point for the parties involved and his report on the exercise can be found below in a question-and-answer format.



Rotterdam University of Applied Sciences

What was the motivation for the crisis exercise?

"When drinking water companies along the Meuse are confronted with unforeseen discharges, they must stop the abstraction of river water. Motivated by the incident with prosulfocarb (2019), RIWA-Meuse drafted a protocol for this. However, this protocol had not yet been tested in practice, so it wasn't clear whether it actually worked. This is why this crisis exercise was organised".

Who was involved in the exercise?

"The joint exercise was intended to facilitate future cooperation during a crisis situation. Evides and Dunea, Rijkswaterstaat and the Aa and Meuse Water Board participated in the exercise, together with RIWA-Meuse. The Aa and Maas Water Board was the connecting part in this exercise for other water boards".

What working format did the crisis exercise have?

"During the preparation for the exercise, we decided to deviate from the standard crisis exercise. By 'we', I mean Rob Westra, Arnoud Wessel from Evides, and Maarten van der Ploeg from RIWA-Meuse. In place of that, we opted for a kind of 'dilemma session' with a workshop character. In this way, we could examine the protocol more substantively".

A fictional example was opted for the exercise. What situation did the participants have to deal with?

"We simulated a crisis from the Helmond sewage treatment plant. The participants were confronted with a discharge of an unknown substance by a fictional new business that was discharging into the sewer. The substance broke down after discharge and was then discharged into the Meuse via the Helmond sewerage plant. After this, the substance was detected at the drinking water abstraction station at the Bergsche Maas. The scenario concerned a substance that remained anonymous for a long time, so it was extra difficult to discover where it might have come from. We deliberately opted for this, because it has emerged from practice also that the identification of a substance can take up to three weeks. This happened previously for example, in the case of GenX and pyrazole".

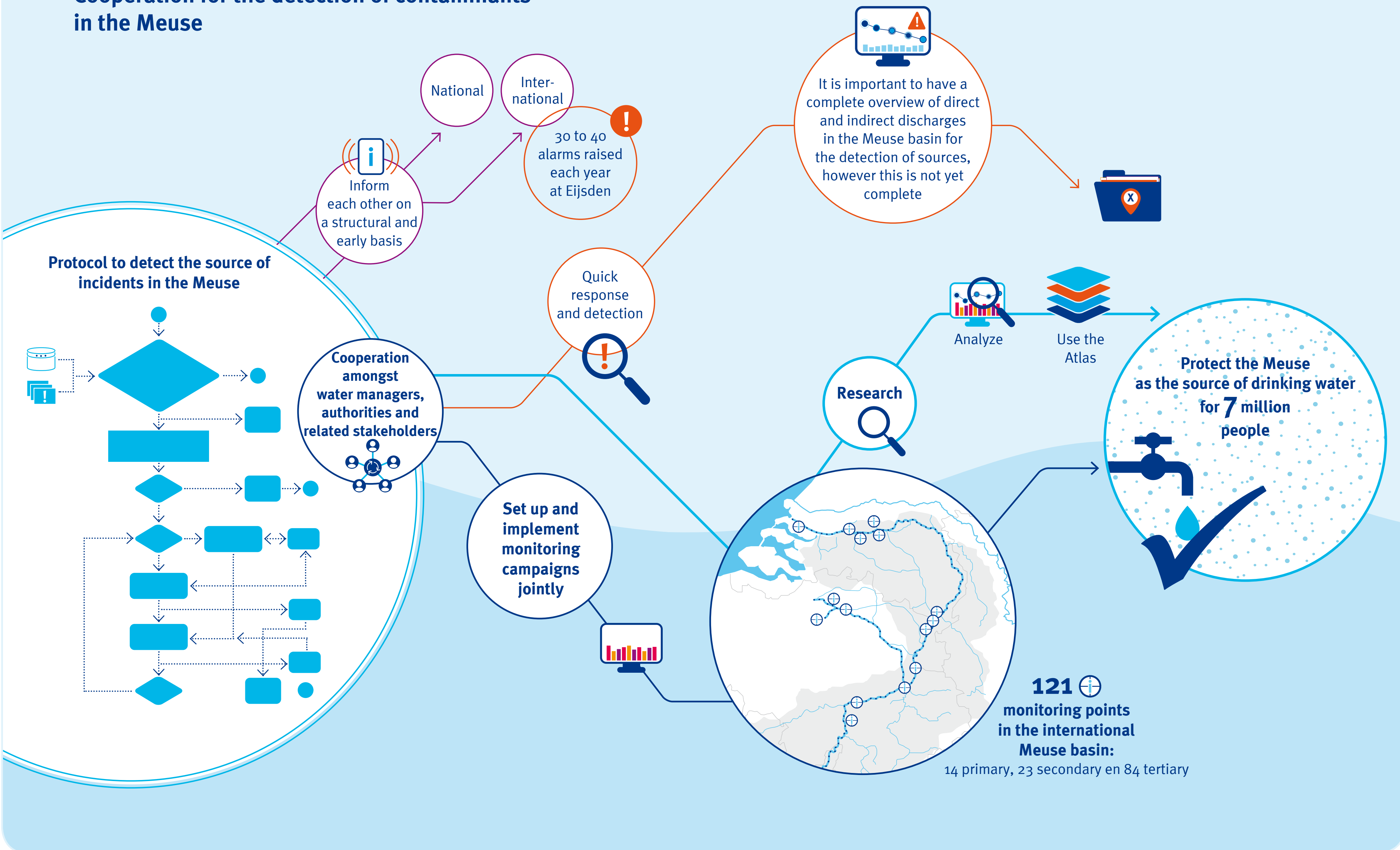
What key points were central during the exercise?

"Many questions were asked. To mention a couple of examples: it was about the detail level of discharge permits. The question was: in the tracking down of dischargers, do we in the future want to be able to gain insight into the possible location of the discharger via office investigations? This would be possible for example via the Atlas for a Clean Meuse, where Rijkswaterstaat's direct discharge permits can already be referred to, but not yet with indirect discharges.

Another key point was the practical question of how long different drinking water companies could stop their water abstraction for, and when the situation would become problematic. This information is important to allow us to mutually help each other.

A further question was how long does it take before a discharge is localised. Do we want to be able to do this more quickly, or not? And what factors play a role in the consideration of whether to be able to localise a discharge quicker. As costs also play a role in this of course. Do we want to be able to charge the damage from an incident to the party that caused the discharge?

Cooperation for the detection of contaminants in the Meuse



RIWA
RIWA-Meuse

Rotterdam University of Applied Sciences

Finally, the water board indicated that it wants to be involved much earlier in the information provision about incidents along the Meuse. After all, they also abstract Meuse water. Therefore, the question was when exactly do they want to be informed? And how can the water boards then remain more closely involved in the provision of information provision regarding an incident".

What will happen now after the exercise?

"The exercise yielded 40 recommendations, varying in nature and extent. Some for example concern the way in which information exchange happens. Sometimes the improvement points are very practical, such as including the water boards in an app group, or about deputization in the absence of specific contact persons.

There were also points about the use of each other's facilities in emergency, such as analyses by laboratories. Sometimes the recommendations were aimed at the management method. One for example concerned the integration of the operational and policy groups that are instituted during an incident. It emerged from the exercise that the various organisations would be happy to have their protocols linked together. This is an important conclusion".

My recommendation to the working party? The point now is to see which of the 40 recommendations can be incorporated into the Protocol for Source Tracking. After this iteration cycle, a new crisis exercise could be organised, but then with the traditional character of an actual simulation".

What needs to happen and why?

"The recommendations put forward deserve a follow-up. A number can be incorporated into the protocol rapidly. The cooperation among the parties that participated in the exercise ought also to receive feedback. The SMWK (Clean Meuse Water Chain) could be a good platform for this. The parties considered it useful to be able to speak together about each other's interests and actions.

Another possibility is to expand this network with other water boards, municipalities, and environmental agencies. This is important when the issue is related to a discharge from a sewage treatment plant. At the time of the GenX incident, it took months before the discharge was tracked down. This needs to be different in future".

Limburg Water Board

Gabriël Zwart regarding new possibilities for monitoring substances of emerging concern

'Limburg Water Board screens effluent from sewage treatment plants, as well as drinking water-relevant substances'

Since 2020, Limburg Water Board has been using the same screening technique as the one used by the drinking water sector. This is to gain a better view of the composition of effluents coming from these plants. Gabriël Zwart from the Limburg Water Board reports on new possibilities for monitoring new substances that are arising through the use of screening methods.

Water quality and sewage treatment plants

Gabriël Zwart is a senior advisor at Limburg Water Board. "My remit is broad: it concerns monitoring water quality and the analysis of the data, its interpretation, and finally providing recommendations to the organisation and management".

The topics related to surface water quality and sewage treatment plants (STPs) are two separate tracks at the water board. "However, the continuous attention for new substances that is demanded by the drinking water sector served as a motivation for the water board to make extra efforts to link these two tracks together".

From a practical standpoint this is now possible too because the methods for detecting organic micro-contaminations have improved and can be applied regularly. In 2019, the project 'Small Screening of the Meuse Region' shed light on the potential of these methods and what they can provide".

Close screening for a wide view

Gabriël draws attention to a large monitoring programme in the Meuse region, in which the drinking water companies, provinces, water managers, Rijkswaterstaat and the Brabant and Limburg Water Boards acted together.

Limburg Water Board

"The intention was to develop a wider view of the water quality of the Meuse. To this end, the library screening method, which is also used by drinking water companies, was applied to the screening of the effluent from STPs for organic micro-contaminations".

The screening method works as follows. "The starting point is the substances library, a list of 1,800 to 2,000 known organic substances. Next, water samples are analysed using chromatography (to separate the substances) followed by high resolution mass spectrometry (to identify the substances based on their mass). The peaks detected in the water sample are compared with the peak patterns in the substances' library. In 2019, this screening was carried out by Het Waterlaboratorium (HWL)".

Gabriël was immediately captivated by the method: "Of the 1800 substances in the library, it emerged that 500 different substances were actually present in the effluent from the STPs. In other words: if we want to know more about new substances in the surface water, we can extract more information out of the STP effluent with this technique".

Seventeen sewage treatment plants under the microscope

In 2020, following this inspiring Meuse-wide collaborative project Limburg Water Board decided to implement the screening method itself. "This involved 17 STPs in the area. In this approach the screening is repeated from two to six times. This is to see which other substances (besides all the medication residues) could also be relevant to the ecosystem.

With the results from the screening, we can't yet say anything about how problematic the substances that were found are, nor about possible breaches of standards. For this, target substance analyses are needed to determine the concentrations of the substances. However, after the screening you already have a good indication of the wide spectrum of substances that are present".

In 2021, the Aa en Maas Water Board also decided to investigate several STPs in the area with screening. "We then combined their data with ours. It was time for the following step: the interpretation of the results. The question is: which of the detected substances can potentially become a problem for the water quality? For this assessment, we hired the external consultancy company Ecovide".

Interpretation of the results

The point of the assessment for the water board is mainly related to the risks posed to the ecosystem. "Which of the 500 substances we detect are problematic from an eco-toxicological perspective? In our case, it proved to be biocides, medication residues (800 in the substances library) and a few industrial substances. Besides these, we also found consumer products and (illicit) drugs. Particularly this last category is new, and therefore interesting for further research".

He continues: "Until now, the monitoring of drugs has been problematic, because these substances are strictly regulated. The laboratory must have a permit to be allowed to work with such target substances (drugs). This makes the analysis very expensive. But with the screening technique, you can just include the drugs in the substances library. There are around 40 types of (illicit) drugs in this list. Of these, we have actually found around 30 in the effluent from our sewage plants".

Limburg Water Board

Together with the eco-toxicological interpretation, the Limburg Water Board's list of 500 detected substances was also presented to the drinking water companies. "Evides and Aqualab Zuid particularly helped us in the interpretation of the substances (more on this matter in following sections of the report). Based on the two angled approach (eco-toxicology and drinking water relevance), follows the development of a list of substances is which will be used by the Limburg Water Board in coming years for further investigation. This will happen with target analyses".

Innovation at sewage treatment plants

For example, the list of targets substances to be monitored will be used for research into innovations and at STPs in the area. "You can't do everything all at once. To allow the sewage plants to be prioritised in the coming years, we will first determine which belong to the 'hot-spots'. In other words: where does the discharge of effluent have the greatest impact on the abstracted water? To give an example: the Venlo STP discharges into the Meuse, where the effluent is highly diluted. This is not a hot spot. But another STP that discharges directly into the Geleenbeek, is one".

Gabriël continues: "Once we identify the hot-spots, we investigate the purification efficiency of particular measures at the STP in question. We are doing this for example at the Simpelveld STP in Zuid-Limburg, which discharges into a very small rivulet. There, the Waterschapsbedrijf Limburg (Limburg Water Board Company) -commissioned by the water board - is looking at the effects of active carbon dosing on the substances discharged in the effluent. Because wastewater is treated on two lines in this plant, we can compare the effect of dosing with carbon powder well. Carbon is added to one stream, but not to the other".

For the analysis of the effluent, the water board not only uses the prescribed list of guide substances, but also a number of relevant substances that emerged from the library screening. "There are also a number of drinking water-relevant substances in there".

Drinking water-relevant substances in one go

This is also new. Normally, the water board tracks the effects of discharges on the ecosystem. The fact that the water board can now also look out for drinking water-relevant substances is the result of successful recent collaborative projects in which screening techniques are being used.

Gabriël: "Drinking water companies have been banging the drum for ages because particular substances are causing them trouble. In the past for example, RIWA-Meuse was busy trying to get glyphosate and AMPA on the map. These substances were at that time less relevant to the water board because they are removed in the STPs. But we did then participate actively in monitoring them.

Besides this, we realised that we ought to pay more attention to other emerging substances. With the coming of the new screening techniques, this is also a practical thing to do. In other words: we've experienced the value of the library screening ourselves".

Sitech

Hans Geijselaers on the maximization of discharge controls to reduce incidents

An abnormal discharge can always happen at a factory. But if you have your operations properly under control, you can prevent it from developing into an incident in the surface water. This arises from Hans Geijselaers' tale on technical service provider Sitech Services, which is responsible for the wastewater management at the Chemelot industrial complex.

Chemelot is an industrial estate covering 800 hectares in Zuid-Limburg. It is home to 54 factories and over 150 different businesses. Sitech arranges that the wastewater from the factories is transported via a 290 km sewerage system to the central biological wastewater treatment plant, where it is purified before being discharged into the Grens Meuse (Border Meuse) and Meuse.

What is special about the discharge situation at Chemelot is that a little further on at Roosteren, drinking water is made from the Meuse water. The river water there must meet the strict abstraction standards to produce drinking water. The discharge from Chemelot must take this into account. This means that the effluent that leaves the discharge pipe from the industrial estate is monitored 24/7.

Sitech

"But at the I-WWTP (industrial wastewater treatment plant), you're sometimes already too late," admits Hans Geijselaers, who has been manager of wastewater treatment at Sitech for 3,5 years. He also pleads for an approach at the source to reduce discharges. On request, Hans answers 11 questions about how Sitech goes to work at Chemelot.

1 Fifty-four factories discharge into your industrial wastewater treatment plant (I-WWTP). How do you get a grip on this complex process?

"Agreements with the companies are largely laid down in contracts. Besides this, we operate within the discharge permit, which is one permit for the entire site that includes all the factories. Our contracts with the companies are therefore essentially an extension of our discharge permit. Our I-WWTP team coordinates all the circumstances concerning the permit, and how we can meet the requirements.

Our discharge permit is relatively new. For several years, the discharge has been viewed in a completely different light, namely at the level of individual substances. Before this, we controlled the quality of the effluent based on group parameters and only on a few individual substances. To get a view of any more individual substances in the effluent, we invested significantly in new monitoring and analysis techniques.

All this also fits in with the 'greening vision' of the entire Chemelot site, aimed at enhancing and reaching sustainability and circularity. To this end, specific discharges are going to be significantly reduced into the future. At this point, there is a survey underway of everything we can do to reach that objective (circularity)".

Checklist for permits

1. Is the permit accessible?* and if so:
a. How is it accessed:
- digitally available;
- fully searchable;
- hardcopy available.

b. Is all information in one platform or spread across multiple platforms?
c. Is it an IPPC registered industry and is there a PRTR report available?

2. Is the permit complete or missing information on:
a. Substances of Very High Concern;
b. Drinking water relevant substances;
c. Substances used in industrial processes and which (may) end up in the discharge;
d. Recent 90-percentile runoff;
e. Purification steps and their efficiency;
f. Monitoring (both the monitoring program and the results thereof).

3. Is the permit recent?
a. Between five and ten years old;
b. Over ten years old.

4. Were drinking water companies actively involved in the process of granting the permit at hand?

* All permits should by definition be publicly available/accessible.

Sitech

2 You supervise the process and know what is happening in it. What role does monitoring have in this?

“Monitoring is crucial and it happens at various places on the site. It starts in the factories themselves. Next, the wastewater goes into the sewerage pipes where we have analysis equipment present in several places. Finally, we measure the wastewater just before and after it is purified in the I-WWTP. In this case, we conduct targeted analyses and a broad screening of the effluent. This moment is your last line of defence: if something has gone wrong in a factory, you would naturally prefer to detect it as early as possible. If you notice it in time, you can then act accordingly to prevent it leading to an improper discharge into surface water bodies”.

3 In a nutshell: you monitor the substances in the permit at different places, and as a safety net, you have extra screening of the effluent in case incidents occur, is this right?

“Yes, we’ve been doing the measurement of effluents for years. But in recent years, the measurement package has indeed been significantly expanded. We use five different analytical techniques to determine whether any deviations can be detected in the effluent.

For example, for one year we have been working with a bio-monitor to measure toxicity; this is done with mussels. They are highly sensitive to toxic substances. These cause the mussels to close up. We can record this movement using electrodes, and then we check whether something is the matter.

The importance of good screening and monitoring is that you can act quickly in the case of an irregular situation. You preferably want to prevent breaches of the standard taking place. But if this should happen, then you want to restrict the breach as far as possible”.

4 What do you do in case of deviations in the discharge?

“Firstly, we want to know the concentration of the substance. To be clear: if we see something in the screening, we’re by definition talking about very low concentrations. Then fortunately we’re still far from the phase where there is a problem. For surface water, we screen substances at concentrations of 0.1 micrograms per litre, while the warning level for abstraction for the drinking water companies is 1 microgram per litre. You’ve already built in a safety factor with this factor of 10.

Follow-up? This can go into two directions. If it’s a known substance, we can respond very quickly. If it’s an unknown substance, we must start looking. This involves real ‘detective’ work: identification and tracking. We do this together with Aqualab Zuid’s laboratory. By applying different analysis techniques, we define a molecular formula and then we search for this molecule further back in the stream”.

5 How do you proceed if the problem is unknown substances at very low concentrations?

“We work with five different screening methods, of which a couple are also used by the drinking water companies themselves. This is useful, because then we’re speaking the same language. If we detect a peak in an effluent sample, that single peak can also be caused by three different substances together.

RIWA
RIWA-Meuse

Sitech

For this reason, the laboratory possesses techniques with which they can determine the molecular mass. Once you know this, your next steps can be highly focused. Then you can also do an actual analysis on your water streams to trace the substance. This way of working is really intended to put the dots on the i's, and to ensure that you don't see any alien substances. Because when you screen, you really see everything, in spite of concentrations at hand being often very low".

6 Some substances, such as PFAS, are already problematic for drinking water production even at extremely low concentrations. How do you determine whether a new, unknown substance is a problem?

"The laboratory then gets to work to determine the molecular structure and molecular mass. If you're in luck you know which substance it could be. Then you can search in a directed way for information about the substance to find out the degree to which it is 'water-problematic'. You can use resources including the ECHA/REACH files for this, but these are unfortunately often incomplete.

So, we research further in literature, or in the databases of suppliers of chemicals. The laboratories themselves also have information. But if everything still yields insufficient information, we have a comprehensive study done. Then you have to have toxicity tests conducted".

7 When do you determine how problematic a substance is: what procedure do you use to set priorities for all these substances?

"We cooperate closely with the drinking water companies and we seek advice from KWR and Aqualab Zuid. You must realise that we abstract Meuse water and that we also discharge it again. Whatever is in the Meuse, we draw from it. This is why we also monitor the background level of the substances in the water that we abstract. Recently, we found four PFAS components in our effluent, while these substances do not arise in our usual discharge. These substances proved to be already present in the Meuse water that we abstract. They have no priority for us to search any further".

8 Do you also use screening to manage abnormal discharges?

"Be aware: investigating emerging substances and managing incidents are two different things. The screening discussed above is intended as a safety net. Large streams are never involved here, because the substances in the large streams are known and you don't need any screening for this. We know all the individual substances that we discharge; these are listed in the permit and are measured.

Things proceed differently when it comes to an unusual discharge. If something unforeseen happens in a factory, we have monitoring points at various places in the process to spot an unintended discharge coming along. In this case, we can switch the stream to the storage basin and enter discussion with the factory to stop the discharge. In this way, we prevent the discharge ending up in the I-WWTP and then in the surface water.

Sitech

But I must confess that this doesn't always work. The wastewater goes quickly through the sewer. We have an average of four hours before it arrives at the I-WWTP. Sometimes therefore we exceed our discharge standard. Thanks to all the monitors we have installed, we can ensure that discharge is noticed quickly. We can prevent the discharge being long-term, with detrimental consequences for the surface water or at any event minimise the potential consequences.

Usually, the impact of an abnormal discharge proves to have less detrimental consequences. Often the abnormal discharge is not observable at the drinking water abstraction point. Recently, we had to deal with a short-term standards breach. To prevent the drinking water companies being jeopardized by this, we immediately phoned the WML drinking water company. But they didn't see any peak in their screening".

9 How can it happen that a standards breach is not measured further down the Meuse?

"This has to do with extra safety margins that are built in. If I talk about a breach in standards, I mean a standard that applies to our I-WWTP permit. The standard for surface water is translated back into a standard for our effluent in the permit.

Because we discharge into the Grensmaas, this standard is adapted to the receiving surface water, and moreover calculated for a very low Meuse water level. The standard is therefore set for situations of low water flow. In other words: if we exceed our standard in the effluent, whilst the water discharge in the Meuse is not low, it will usually cause no problem. It remains the case that we don't accept any standards breaches".

10 If we are talking about the impact of substances, what about indicative target values?

"This is quite complicated. If you identify a known substance, you can find toxicological information about it. Once you have this data you can derive a standard based on it and then you know what your limit is with regards to the discharge. The more data you have, the more accurately you can derive the standard. If you have too little data for a standard, you then must work with safety factors and thereby the standard becomes an indicative one. You can then compare a substance with another that closely resembles it. Based on this you can still derive an indicative standard.

You don't do this just like that; all kinds of strict rules apply to it. The RIVM has instructions on how you should do this. This costs time. Mainly because

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the standard application must be tested in a scientific sounding board group that only meets a couple of times a year and they can only handle a limited number of applications each time.

Briefly: if you must apply for many standards, it can take quite a while. This is a stumbling block for innovation." We often want to introduce new substances into the production process, which are better or less harmful than existing substances. You want to implement this as quickly as possible".

11 Your way of working has proved successful because drinking water companies see far fewer incidents than previously. Do you agree?

"We've had a better grip on the process for quite a while, ever since the incident with pyrazole in 2015. This was a national wake-up call at the time; afterwards there was attention to individual substances. We went to work immediately, and I now dare to say that we have the situation well under control. That's not to say that nothing ever happens. But if something goes wrong, we're on it in a flash. We also always communicate with the Limburg Water Board, Rijkswaterstaat and the drinking water companies. In this way, we can prevent a repeat of an incident like that one of 2015.

Our vision of the future? The dot on the horizon is finally zero discharges. Until that time, we will need to manage and mitigate the current residual risk even better. Therefore, we work more and more at the source, in the factories themselves. The source approach is extremely important, especially for abnormal discharges".

Annexes

Annex 1

Substances that exceeded the ERM target value in 2021

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Industrial pollutants and consumer products																566	2813	20,1%
cyanuric acid	108-80-5	0,1	µg/L					1,7		2,3	1,1		0,96	2,7	2,3	46	46	100,0%
sulfamic acid	5329-14-6	0,1	µg/L					15		23	31		38	41	77	46	46	100,0%
Trifluoroacetic acid (TFA)	76-05-1	0,1	µg/L								1,1		1,2	1,1	1,3	39	39	100,0%
Ethylenediaminetetraacetic acid (EDTA)	60-00-4	1	µg/L		5,3	7,6	7,6	8,7		11	27		16	30	13	85	86	98,8%
Sucralose	56038-13-2	1	µg/L								2,5	3	3,9	3,2	1,8	34	43	79,1%
Trichloroacetic acid (TCA)	76-03-9	0,1	µg/L								0,24	1,2	0,24	0,4	0,19	40	52	76,9%
dichloromethane sulfonic acid	53638-45-2	0,1	µg/L					0,44		0,29	0,16		0,24	0,35	0,23	32	46	69,6%
methenamine	100-97-0	1	µg/L		3,67	6,11		2,8		2	1,5		1,7	1,2	1,8	49	89	55,1%
1,2-Dimethoxyethane	110-71-4	0,1	µg/L				<0.05		<0.05	<0.05	<0.05		<0.05		1	17	35	48,6%
8-Hydroxypenillic acid	3053-85-8	0,1	µg/L										0,43	0,54	0,11	11	26	42,3%
1,4-Dioxane	123-91-1	0,1	µg/L				0,5	<0.2		<0.2	0,2	0,24	0,22	0,2	0,62	29	88	33,0%
Di-iso-propylether	108-20-3	1	µg/L		<0.1	14,04	10	6,2	1,1	1,5	0,02	2,4	0,39	0,4	0,26	31	149	20,8%
Trifluoromethanesulfonic acid	1493-13-6	0,1	µg/L					0,41		0,4	0,12		0,34	0,04	0,06	9	46	19,6%
1,3,5-triazine-2,4,6-triamine (melamin)	108-78-1	1	µg/L		0,453	0,637		1,1		1,4	2,2	4,5	2,3	3,3	1,7	38	238	16,0%
Nitrilotriacetic acid (NTA)	139-13-9	1	µg/L		<1	<1	7,4	<1		<1	<1		<1	<1	<1	13	86	15,1%
Tetrahydrofuran (THF)	109-99-9	0,1	µg/L					0,2		0,083			0,25	0,28	0,16	8	55	14,5%
Diethylenetriaminepentaacetic acid (DTPA)	67-43-6	1	µg/L		<1	<1	<1	<1		1,1	10		3,7	2,6	1,3	11	86	12,8%
nonionic detergents		0,001	mg/L										0,1	<0.1	<0.1	1	8	12,5%
Tributylphosphate (TBP)	126-73-8	1	µg/L		0,022	9,047	3,42		0,154	0,249	0,13	0,27	0,307		0,196	4	39	10,3%
PAHs, sum 16 of EPA		0,1	µg/L		0,185	0,074										2	20	10,0%
sum of trihalomethanes		0,1	µg/L			0,16		0,13		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5	99	5,1%
1,3-Diphenylguanidine	102-06-7	0,1	µg/L					0,1		0,055			0,059	0,08	<0.05	1	44	2,3%
ethyl sulfate	540-82-9	0,1	µg/L					0,1		<0.1	<0.1		<0.1	<0.1	<0.1	1	46	2,2%
benzotriazole	95-14-7	1	µg/L		0,84	1,286		0,9		0,58	0,62	0,95	0,55	0,6	0,61	2	95	2,1%
PAHS, sum of 10		0,1	µg/L					0,036		0,033	0,02	0,12	0,082			1	53	1,9%
Diacetone acrylamide	2873-97-4	0,1	µg/L										0,26	<0.05	<0.05	1	65	1,5%
Dichloroacetic acid	79-43-6	0,1	µg/L					<0.1		<0.1	0,04	0,13	0,04	0,04	0,05	1	66	1,5%
Chloroethene	75-01-4	0,1	µg/L	<0.1	0,12	<0.1	0,13	0,053	<0.045	<0.045	<0.045	<0.05	<0.045	<0.045	<0.045	2	148	1,4%
Pyrazole	288-13-1	1	µg/L				<0.5	<0.5		<0.5	0,45	0,36	<0.5	<0.5	1,3	1	75	1,3%
tetra- and trichloroethene (sum)		0,1	µg/L		0,11			<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1	78	1,3%
Phenanthrene	85-01-8	0,1	µg/L	0,008	0,0197	0,0257	0,279	0,0058	0,0582	0,00857	0,00881	0,01	0,03	0,0101	0,00812	1	133	0,8%
Fluoranthene	206-44-0	0,1	µg/L	0,013	0,0415	0,0232	0,694	0,0071	0,0934	0,0251	0,00933	0,02	0,0576	0,0163	0,0145	1	133	0,8%
Pyrene	129-00-0	0,1	µg/L	0,007	0,0272	0,0186	0,475	0,0065	0,0671	0,0232	0,00942	0,02	0,0467	0,0135	0,0169	1	133	0,8%
1,2-Dichloroethane	107-06-2	0,1	µg/L	<0.1	0,11	<0.1	<0.1	<0.05	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	1	161	0,6%
Tetrachloroethene	127-18-4	0,1	µg/L	<0.2	0,11	<0.1	0,058	<0.05	<0.019	0,02	<0.019	0,05	0,031	0,035	<0.019	1	161	0,6%

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Pharmaceuticals and Endocrine Disrupting Chemicals (EDCs)																134	848	15,8%
Diaminomethylideneurea	141-83-3	1	µg/L					1,5	1,3	0,59		1,5	1,7	1,8		24	39	61,5%
Vigabatrin	60643-86-9	0,1	µg/L					0,55		0,81			0,57	0,68	0,55	14	44	31,8%
valsartan acid	164265-78-5	0,1	µg/L					0,085		0,084			0,15	0,18	0,23	14	44	31,8%
Metformin	657-24-9	1	µg/L		2,26	2,21		1,6		1,1	0,85		0,86	0,95	0,75	25	94	26,6%
N-formyl-4-aminoantipyrine (FAA)	1672-58-8	0,1	µg/L					0,01		0,011	0,074		0,097	0,071	0,23	12	57	21,1%
Theobromine	83-67-0	0,1	µg/L					0,12		0,26			0,1	0,11	0,1	9	44	20,5%
N-acetyl-4-aminoantipyrine (AAA)	83-15-8	0,1	µg/L					0,022		0,025	0,074		0,061	0,049	0,16	11	57	19,3%
ER-Calux in 17beta-estradiol equivalents		0,25	ng/L		0,27	0,39		0,17		0,34	0,122	0,171	0,27	0,28	0,19	8	63	12,7%
paracetamol	103-90-2	0,1	µg/L					0,16		0,3			0,1	<0.02	0,061	4	44	9,1%
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	0,1	µg/L				<1		<1	<1	<0.5		1,2		<1	1	12	8,3%
candesartan	139481-59-7	0,1	µg/L					0,016		0,012	0,084		0,059	0,062	0,13	3	57	5,3%
Lamotrigine	84057-84-1	0,1	µg/L		0,0636	0,0655		0,079		0,087	0,077		0,1	0,1	0,1	4	83	4,8%
valsartan	137862-53-4	0,1	µg/L		0,0957	0,088		0,052		0,068	0,052		0,097	0,047	0,12	3	83	3,6%
Amantadine	768-94-5	0,1	µg/L					<0.005		<0.005			0,005	0,007	0,11	1	44	2,3%
Tramadol	27203-92-5	0,1	µg/L		0,092	0,1039		0,087		0,084	0,061		0,067	0,073	0,044	1	83	1,2%

ERM-sw = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Luik, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, HEU = Heusden, BRA = Brakel, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.
In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of samples.

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Plant Protection Products, Biocides and their metabolites																213	1585	13,4%
Aminomethylphosphonic acid (AMPA)	1066-51-9	0,1	µg/L	0,163	0,382	0,41	0,526	2,2	1,93	1,9	1,09	1,58	1,1	1,2	0,5	113	126	89,7%
Chloridazon-desphenyl	6339-19-1	0,1	µg/L		0,173	0,178		0,19		0,27	0,18		0,25	0,24	0,25	66	82	80,5%
metolachloro-S-metabolite	171118-09-5	0,1	µg/L		0,091	0,101					0,11					7	37	18,9%
Propamocarb	24579-73-5	0,1	µg/L								0,069	0,36	0,069	0,13	0,064	7	91	7,7%
Glyphosate	1071-83-6	0,1	µg/L	<0.05	0,063	0,078	0,161	0,14	0,188	0,095	0,045	0,11	0,084	0,086	0,041	7	126	5,6%
metazachloro-S-metabolite	172960-62-2	0,1	µg/L		0,06	0,065					0,05		0,099	0,054	0,13	1	61	1,6%
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	0,1	µg/L	<0.01	<0.03	<0.03	0,01	0,024	0,18	0,14	0,03	0,03	<0.05	<0.02	<0.02	2	136	1,5%
Ethofumesat	26225-79-6	0,1	µg/L		0,171	<0.02		<0.02		0,043	0,03	0,06	0,045	<0.02	<0.02	1	78	1,3%
Metolachlor	51218-45-2	0,1	µg/L	0,034	0,134	0,073	0,047	0,087	0,0626	0,113	0,0311	0,03	0,0568	0,0139	0,0381	2	161	1,2%
Terbutylazine	5915-41-3	0,1	µg/L	0,02	0,111	0,053	0,0427	0,11	0,0552	0,039	0,0443	0,04	0,0498	0,0163	0,0565	2	161	1,2%
Propiconazole	60207-90-1	0,1	µg/L				0,175		0,0824	0,035	0,00993		0,0308	0,0277	0,0117	1	82	1,2%
Dimethenamid	87674-68-8	0,1	µg/L	0,068	0,112	0,084					0,045	0,046				1	88	1,1%
Prosulfocarb	52888-80-9	0,1	µg/L								0,05	0,23	<0.05	0,084	<0.05	1	91	1,1%
Nicosulfuron	111991-09-4	0,1	µg/L	0,406	<0.03	<0.03		<0.02		0,022	<0.05	<0.05	<0.02	0,022	0,02	1	132	0,8%
Metamitron	41394-05-2	0,1	µg/L	<0.015	0,115	<0.025		<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1	133	0,8%

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
General parameters and nutrients																288	746	38,6%
Dissolved Organic Carbon (DOC)		3	mg/L C	6,08			5,3		5,9	7,5	4,91	4,48	4,9	7,9	5,9	156	211	73,9%
Total Organic Carbon (TOC)		4	mg/L C		6,7	8,2	6,2	4,7	5,9	8	5,1		6,7	9,1	6,1	125	225	55,6%
ammonium	6684-80-6	0,3	mg/L NH4			0,29				0,77	0,26					6	116	5,2%
Fluoride	16984-48-8	1	mg/L F	0,133	0,13	1,01	0,34		0,31	0,29	0,22		0,24	0,22	0,18	1	194	0,5%

ERM-sw = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Luik, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, HEU = Heusden, BRA = Brakel, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.
In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of samples.

Annex 2

Abstraction stops and restrictions and alarm notifications as a result of water contamination

There were no abstraction stops or restrictions at Tailfer or Brakel (announcements from Vivaqua and Dunea)

Intake point: water-link, Broechem (Albertkanaal)						
No.	**Start**	**End**	**Duration [d]**	**Duration [h]**	**Cause**	**Explanation behind intake stop**
1	Sat 28-08-21 21:00	Sun 29-08-21 09:00	0.50	12.00	Exceedance of the target/alarm value of a regular measurement	UV-extinction, 254 nm [1/m]
2	Mon 30-08-21 00:30	Mon 30-08-21 03:30	0.13	3.00	Exceedance of the target/alarm value of a regular measurement	UV-extinction, 254 nm [1/m]
			0.63	15		

Intake point: water-link, Lier (Netekanaal)						
No.	**Start**	**End**	**Duration [d]**	**Duration [h]**	**Cause**	**Explanation behind intake stop**
3	Sun 25-04-21 20:30	Sun 25-04-21 22:15	0.07	1.75	Exceedance of the target/alarm value of a regular measurement	chlorophyll-a [µg/l]
4	Sat 15-05-21 04:06	Sat 15-05-21 10:20	0.26	6.23	Exceedance of the target/alarm value of a regular measurement	turbidity [FTE]
5	Sat 10-07-21 02:50	Sat 10-07-21 08:30	0.24	5.67	Exceedance of the target/alarm value of a regular measurement	turbidity [FTE]
6	Tue 17-08-21 23:35	Wed 18-08-21 10:35	0.46	11.00	Exceedance of the target/alarm value of a regular measurement	turbidity [FTE]
7	Thurs 23-09-21 17:43	Thurs 23-09-21 18:35	0.04	0.87	Exceedance of the target/alarm value of a regular measurement	
8	Wed 13-10-21 17:35	Wed 13-10-21 20:30	0.12	2.92	Exceedance of the target/alarm value of a regular measurement	turbidity [FTE]
9	Mon 01-11-21 11:20	Mon01-11-21 19:40	0.35	8.33	Exceedance of the target/alarm value of a regular measurement	UV-extinction, 254 nm [1/m]
10	Tue02-11-21 15:40	Tue 02-11-21 17:20	0.07	1.67	Exceedance of the target/alarm value of a regular measurement	turbidity [FTE]
11	Sat13-11-21 12:20	Sun 14-11-21 01:00	0.53	12.67	Exceedance of the target/alarm value of a regular measurement	(Electrical conductivity 20 °C) [mS/m]
12	Tue 16-11-21 10:32	Wed 17-11-21 12:50	1.10	26.30	Preventive, visible contamination (oil)	mineral oil [µg/l]
13	Thurs 18-11-21 11:45	Thurs 18-11-21 16:15	0.19	4.50	Preventive, visible contamination (oil)	
14	Sun 21-11-21 09:30	Sun 21-11-21 16:00	0.27	6.50	Preventive, visible contamination (oil)	mineral oil [µg/l]

Intake point: water-link, Lier (Netekanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
15	Mon 06-12-21 12:45	Mon 06-12-21 16:00	0.14	3.25	Exceedance of the target/alarm value of a regular measurement	turbidity [FTE]
16	Thurs 09-12-21 10:50	Thurs 09-12-21 16:10	0.22	5.33	Preventive, visible contamination (oil)	
17	Mon 27-12-21 18:00	Tue 28-12-21 09:30	0.65	15.50	Exceedance of the target/alarm value of a regular measurement	
			4.71	112.49		

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
18	11-1-2021	14-1-2021	3.0	24.0	Cal A1: Tributyl phosphate 5,5 µg/l, Cal A2: DIPE, H1: LC Aqua 502: 1,2 µg/l, turbidity, mussel monitor	Quality
19	18-1-2021	18-1-2021	0.2	1.6	turbidity	Quality
20	21-1-2021	25-1-2021	4.0	32.0	Cal A3: unknown 12,7 µg/l, Meuse discharge >1000 m^3/s	Quality
21	26-1-2021	26-1-2021	0	0	Dtox	Quality
22	27-1-2021	28-1-2021	1.0	8.0	turbidity	Quality
23	29-1-2021	9-2-2021	11.0	88.0	H2 LCAqua-502 1,2 µg/l, Meuse discharge > 1000 m^3/s	Quality
24	16-2-2021	17-2-2021	1.0	8.0	mussel monitor, turbidity	Quality
25	17-2-2021	18-2-2021	1.0	8.0	mussel monitor, turbidity	Quality
26	19-2-2021	22-2-2021	3.0	24.0	turbidity, mussel monitor	Quality
27	23-2-2021	23-2-2021	0.4	3.2	mussel monitor	Quality
28	25-2-2021	25-2-2021	0,1	0.8	turbidity	Quality
29	26-2-2021	26-2-2021	0,1	0.8	turbidity	Quality
30	27-2-2021	1-3-2021	2.0	16.0	turbidity	Quality
31	2-3-2021	4-3-2021	2.0	16.0	Dtox	Quality
32	5-3-2021	8-3-2021	3.0	24.0	mussel monitor, turbidity, H3; LC Aqua-562 1,0 µg/l, Cal A4; Tributyl phosphate 3,8 µg/l	Quality
33	11-3-2021	11-3-2021	0.1	0.8	mussel monitor	Quality
34	11-3-2021	12-3-2021	0.5	4.0	turbidity	Quality
35	12-3-2021	12-3-2021	0.1	0.8	turbidity	Quality
36	12-3-2021	12-3-2021	0.1	0.8	turbidity	Quality
37	14-3-2021	15-3-2021	1.0	8.0	turbidity, mussel monitor	Quality
38	17-3-2021	18-3-2021	0.5	4.0	turbidity	Quality
39	21-3-2021	22-3-2021	1.0	8.0	mussel monitor	Quality
40	24-3-2021	25-3-2021	1.0	8.0	Dtox	Quality / Technical

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
41	27-3-2021	27-3-2021	0.1	0.8	turbidity	Quality
42	12-4-2021	19-4-2021	7.0	56.0	H4 LC Aqua-566 1,4 µg/l, Cal A6 zinc 232 µg/l, Cal A7 Daphnia alarm	Quality
43	21-4-2021	21-4-2021	0.3	2.0	Dtox	Technical
44	21-4-2021	23-4-2021	2.0	16.0	Maas Luikoil contamination	Quality
45	4-5-2021	4-5-2021	0.1	0.8	pH too low	Quality
46	7-5-2021	7-5-2021	0.2	1.6	Dtox	Technical
47	9-5-2021	10-5-2021	1.0	8.0	Dtox	Technical
48	17-5-2021	20-5-2021	3.0	24.0	Cal A8 3,2 µg/l Eijs-062, Sitech free Cyanide, turbidity	Quality
49	21-5-2021	26-5-2021	5.0	40.0	H5; Benzecarbothioicacid, 2,6 -dichloro-S-methylester 1,1 µg/l , Cal A9; Tributyl phosphate 5,6 µg/l	Quality
50	26-5-2021	31-5-2021	5.0	40.0	Cal A10 DIPE 10,7 µg/l, Cal A11 Tributyl phosphate 9,4 µg/l	Quality
51	3-6-2021	9-6-2021	6.0	48.0	Cal A12, Tributyl phosphate 7,7 ug/l. Cal A13 unknown substance 3,8 µg/l	Quality
52	11-6-2021	11-6-2021	0.1	0.8	Oil spill Heel lock (Waarschijnlijk Gasolie)	Quality
53	16-6-2021	18-6-2021	2.0	16.0	Dtox, Sitech pyrazole daily average; pyrazole 35 ug/l	Quality / Technical
54	26-6-2021	28-6-2021	2.0	16.0	mussel monitor	Quality
55	30-6-2021	7-7-2021	7.0	56.0	mussel monitor, Cal A14 zinc; 350 µg/l, Metobromuron 1,1 µg/l in week sampler, Cal A15 Tributylphosphate; 4,0 µg/l, Cal A16 copper and zinc , H6: LCAqua-507 1,1 µg/l en significant deviation	Quality
56	11-7-2021	12-7-2021	1.0	8.0	mussel monitor	Quality
57	13-7-2021	14-7-2021	1.0	8.0	mussel monitor	Quality
58	14-7-2021	26-7-2021	12.0	96.0	Discharge Maas > 1000 m^3/s, H7 unknown 2,1 µg/l en 1,8 µg/l	Quality
59	26-7-2021	27-7-2021	1.0	8.0	Metolachlor 1,2 µg/l, mussel monitor	Quality
60	31-7-2021	2-8-2021	2.0	16.0	pH too low, mussel monitor	Quality
61	4-8-2021	5-8-2021	1.0	8.0	pH too low, mussel monitor	Quality
62	6-8-2021	9-8-2021	3.0	24.0	pH too low, mussel monitor	Quality
63	11-8-2021	12-8-2021	1.0	8.0	pH too low, mussel monitor	Quality
64	12-8-2021	13-8-2021	1.0	8.0	pH too low, turbidity	Quality
65	13-8-2021	19-8-2021	6.0	48.0	ph too low, Cal A19 1-n-Butanol 26 µg/l, Cal A20 LC-Aqua 482 3,3 µg/l	Quality
66	23-8-2021	23-8-2021	0.1	0.8	mussel monitor	Quality

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
67	24-8-2021	30-8-2021	6.0	48.0	Cal A21 unknown Eijs-067 7,8 en 10,3 µg/l, Cal A22 prosulfocarb 1,1 µg/l, Dtox	Quality / Technical
68	3-9-2021	7-9-2021	4.0	32.0	H8 Cyclohexanone-D10-oxime 5 µg/l, pH	Quality
69	9-9-2021	9-9-2021	0.1	0.8	Cal A23 prosulfocarb 2,0 µg/l	Quality
70	11-9-2021	13-9-2021	2.0	16.0	mussel monitor	Quality
71	13-9-2021	27-9-2021	14.0	112.0	Cal A23 prosulfocarb 2,0 µg/l, NTU several times due to canal dredging, Cal A24 Propamocarb 5,1 µg/l, Dtox	Quality
72	29-9-2021	4-10-2021	5.0	40.0	H9 Propamocarb 0,48 µg/l, Cal A25 Prosulfocarb 3,4 µg/l,	Quality
73	6-10-2021	8-10-2021	2.0	16.0	H10 Propamocarb 0,16 µg/l, mussel monitor,	Quality
74	9-10-2021	11-10-2021	2.0	16.0	Cal A26 Tributyl phosphate 26,7 µg.l	Quality
75	15-10-2021	18-10-2021	3.0	24.0	Cal A27 DIPE 13,3 µg/l, mussel monitor	Quality
76	20-10-2021	22-10-2021	2.0	16.0	Sitech 18-10-21 Cyanide 20 µg/l gemeld op 20-10-21, mussel monitor Sitech, mussel monitor WML	Quality
77	27-10-2021	27-10-2021	0.4	3.2	turbidity	Quality
78	27-10-2021	29-10-2021	2.0	16.0	H11 propamocarb; Unsubscribed	Quality
79	1-11-2021	4-11-2021	3.0	24.0	Dtox, mussel monitor (multiple times), turbidity	Quality
80	8-11-2021	9-11-2021	1.0	8.0	mussel monitor	Quality
81	14-11-2021	16-11-2021	1.0	8.0	mussel monitor	Quality
82	16-11-2021	18-11-2021	0	0	[Early Warning System] Pump malfunction	Quality
83	21-11-2021	22-11-2021	1.0	8.0	mussel monitor, Dtox, Cal A28 DIPE 12,0 µg/l	Quality / Technical
84	22-11-2021	24-11-2021	2.0	16.0	H12 LCAqua-013 met 2,6 µg/l,unknown met 1,2 µg/l, mussel monitor	Quality
85	26-11-2021	2-12-2021	6.0	48.0	mussel monitor, CAL A29, Cal A30, Sitech notification, cleaning intake pipe.	Quality / Technical
86	7-12-2021	13-12-2021	6.0	48.0	mussel monitor, H13 Propamocarb 0,23 µg/l; Sitech Notifications free Cyanide 20 en 21 µg/l	Quality
87	19-12-2021	20-12-2021	1.0	8.0	mussel monitor	Quality
88	21-12-2021	31-12-2021	10.0	80.0	mussel monitor, Sitech notification op 52 µg/l Pyrazole, preventive intake stop Christmas / New Year turbidity	Quality
			154.7	1435.6		

Intake point: Evides Waterbedrijf, Biesbosch (Gat van de Kerksloot)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
89	Vr 01-01-21 00:00	sat 02-01-21 11:00	1.46	35.00	Increased turbidity	
90	Wed 06-01-21 02:45	Wed06-01-21 10:45	0.33	8.00	Biomonitor Alarm (daphnia)	Not valid
91	Tue 09-03-21 10:30	Wed 17-03-21 11:00	8.02	192.50	Warning water board, alert incident AVI Den Bosch	
92	sat 27-03-21 04:30	Mon 29-03-21 11:45	2.30	55.25	Biomonitor Alarm (daphnia)	
93	Mon 29-03-21 17:15	Tue 30-03-21 09:15	0.67	16.00	Biomonitor Alarm (daphnia)	
94	Tue 30-03-21 21:00	Wed 31-03-21 15:30	0.77	18.50	Biomonitor Alarm (daphnia)	
95	Sun 04-04-21 11:00	Tue06-04-21 08:30	1.90	45.50	Biomonitor Alarm (daphnia)	
96	Tue 13-04-21 07:00	Tue13-04-21 15:30	0.35	8.50	Biomonitor Alarm (daphnia)	
97	Fri 16-04-21 01:00	Fri 23-04-21 14:00	7.54	181.00	Biomonitor Alarm (daphnia)	
98	Tue 04-05-21 03:30	Tue 04-05-21 16:00	0.52	12.50	Biomonitor Alarm (daphnia)	
99	Wed 02-06-21 13:00	Mon 07-06-21 14:30	5.06	121.50	Warning water board N-ethyl-2pyrrolidone	Substance of very high concern (SVHC)
100	Fri 16-07-21 08:30	Wed 28-07-21 11:30	12.13	291.00	Warning from border monitoring station Eijsden	High water July 2021
101	Fri 13-08-21 18:15	Mon 16-08-21 09:00	0	0	Malfunction monsternamewater	No online measurement available
102	Thurs 02-09-21 12:30	Mon 06-09-21 16:00	4.15	99.50	Warning from border monitoring station Eijsden increased levels of prosulfocarb	Preventive stop, not confir-med by own measurements
103	Fri 15-10-21 14:15	Tue 19-10-21 12:00	3.91	93.75	Warning from a fellow drinking water company	Preventive with regards to warning from AVI Den Bosch
			49.11	1178.5		

Intake point: Evides Waterbedrijf, Haringvliet

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
104	Wed 03-02-21 16:00	Mon 08-02-21 19:00	5.13	123	Exceedance alarm signal	
105	Wed 10-02-21 10:00	Thurs 11-02-21 08:00	0	0	Technical (Drinking water company)	
106	Fri12-02-21 01:00	Fri 12-02-21 06:00	0	0	Malfunction	
107	Sat13-02-21 04:00	Mon 15-02-21 07:00	0	0	Malfunction	
108	Tue 02-03-21 02:00	Tue 02-03-21 06:00	0	0	Malfunction	
109	Tue23-03-21 09:00	Tuei 23-03-21 14:00	0	0	Technical Company	
110	Mon 29-03-21 09:00	Mon 29-03-21 15:00	0	0	Maintenance	
111	Sat 17-04-21 22:00	Sun 18-04-21 07:00	0	0	Malfunction	
112	Mon 10-05-21 08:00	Wed 12-05-21 13:00	0	0	Maintenance	
113	Sat 15-05-21 08:00	Sun16-05-21 11:00	0	0	Malfunction	
114	Tue 08-06-21 18:00	Wed 09-06-21 08:00	0	0	Malfunction	

Intake point: Evides Waterbedrijf, Haringvliet

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation behind intake stop
115	Sat 19-06-21 04:00	Sat 19-06-21 09:00	0	0	Malfunction	
116	Mon 21-06-21 22:00	Tue 22-06-21 08:00	0	0	Malfunction	
117	Wed 23-06-21 17:00	Wed 23-06-21 21:00	0	0	Malfunction	
118	Sun 27-06-21 16:00	Sun 27-06-21 21:00	0	0	Malfunction	
119	Wed 30-06-21 06:00	Wed 30-06-21 16:00	0	0	Maintenance	
120	Tuei 20-07-21 22:00	Tue 27-07-21 13:00	6.63	159	Exceedance alarm signal	
121	Wed 20-10-21 02:00	Wed 20-10-21 08:00			Malfunction	
122	Wed 24-11-21 02:00	Wed 24-11-21 07:00			Malfunction	
			11.76	282		

Alarm notifications (source: Rijkswaterstaat)

No.	Parameter	CASRN	Concen-tration		Water Discharge		Date	Location	Remark
CAL A1	Tributyl phosphate	126-73-8	5,5	µg/l	267	m³/s	10-1-2021	Monitoring Station Eijsden	The aggregate sample from 9/10-1-2021 18-06 hours contains Tributyl phosphate with a concentration of 5.5 ug/litre. This is above the alarm limit of 3.0 ug/litre.
CAL A2	diisopropyllether	108-20-3	10,5	µg/l	234	m³/s	11-1-2021	Monitoring Station Eijsden	In the PT-GCMS sample of 11-1-2021 18:00 hours there is a concentration of 10.5 ug/litre Diisopropyl ether (DIPE). This is above the alarm limit of 10.0 ug/litre.
CAL A3	unknown substance		12,7	µg/l	668	m³/s	21-1-2021	Monitoring Station Eijsden	In the sample 11.45 hours on the PE-GCMS system, there was an exceedance of an unknown substance with a concentration: 12.7 ppb. Retention time: 11.86 min. R(rt): 1.04. This is above the alert limit.
CAL A4	Tributyl phosphate	126-73-8	3,8	µg/l	176	m³/s	7-3-2021	Monitoring Station Eijsden	There is an exceedance of the alarm limit (3 ug/l) of Tributyl phosphate with a concentration = 3.8ug/l
CAL A5	unknown substance		3,4	µg/l	312	m³/s	12-4-2021	Monitoring Station Eijsden	Exceedance of an unknown substance (alarm value 3ug/l). Measured value: 3.4ug/l, in the analysis of the 7:15h sample with SPE LCUV at Monitoring Station Eijsden. No particularities were observed with regards to biological monitoring. As a result, no consequences for the aquatic system are expected.

Alarm notifications (source: Rijkswaterstaat)

No.	Parameter	CASRN	Concen-tration		Water Discharge		Date	Location	Remark
CAL A6	Dissolved Zinc		232,7	µg/l	285	m³/s	13-4-2021	Monitoring Station Eijsden	Measured value is well above the alarm value (65 ug/l). The maximum acceptable concentration (MAC-EQS) for dissolved zinc according to the Water Framework Directive is 15.6 µg/l. Aquatic effects cannot be excluded with such a concen-tration. Over the past 15 years, peak concentrations have previously been observed (including a concentration in 2007 of 330 ug/l), which have not directly led to large-scale effects. A verification measurement has been started, the results will be available in a few hours
CAL A7	Biological Alaram				171	m³/s	15-4-2021	Monitoring Station Eijsden	Daphnia biological alarm for a sample taken on April 15 (2:30 pm.). Daphnia died. Cause is yet unknown. The 18:30 p.m. sample found no exceedances of physical parameters: LCUV or GCMS.
-	Hydrocarbon				125	m³/s	19-4-2021	Meuse Luik contamination HWP	Hydrocarbon. Somewhat visible from the oil port. The pollution is clearly visible from Rue du Dossay on the TOTAL unloading station. The source has not yet been identified. Firefighters were present. The origin has not been found. Given that the origin could not be determined, no action has been taken at this time.
CAL A8	unknown substance		3,2	µg/l	82	m³/s	14-5-2021	Monitoring Station Eijsden	In the sample of 14-5-2021 (06.00-18.00 hours) is 34.90-2021-Eijs-062 with a concentration of 3.2 ug/l and a retention time of 30.69 minutes.
CAL A9	Tributyl phosphate	126-73-8	5,6	µg/l	125	m³/s	23-5-2021	Monitoring Station Eijsden	In the Meuse, at the Monitoring Station Eijsden, an exceedance of Tributyl phosphate (5.6 ug/l) (alarm value of (3 ug/l)) was found in the aggregate sample of 22-05-2021 06.00-18.00h, In the follow-up sample of 22-05-2021 18.00-06.00h, the concentration (1.7 ug/l) dropped below the alarm value.
CAL A11	Tributyl phosphate	126-73-8	9,4	µg/l	210	m³/s	26-5-2021	Monitoring Station Eijsden	In the Meuse at measuring station Monitoring Station Eijsden, an exceedance (9.4 ug/l) (with an alarm value (3 ug/l)) of the t substance Tributyl phosphate was found in the aggregate sample of 25/26-5-2021 18:00-06:00 hours. Tributyl phosphate is used as a solvent in the chemical industry. Drinking water companies are informed, no effects on the aquatic environment or media reports are expected

Alarm notifications (source: Rijkswaterstaat)

No.	Parameter	CASRN	Concen-tration		Water Discharge		Date	Location	Remark
CAL A10	diisopropylether	108-20-3	10,7	µg/l	210	m³/s	26-5-2021	Monitoring Station Eijsden	A slight exceedance (10.7 µg/l) for the substance Diisopropyl ether (alarm value (10 µg/l)) was found in a random sample dated 26-5-2021 8:00 A.M. at Eijsden monitoring station. Diisopropyl ether is a solvent widely used in the chemical industry. No effects on the aquatic environment or media reports are expected
CAL A12	Tributyl phosphate	126-73-8	7,7	µg/l	107	m³/s	1-6-2021	Monitoring Station Eijsden	The SPE/GC-MS aggregate sample (from 31-5-2021 18:00 hours to 1-6-2021 06:00 hours) presents a content of 7.7 ug /l Tributyl phosphate. This is above the alarm limit of 3.0 ug/l.
CAL A13	unknown substance		3,8	µg/l	119	m³/s	4-6-2021	Monitoring Station Eijsden	Exceedance (3 ug/l) of an unknown substance (start 29-05-21). Last exceedance 02-06-21 (3.8 ug/L). Day durations of these concentrations have been calculated.
CAL A14	Zinc	7440-66-6	350	µg/l Zn	63	m³/s	15-6-2021	Monitoring Station Eijsden	In the aggregate sample of 15 June 18:00 – 06:00 location Monitoring Station Eijsden (Meuse), a possible exceedance of the parameter Zinc (reported value 350 ug/l, alarm value 65 ug/l) was detected. Monitoring Station Eijsden is currently under maintenance. The samples are taken by RWS, but the analysis has been carried out by an external party. When a high measured value is reported, this measurement value is confirmed according to our own procedure by measuring a diluted sample. If this diluted sample also shows a high measurement value, there is an alarm. Unfortunately, the analysis of a dilution could not take place because due to the late detection of the exceedance, hence no sample was available. The measured value for Zinc in the aggregate samples before and after the elevated sample do not show an increased value (reported value < reporting limit). Within RWS-LCM there is doubt about the reliability of the measured value: reanalysis is unfortunately not possible. Drinking water companies are informed. In addition, the interested party will also be communicated on this matter via email.

Alarm notifications (source: Rijkswaterstaat)

No.	Parameter	CASRN	Concen-tration		Water Discharge		Date	Location	Remark
CAL A16	Zinc; Copper		94; 17	µg/l	383	m³/s	30-6-2021	Monitoring Station Eijsden	At the Monitoring Station Eijsden (in the aggregate sample of 30-6-2021 6:00 -18:00), an exceedance of copper with a concentration of 17 ug/l (alarm limit 15 ug/l) and an exceedance of Zinc with a concentration of 94 ug/l (alarm limit is 65 ug/l) was observed. Due to the maintenance operations being conducted at the monitoring station, this message has only been received today. In the follow-up sample of 30/1-7-2021 18-6 hours, the values are again below the alarm limit (Copper 12 ug/l, Zinc 53 ug/l).
CAL A15	Tributyl phosphate	126-73-8	4	µg/l	268	m³/s	5-7-2021	Monitoring Station Eijsden	There is an exceedance of the alarm limit (3ug/litre) of the substance: Tributyl phosphate. The concentration is 4.0 ug/litre in the aggregate sample from 3-7-21 06:00 to 3-7-2021 18:00 from the Maas Eijsden.
CAL A17	Zinc, Copper en Lood		110; 16; 29	µg/l	823	m³/s	19-7-2021	Monitoring Station Eijsden	At the Monitoring Station Eijsden: the sample of 14 July 16:10h was measured by the external laboratory AL-west (due to maintenance operations being conducted at the station). They give an overrun for: Zinc: 110 ug/l (max: 65) Lead: 29 ug/l (max 15) Copper: 16 ug/l (max 15).
	Nafta		N/A			m³/s	20-7-2021	Km 36,3 from the Grensmaas	This morning a reduction in pressure was observed in the naphtha pipe at km 36.3 of the Grensmaas. This pipe is in the water bottom of the Meuse but has now been released free due to the high water. The stretch between Leut and port Stein is now blocked. From Leut, water was pumped into the pipe and the 200 m³ naphtha that was in the pipe was collected in Stein. Now there is only water in the pipe. Naphtha is very volatile; smell was detected at the location. No visual effects on the Grensmaas were observed. No sample was taken of the river water. There is no information about the amount of leaked naphtha.
CAL A18	unknown substance		5,3 - 11	µg/l	207	m³/s	7-8-2021	Monitoring Station Eijsden	In the Meuse at Monitoring Station Eijsden, an exceedance (ranging from 5.3 ug/l - 11 ug/l) of the alarm value (3 ug/l) of an unknown substance was observed on 7 and 8 August. On 9 August, the value dropped below the alarm limit again. Due to maintenance operations currently conducted at the station, the measurements are now carried out by an external party. Therefore, information is available later than usual. Drinking water companies are informed. No effects on the aquatic environment or media reports are expected.

Alarm notifications (source: Rijkswaterstaat)

No.	Parameter	CASRN	Concen-tration		Water Discharge		Date	Location	Remark
CAL A20	LcAqua-482		3	µg/l	120	m^3/s	13-8-2021	Monitoring Station Eijsden	In the sample from 13-8-2021 8.00 hours an unknown substance LcAqua-482 with a concentration of 3.0 ug/l was detected
CAL A19	1-n-Butanol	71-36-3	42	µg/l	118	m^3/s	14-8-2021	Monitoring Station Eijsden	Alarm exceedance (42 ug/l) of 1-n-Butanol (alarm limit for organic compounds 3 ug/l), at Eijsden monitoring station.
CAL A21	unknown substance		7,8 - 10,3	µg/l	121	m^3/s	24-8-2021	Monitoring Station Eijsden	
CAL A22	prosulfocarb	52888-80-9	1,1	µg/l	94	m^3/s	25-8-2021	Monitoring Station Eijsden	Prosulfocarb is a plant protection product. The chemical name is S-Benzyl dipro-pylthiocarbamate.
CAL A23	prosulfocarb	52888-80-9	2	µg/l	69	m^3/s	9-9-2021	Monitoring Station Eijsden	The substance prosulfocarb (plant protec-tion product) was found in the aggregate sample (2,0 ug/L). Drinking water com-panies are informed. Currently, we do not expect any adverse effects on water quality or media reports.
CAL A24	prosulfocarb	52888-80-9	5,1	µg/l	101	m^3/s	16-9-2021	Monitoring Station Eijsden	There is an exceedance (5.1 µg/l) of the substance prosulfocarb (of the alarm value (1 µg/l)) in the Meuse near Eijsden. Prosulfocarb is a broad-acting soil herbici de that has a contact effect on both grasses and broadleaf weeds. The concentration of this substance in the Meuse has fluctuated around the alarm value in the past month. Drinking water companies have been warned.
CAL A25	prosulfocarb	52888-80-9	3,4	µg/l	75	m^3/s	30-9-2021	Monitoring Station Eijsden	In the sample of 30-9-2021 05.00-06.30 hours there is an exceedance of prosul-focarb with a concentration of 3.4 ug/l.
CAL A26	Tributyl phosphate	126-73-8	26,7	µg/l	128	m^3/s	8-10-2021	Monitoring Station Eijsden	Sample of 7/8-10-2021 18.00h-06.00h with a concentration = 26.7 ug/l rt = 28.63
CAL A27	Diisopropyl ether	108-20-3	13,3	µg/l	87	m^3/s	13-10-2021	Monitoring Station Eijsden	In the PT-GCMS sample of 13-10-2021 13:00 hours there is a concentration of 13.3 ug/litre Diisopropyl ether. This is above the alarm limit of 10 ug/litre. Follow-up analyses; Cal A27 Maas Eijsden. 13-10-2021 18:00 hrs 23,8 ug/l Diisopropyl ether 14-10-2021 00:00 hrs 26,7 ug/l Diisopropyl ether 14-10-2021 06:00 hrs 31,5 ug/l Diisopropyl ether 14-10-2021 13:00 hrs 28,1 ug/l Diisopropyl ether 14-10-2021 18:00 hrs 28,1 ug/l Diisopropyl ether 14-10-2021 18:00 hrs 13:00 hrs 23,8 ug/l Diisopropyl ether 14-10-2021 06:00 hrs 31,5 ug/l

Alarm notifications (source: Rijkswaterstaat)

No.	Parameter	CASRN	Concen-tration		Water Discharge		Date	Location	Remark
CAL A27 (contin-uation)									Diisopropyl ether 14-10-1021 18:00 hrs 13:00 hrs 26,7 ug/l Diisopropyl ether 14-10-2021 26,7 ug/l Diisopropyl ether 14:00 hrs 13:00 hrs 23,8 ug/l Diisopropyl ether 14-06:00 hrs 00:00 hrs 26,7 ug/l Diisopropyl ether 14-10-2021 26,7 ug/l Diisopropyl ether 14:00 hrs 2021 13:00 hrs 23,8 ug/l Diisopropyl ether 14-10-2021 000 hrs 26,700 hours 28.2 ug/l Diisopropyl ether 15-10-2021 00:00 hours 24.4 ug/l Diisopropyl ether 15-10-2021 06:00 hours 16.4 ug/l Diisopropyl ether 16-10-2021 13:00 hours 9.7 ug/l Diisopropyl ether 16-10-2021 18:00 hours 8.9 ug/l Diisopropyl ether
-			N/A		84	m^3/s	14-10-2021		WSAM Large fire along Ertveldplas Den Bosch
CAL A28	Diisopropyl ether	108-20-3	12	µg/l	114	m^3/s	21-11-2021	Monitoring Station Eijsden	In the PT-GCMS sample of 21-11-2021 13:00 hours there is a concentration of 12.0 ug/litre Diisopropyl ether. This is above the alarm limit of 10 ug/litre.
CAL A29	Tributyl phosphate	126-73-8	5,8	µg/l	77	m^3/s	25-11-2021	Monitoring Station Eijsden	In the SPE/GC-MS aggregate sample (from 24-11-2021 18:00 hours to 25-11-2021 06:00 hours a) a concentration of 5.8 ug /l Tributyl phosphate was found. This is above the alarm limit of 3.0 ug/l. The retention time is 28.62 min
CAL A30	Diisopropyl ether	108-20-3	13,0	µg/l	81	m^3/s	26-11-2021	Monitoring Station Eijsden	In the Meuse, at monitoring station Eijsden, the sample from 26-11-2021 - 00:00, showed an exceedance of Diisopropyl ether (10.7 ug/l) (alarm value (10 ug/l)). The concentration of the sample from 26-11-2021 - 06:00 is 13.0 ug/l
	pyrazole	288-13-1	30	µg/l	199*	m^3/s	22-12-2021	-	Based on samples and by means of the online monitor effluent from Industrial wastewater Treatment Plant, the concentration may be that a higher than the licensed value which can be seen in the daily sample of today 22-12. Results of the daily sample will not be known until tomorrow 23-12.

Annex 3

Target values in the European River Memorandum

(maximum values, unless stated otherwise)

General parameters	Target value
Oxygen content	> 8 mg/L
Electrical conductivity	70 mS/m
pH value	7 - 9
Temperature	25 °C
Chloride	100 mg/L
Sulphate	100 mg/L
Nitrate	25 mg/L
Fluoride	1.0 mg/L
Ammonium	0.3 mg/L
Composite organic parameters	**Target value**
Total organic carbon (TOC)	4 mg/L
Dissolved organic carbon (DOC)	3 mg/L
Adsorbable organic halogen compounds (AOX)	25 µg/L
Adsorbable organic sulphur compounds (AOS)	80 µg/L
Anthropogenic (non natural) substances	**Target value**
Evaluated substances without known effects on biological systems microbially poorly degradable substances, per individual substance	1.0 µg/L
Evaluated substances with known effects on biological systems, per individual substance	0.1 µg/L*
Non-evaluated substances that cannot be removed sufficiently by natural procedures, per individual substance	0.1 µg/L
Non-evaluated substances that form non-evaluated degradation/transformation products, per individual substance	0.1 µg/L

**except if toxicological findings require an even lower value, e.g. for genotoxic substances)*

(Source: European River Memorandum (2020); https://www.riwa-rijn.org/wp-content/uploads/2020/03/European-River-Memo-randum-2020-English.pdf)

From 2021, testing is done for the following substances against the ERM target value of 1 µg/L, where previously testing was still done against 0.1 µg/L:

Parameter	CASRN	IDRW		ERM-sw	
2-Methoxy-1-propanol	1589-47-5	10,5	µg/l	1	µg/l
guanylurea	141-83-3	22,5	µg/l	1	µg/l
trichloromethane	67-66-3	25	µg/l	1	µg/l
Dihydroxycarbazepine	58955-93-4, 35079-97-1	50	µg/l	1	µg/l
carbamazepine	298-46-4	50	µg/l	1	µg/l
1,3,5-trimethylbenzene	108-67-8	70	µg/l	1	µg/l
Sotalol	3930-20-9	80	µg/l	1	µg/l
Gabapentin	60142-96-3	100	µg/l	1	µg/l
Metformin	657-24-9	196	µg/l	1	µg/l
triglyme	112-49-2	440	µg/l	1	µg/l
diglyme	111-96-6	440	µg/l	1	µg/l
tetraglyme	143-24-8	440	µg/l	1	µg/l
Ethyl lactate	97-64-3	500	µg/l	1	µg/l
1,3,5-naphthalenetrisulfonic acid	6654-64-4	0,7	mg/l	1	µg/l
1,3,6-Naphthalenetrisulfonic acid, trisodium salt	5182-30-9	0,7	mg/l	1	µg/l
1,3,6-naphthalenetrisulfonic acid	86-66-8	0,7	mg/l	1	µg/l
Trisodium 1,3,6-naphthalenetrisulfonate	19437-42-4	0,7	mg/l	1	µg/l
Disodium 1,5-naphthalenedisulfonate	1655-29-4	0,7	mg/l	1	µg/
1,5-naphthalenedisulfonic acid	81-04-9	0,7	mg/l	1	µg/l
1,7-naphthalenedisulfonic acid	5724-16-3	0,7	mg/l	1	µg/l
2,7-naphthalenedisulfonic acid	92-41-1	0,7	mg/l	1	µg/l
2,5-furandicarboxylic acid	3238-40-2	1100	µg/l	1	µg/l
butanone	78-93-3	1,3	mg/l	1	µg/l
saccharin	81-07-2	1300	µg/l	1	µg/l
butoxypopyproyleen glycol	9003-13-8	1400	µg/l	1	µg/l
triethyl phosphate	78-40-0	1400	µg/l	1	µg/l
2-methyl-2-propanol	75-65-0	1,5	mg/l	1	µg/l
cyclamic acid	100-88-9	2500	µg/l	1	µg/l
amsonic acid disodium salt	7336-20-1	7	mg/l	1	µg/l
4,4'-diamino-2,2'-stilbenedisulfonic acid	81-11-8	7	mg/l	1	µg/l

Continuation

Parameter	CASRN	IDRW		ERM-sw	
polysorbate 60	9005-67-8	175	mg/l	1	µg/l
diatrizoic acid	117-96-4	250	mg/l	1	µg/l
iohexol	66108-95-0	375	mg/l	1	µg/l
iopamidol	60166-93-0	415	mg/l	1	µg/l
ioxitalamic acid	28179-44-4	500	mg/l	1	µg/l
iomeprol	78649-41-9	1000	mg/l	1	µg/l

CASRN = CAS registry number, IDRW = Indicative drinking water target value, ERM-sw = target value in the European River Memorandum

In addition to/in deviation from the above, in this report, the following target values are kept to for Meuse water from which drinking water is prepared:

Bromide	: 70 µg/L
Bromate	: 1 µg/L (based on https://www.rivm.nl/publicaties/risicogrenzen-voor-bromaat-in-oppervlaktewater-afleiding-volgens-methodiek-van)
Caffeine	: 1 µg/L (based on Opinion of the Scientific Committee on Food on Additional information on "energy" drink shttp://ec.europa.eu/food/fs/sc/scf/out169_en.pdf)
NDMA	: 12 ng/L (based on the Drinkwaterbesluit (Drinking Water Decree))

The target values for bioassays in this report are the effect-based trigger (EBT) values for human health in Been et al., 2021:

ER-CALUX 17ß-estradiol (E2)	: 0.25 ng E2-eq/L (0.083)
Anti-AR CALUX Flutamide (Flut)	: 4800 ng Flut-eq/L (270)
AR-CALUX Dihydrotestosterone (DHT)	: 4.5 ng DHT-eq/L (0.51)
PR-CALUX Progesterone (P4)	: 15.5 ng P4-eq/L (0.22)
GR-CALUX Dexamethasone (DEX)	: 47.9 ng DEX-eq/L (1.7)
PAH-CALUX Benzo[a]pyrene (BaP)	: 24.4 ng BaP-eq/L (19)

Colophon

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Maps: KWR Water Research Institute, Deltares

Infographics: Ilva Besselink (Studio Ilva)

English Translation: KERN B.V.

Publisher: RIWA-Meuse (Association of River Water Companies)

Designer: Make My Day, Wormer

Photography: Shutterstock, Sitech, Evides, Frans Berkelaar, WML; Kim Willems / Shutterstock.com, Chedko / Shutterstock.com, TasfotoNL / Shutterstock.com

ISBN/EAN: 9789083075983

Publication date: 5 September 2022


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