Upflow GAC

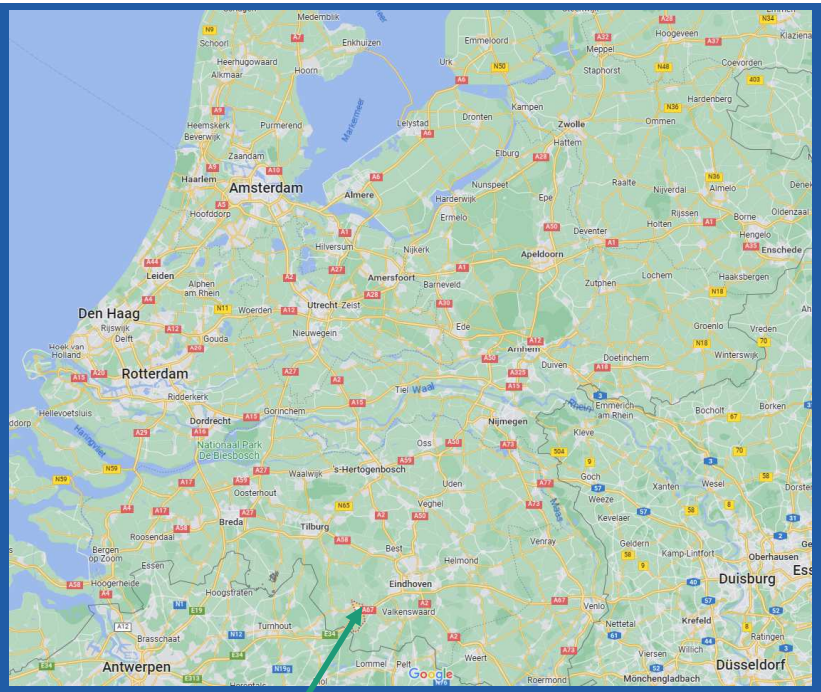
Removal of Micropollutants on WWTP Hapert

08-11-2023 Alexandra Deeke

Pilots Upflow GAC

- Where have the pilots been tested?
- Which technologies are used in the pilottests?
- What are the final results?
- How do these technologies perform compared to the reference technologies?

Where were the pilot installations tested?



Top 10 regional Hotspotanalysis

Aa en Maas	AARLE RIXTEL	8,8%
De Dommel	EINDHOVEN	25,8%
De Dommel	TILBURG-NOORD	13,2%
Aa en Maas	LAND VAN CUIJK (HAPS)	5,4%
Aa en Maas	OIJEN	4,1%
De Dommel	HAPERT	3,1%
Brabantse Delta	RIJEN	1,2%
Limburg	HOENSBROEK	3,7%
Aa en Maas	DINTHER	2,9%
De Dommel	HILVARENBEEK /BIEST-HOUTAKKER	1,9%

RWZI Hapert:

64.373 p.e.

12.085 m³/day (average)

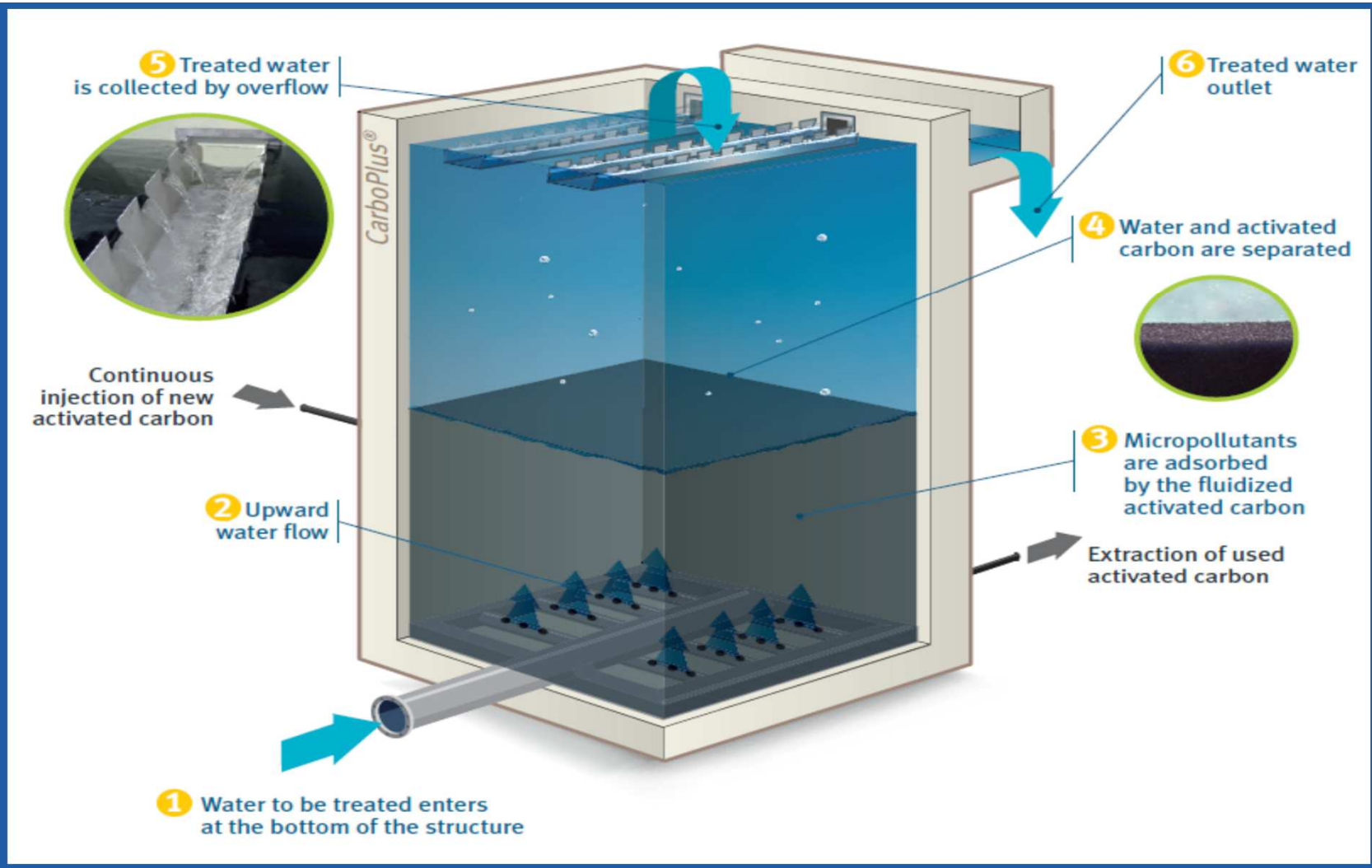
Effluent treated in waterharmonica

Revitalized and released on “Grote Beerze”

Location pilots

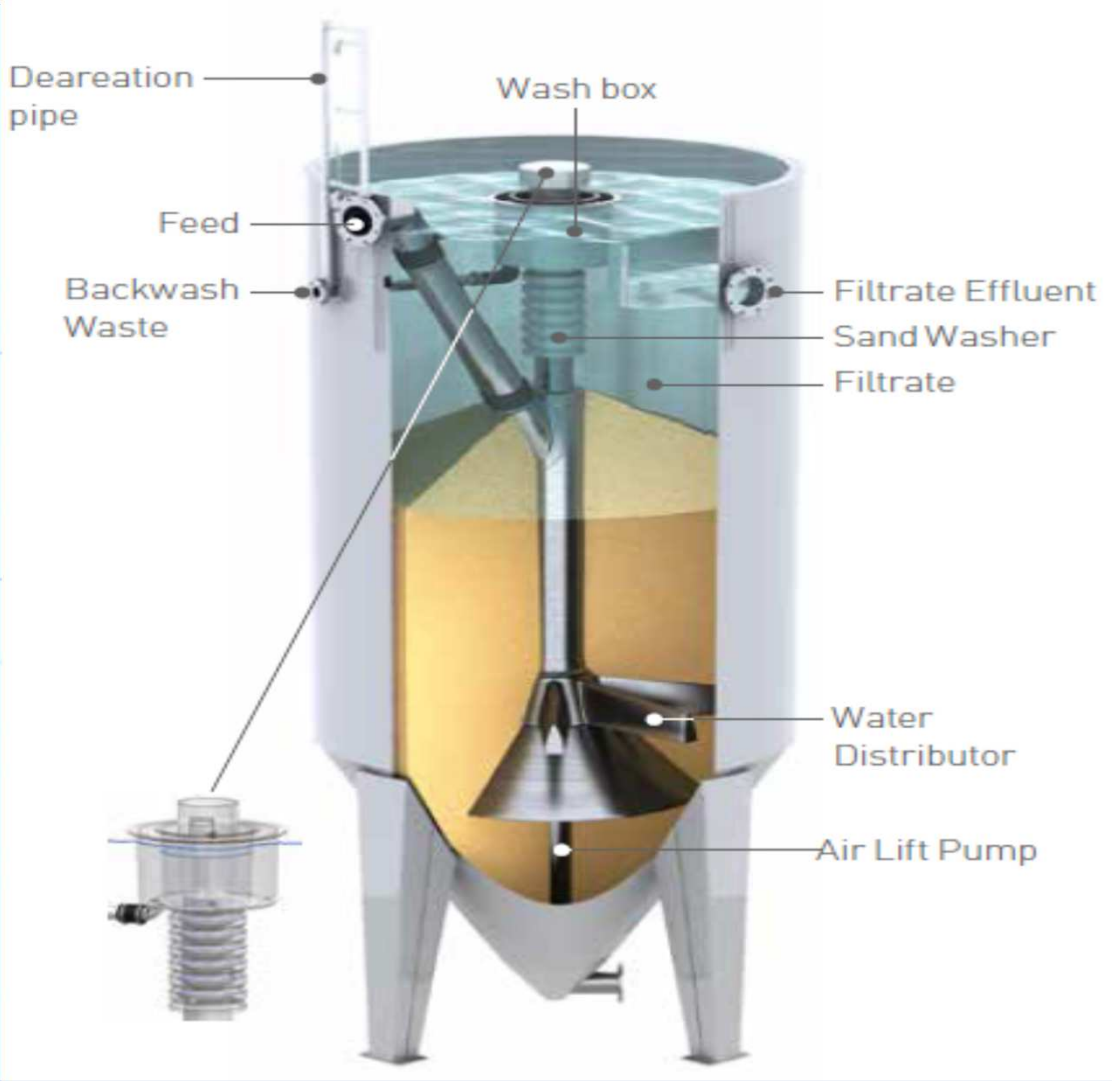
Which technologies?-1 Carboplus

Carboplus
by Stereau

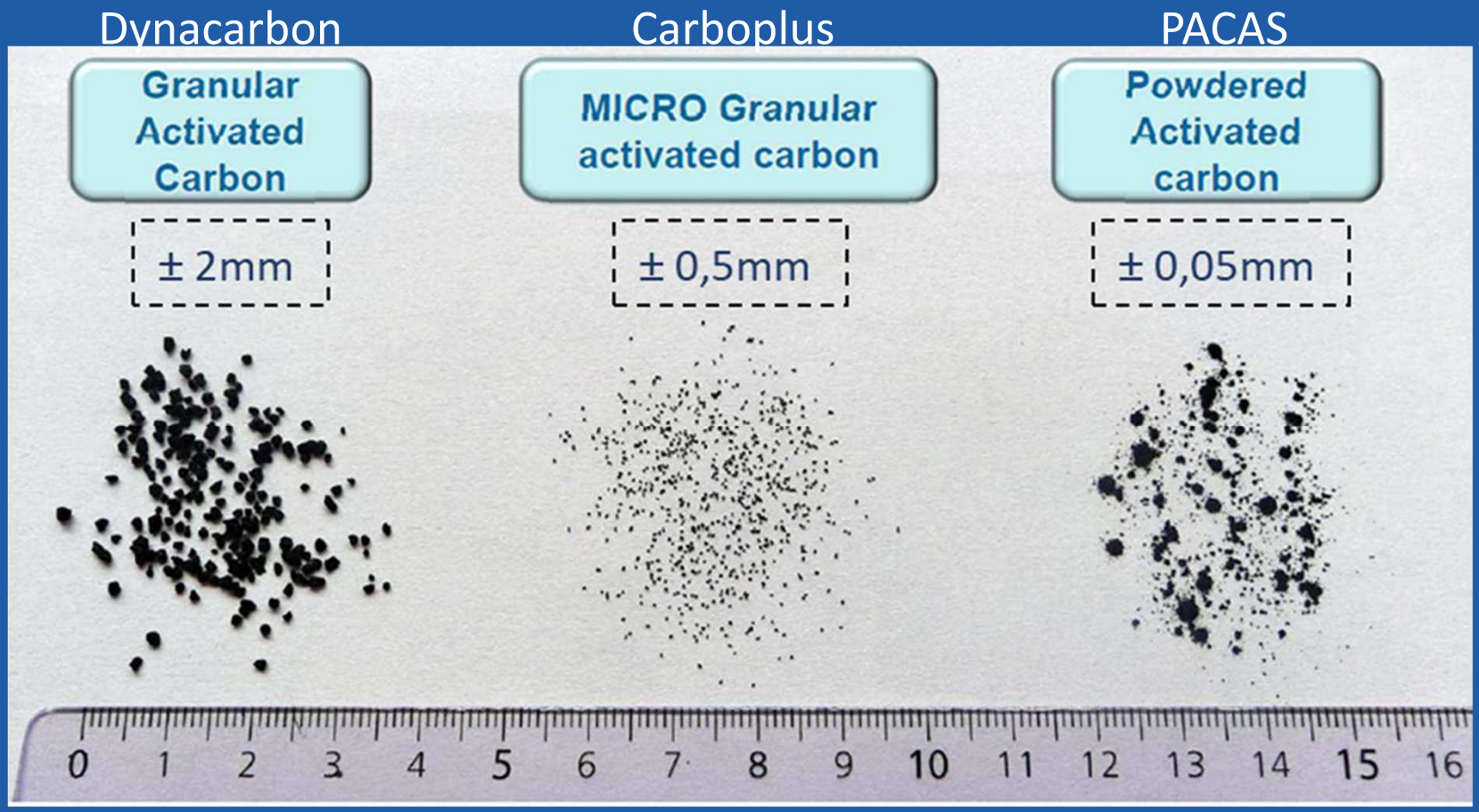


Which technologies? – 2 Dynacarbon

Dynacarbon by Nordicwater



Which type of activated carbon?



Both pilots were operated using Cyclecarb (a reactivated carbon) by Chemviron

Carboplus - pilotinstallation

What does the pilot look like?

Pilot:

Dosage of coal - manually

Extraction of coal - manually

Flushing – manually

Full scale:

Dosage of coal - automatically

Extraction of coal – automatically

Flushing - automatically

Carboplus

Used Carbon: Cyclecarb 305, Chemviron

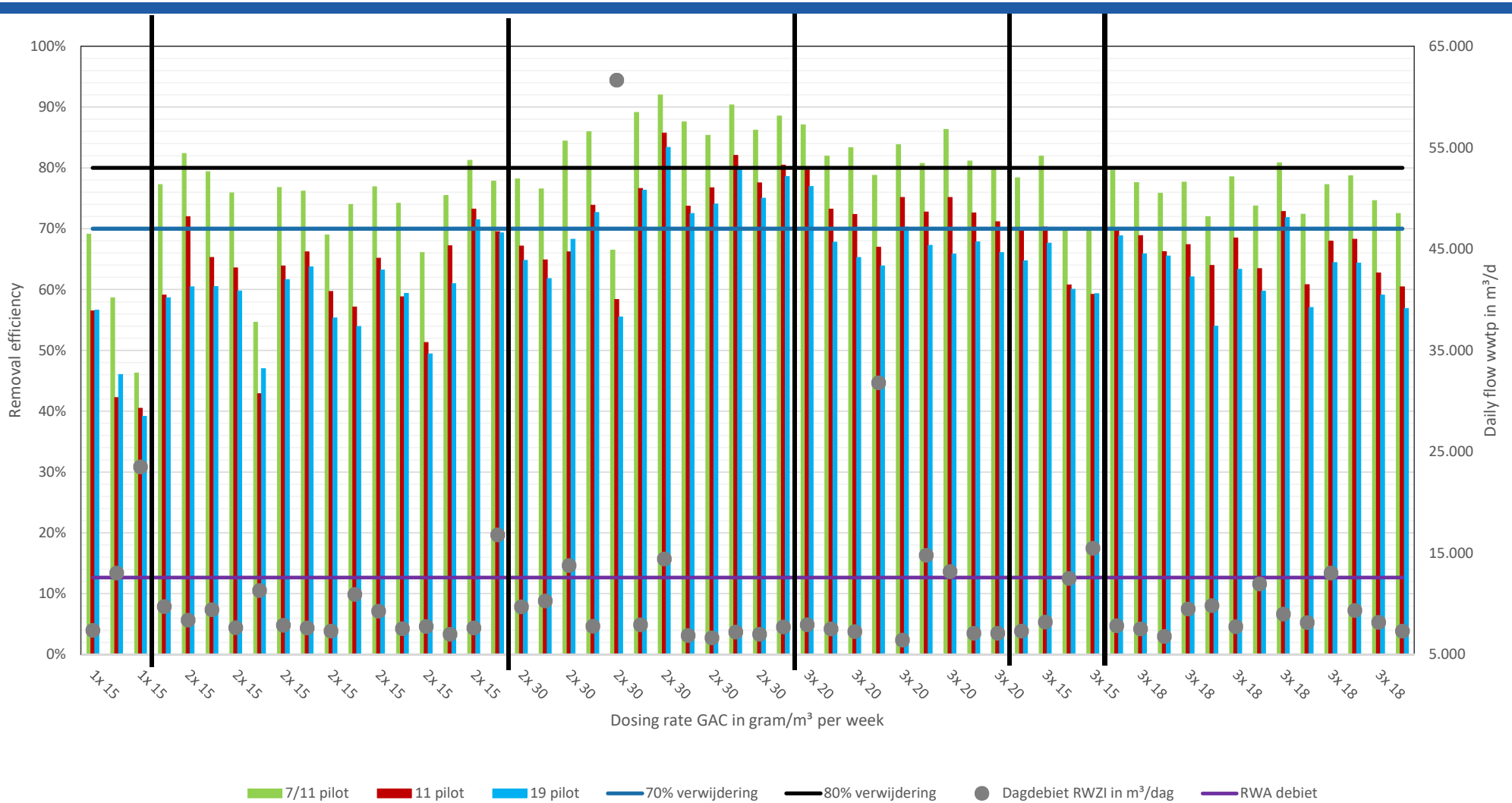
Bed height at rest: ~1,50m => Bed height in expansion: ~ 2,10m

Feed flow rate: ~ 0,266m³/h => Total treated volume: m³

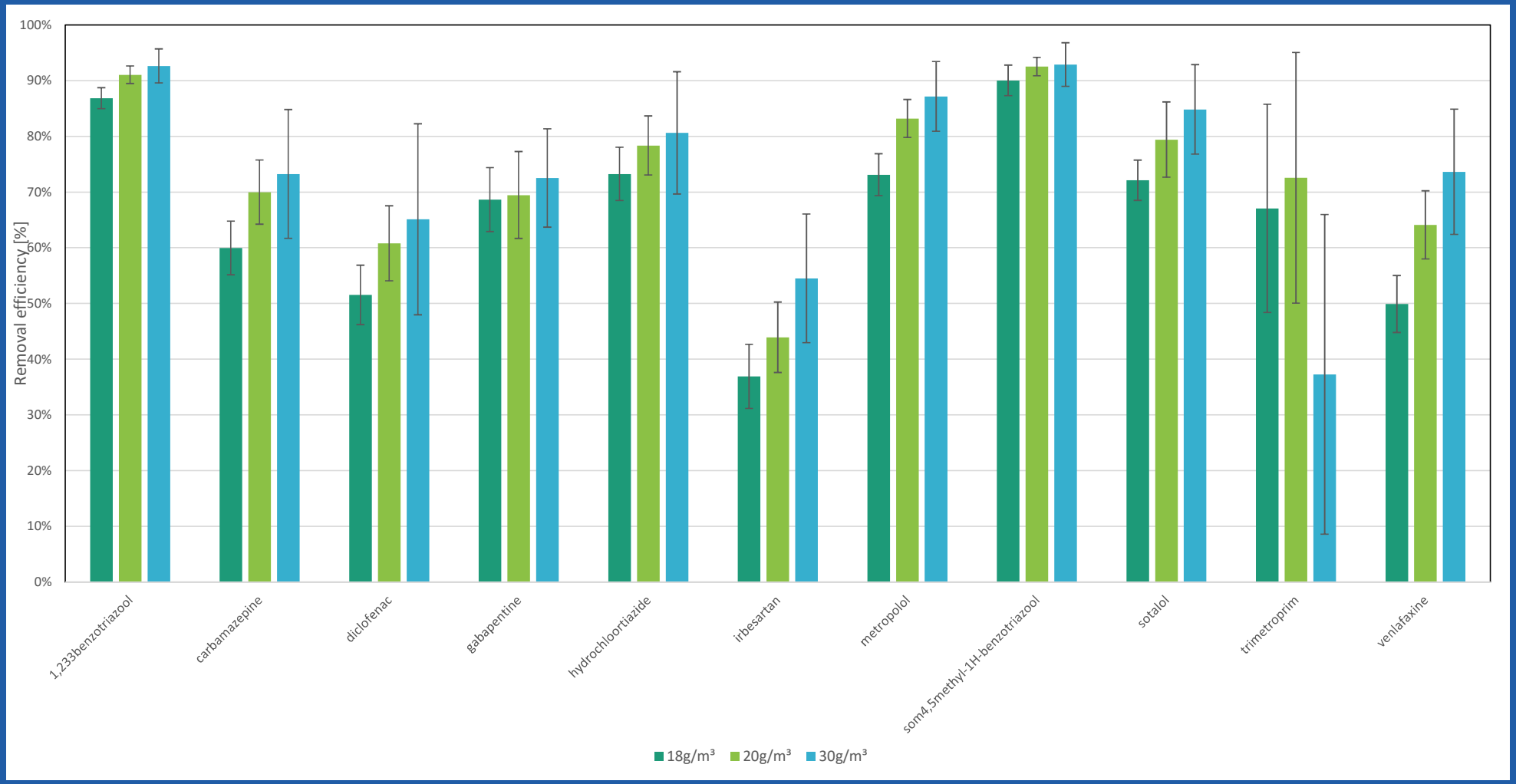
Tested feeding rates: 15, 18, 20, 30 g/m³

	Nov `20	Dec `20	Jan `21	Feb `21	Mar `21	Apr `21	May `21	Jun `21	Jul `21	Aug `21	Sep `21	Oct `21	Nov `21	Dec `21	Jan `22	Feb `22	Mar `22
dosing rate [g/m³]	Start-up		15						30			20	15	18			
Addition of coal [times per week]			1			2								3			
Addition pre-treatment	Without Sobye-filter								With Sobye-filter								

Carboplus


Removal efficiency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Daily flow wwtp in m³/d
65.000
55.000
45.000
35.000
25.000
15.000
5.000
1x 15
1x 15
2x 15
2x 15
2x 15
2x 15
2x 15
2x 15
2x 15
2x 30
2x 30
2x 30
2x 30
2x 30
2x 30
3x 20
3x 20
3x 20
3x 20
3x 20
3x 15
3x 15
3x 18
3x 18
3x 18
3x 18
3x 18
3x 18
Dosing rate GAC in gram/m³ per week
7/11 pilot
11 pilot
19 pilot
70% verwijdering
80% verwijdering
Dagdebiet RWZI in m³/dag
RWA debiet

Carboplus


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Removal efficiency [%]
1,233benzotriazool
carbamazepine
diclofenac
gabapentine
hydrochloortiazide
irbesartan
metropolol
som4,5methyl-1H-benzotriazool
sotalol
trimetroprim
venlafaxine
18g/m³
20g/m³
30g/m³

Dynacarbon - pilotinstallation

What does the pilot look like?

Pre-treatment
effluent wwtp
Sobye-filter
=>algae removal

Data logged and available online:

- Flow
- Treated bedvolumes
- Filter pressure
- EBCT

720kg GAC inserted

Automated liquid and air flush

Influent wwtp in, effluent pilot out

Dynacarbon

Used Carbon: Cyclecarb 401, Chemviron

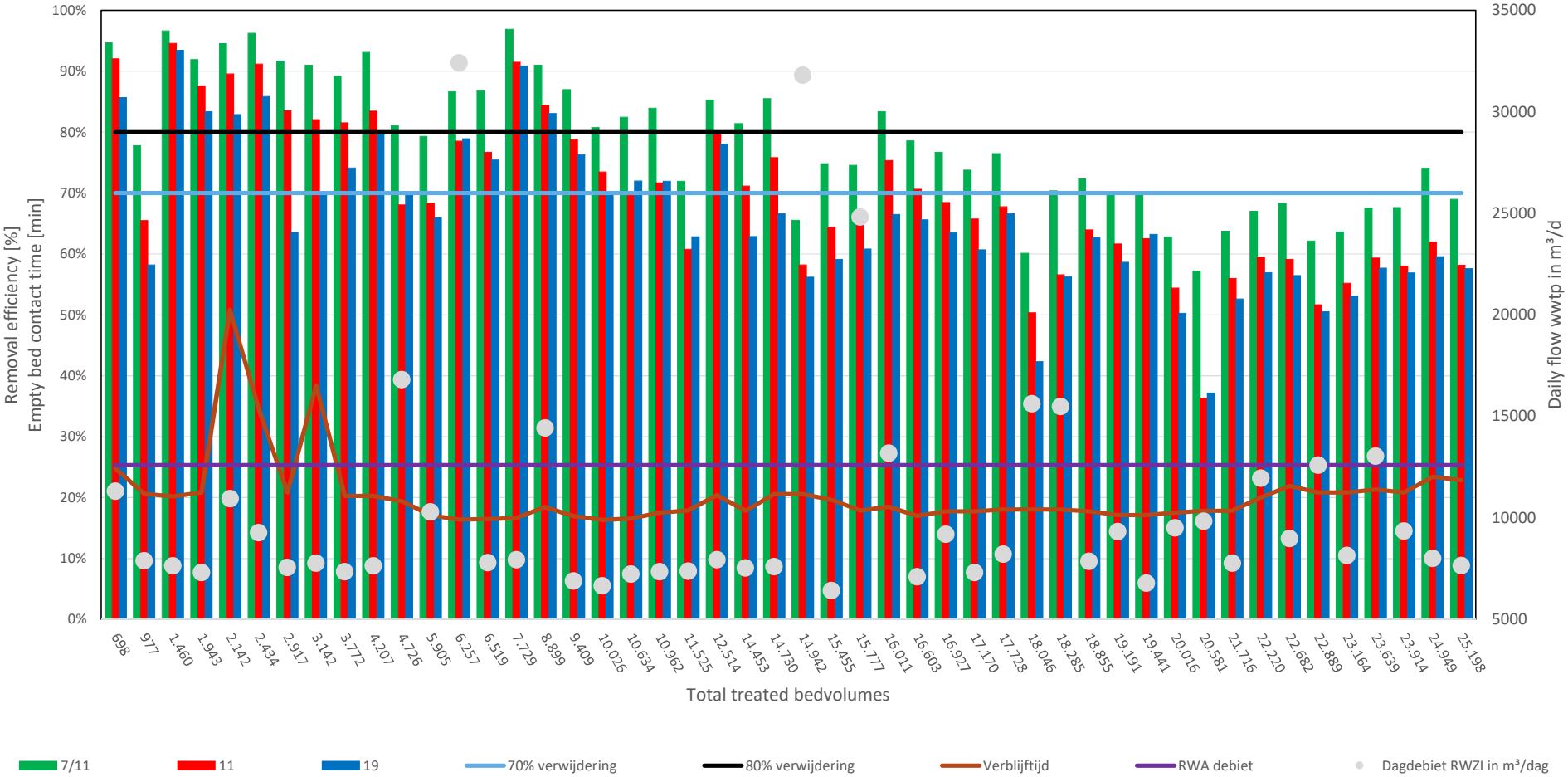
Start november 2020 using 720 kg GAC

Stopped march after 4293m³

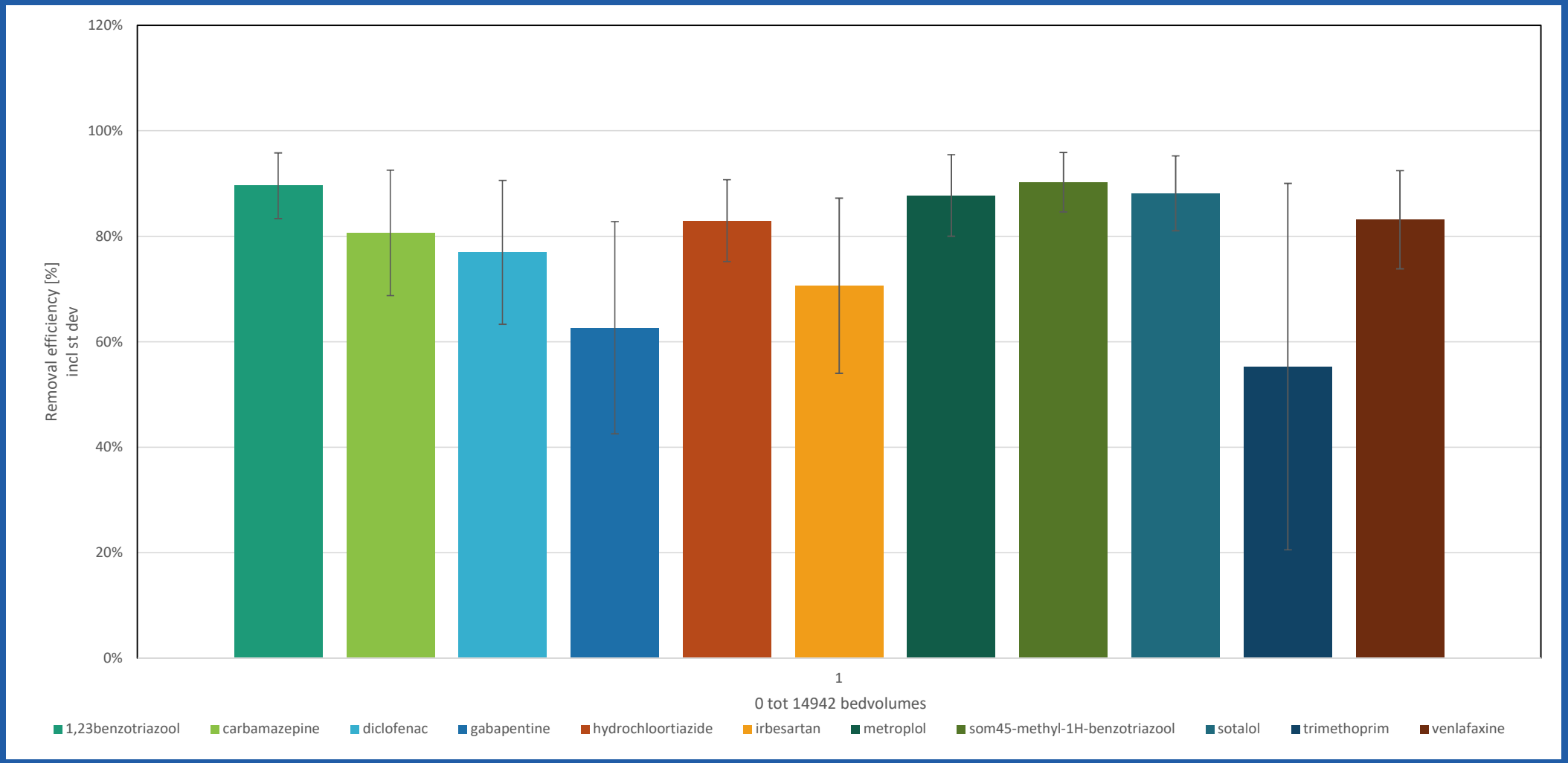
restart 1-4-2021 using 720kg GAC

	Nov `20	Dec `20	Jan `21	Feb `21	Mar `21	Apr `21	May `21	Jun `21	Jul `21	Aug `21	Sep `21	Oct `21	Nov `21	Dec `21	Jan `22	Feb `22	Mar `22
ebct[min]	first start-up								30			20			15	18			
EBCT [min]						28 (with fluctuations)			18							21		23	
Addition pre-treatment	Without Sobye-filter								With Sobye-filter										

Dynacarbon


Removal efficiency [%]
Empty bed contact time [min]
Daily flow wwtp in m³/d
Total treated bedvolumes
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
35000
30000
25000
20000
15000
10000
5000
698
977
1.460
1.943
2.142
2.434
2.917
3.142
3.772
4.207
4.726
5.905
6.257
6.519
7.729
8.899
9.409
10.026
10.634
10.962
11.525
12.514
14.453
14.730
14.942
15.455
15.777
16.011
16.603
16.927
17.170
17.728
18.046
18.285
18.855
19.191
19.441
20.016
20.581
21.716
22.220
22.682
22.889
23.164
23.639
23.914
24.949
25.198
7/11
11
19
70% verwijdering
80% verwijdering
Verblijftijd
RWA debiet
Dagdebiet RWZI in m³/dag

Dynacarbon


120%
100%
80%
60%
40%
20%
0%
Removal efficiency [%]
incl st dev
1
0 tot 14942 bedvolumes
1,23benzotriazool
carbamazepine
diclofenac
gabapentine
hydrochloortiazide
irbesartan
metroplol
som45-methyl-1H-benzotriazool
sotalol
trimethoprim
venlafaxine

Summary Performances

	UNIT	PACAS	Ozone + Sand Filtration	Carboplus	Dynacarbon
CO_2-footprint [1]	g CO_2/m^3	122	128	96 - 173	110 - 187
Costs [1]	€/m^3	0,05	0,17	0,15	0,21
Removal Efficiency Dutch guide substances[2]	%	70-75%	80-85%	80 – 85%	80 – 85%

[1] 1 Per treated m3 wastewater: peak dry weather flow must be treated. ***Please note: standardized cost and CO2 levels for 2018****; recalibration of all CO2- and cost levels will take place during the evaluation of the Innovation Program in 2024*

[2] Overall Removal Efficiency of effluent wwtp to influent wwtp (including bypass post treatment) for 7 of 11 guide substances: benzotriazool, carbamazepine, diclofenac, irbesartan, gabapentine, metropolol, hydrochloorthiazide, mixture of 4- en 5-methylbenzotriazool, sotalol, trimethoprim en venlaflaxine in every 24h or 48h flow or time proportional sample. The sampling has to take the hydraulic retention time of the wwtp into account.

Consequences stricter removal efficiencies Proposal EU Urban Wastewater Treatment Directive (80% in EU in stead of 70% in NL and different guide substances):

- PACAS will have a footprint of 160 g CO2/m3 and a cost level of € 0,08/m^3; no changes for ozone
- Carboplus will have a footprint of 96 - 173 g CO2/m3 and a cost level of € 0,15 €/m^3
- Dynacarbon will have a footprint of 110 - 187 g CO2/m3 and a cost level of € 0,21/m^3

Conclusions

- Carboplus and Dynacarbon remove >85% of Dutch micropollutants (best 7 out of 11)
- Carboplus and Dynacarbon both reduce ecotoxcity with >50%
- Carboplus and Dynacarbon both remove around 20-40% of PFAS
- Carboplus and Dynacarbon remove >85% of European micropollutants
- The Carboplus pilot needed a relatively high dosing rate of 30g/m^3
- The Dynacarbon pilot reached a total of 15.000 treated bedvolumes only
- The Dynacarbon pilot needed a pre-treatment to reach stable operation

Thank you for your attention!

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stowa

Rijkswaterstaat
Ministry of Infrastructure and Water Management

Tackling Micropollutants in Wastewater
Results of the Dutch Innovation and Implementation Program

November 8 and 9 2023
Aquatech Amsterdam