



Industrial Water 2020 – Nov 18th 2020



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**GLOBAL CHALLENGES**  
**DOW'S WATER STRATEGY**  
**REGIONAL COLLABORATION**  
**TERNEUZEN STRATEGY**  
**CONCLUDING REMARKS**

# Key Facts About the “New Dow”

2014 Sales of **\$58,167 million**



Dow Sites Around the World



Corporate

2019: 37,000 employees

Portfolio:

- performance materials
- industrial intermediates
- plastics businesses

Sectors:

construction, paints, automotive, food, consumer goods and energy



# Global challenges

## “society and chemical industry”

*creating the next level of sustainable water usage*



# Which are these societal and industry challenges?

## Raw material and Energy transition

- Climate change related objectives (CO<sub>2</sub>, fossil fuels)
- Exhaust fossil raw material
- Striving for circularity
- Food provision (soil, emissions)
- Industry, agriculture, urban areas

## Europe's quest to meet the Paris agreement & Green Deal

- Targets for CO<sub>2</sub> reduction are ~50% in 2030 and 95% in 2050
- Circularity (raw material and energy transition for industry and agriculture)

## Fresh water availability and supply (climate change / sealevel rise)

## Plastic waste / microplastics

## Reliable and robust operation (can we raise the bar)

What does this mean for **WATER** ????

### By 2030... global challenges



# Delta areas in Europe

salt intrusion due to rising sealevel

*The game is changing*

## Fresh water

- Quantity
- Quality
- Accessibility

## Increasing stress



# Dow's Approach & Strategy

- Identify gaps and demand per site and business unit
- Generate knowledge that can be used and leveraged
- Internal R&D and Technology Centers
- Cooperate “across the fence” in non-competitive areas with vendors, SME's, academia, NGO's, and public parties (facilitated by national and international funding programs)



# Dow's priority water stressed sites

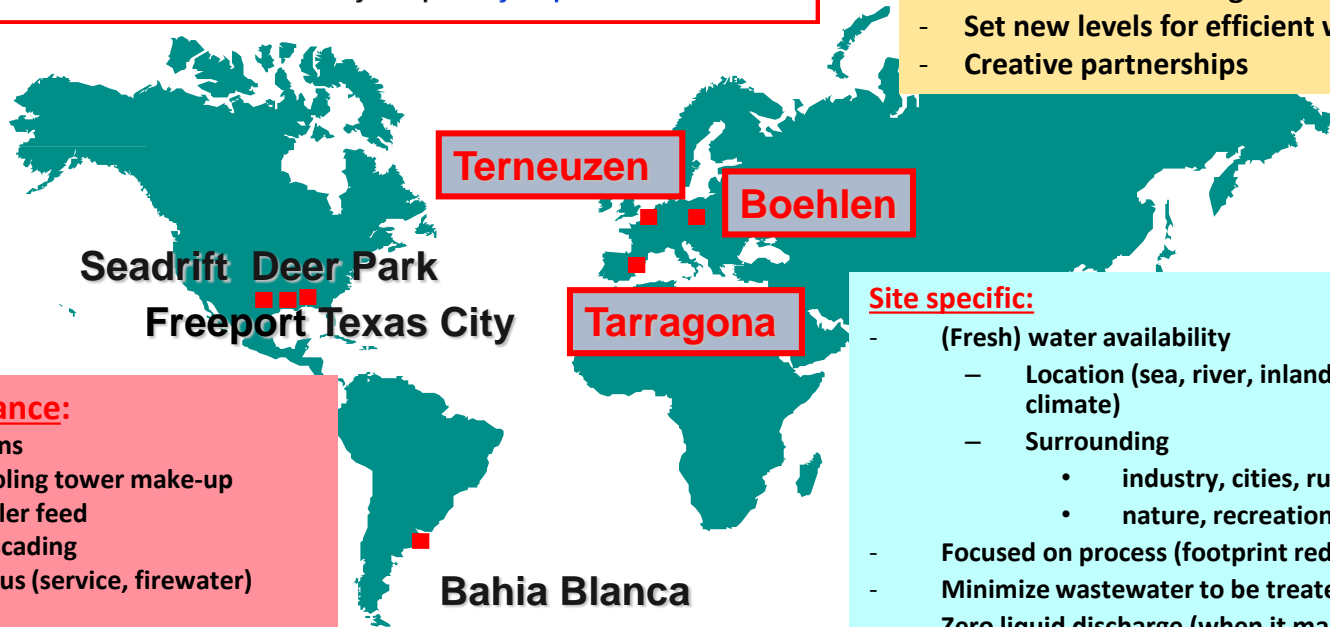
“water tools” – WBCSD, Aquaduct

## Dow's Sustainability Goal #7: World-Leading Operations Performance

By 2025, Dow will reduce its freshwater intake intensity at key water stressed sites and its waste intensity footprint by 20 percent.

## Dow's water vision:

- Sustainable water use and management
- Innovative technologies
- Set new levels for efficient water use
- Creative partnerships



## Water Balance:

- Reuse options
  - Cooling tower make-up
  - Boiler feed
  - Cascading
- Miscellaneous (service, firewater)
- Potable

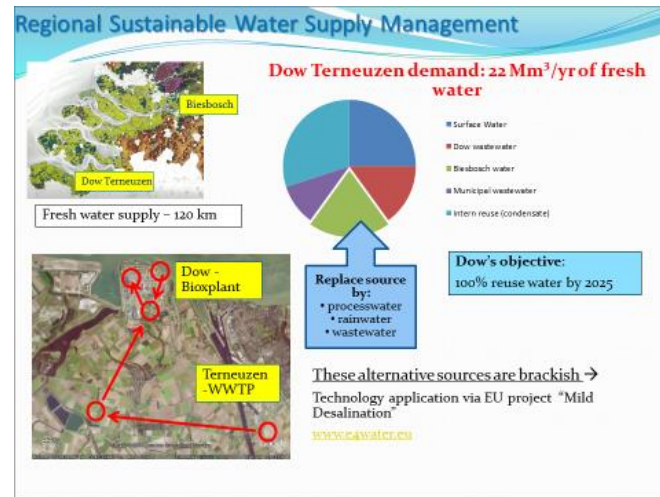
## Site specific:

- (Fresh) water availability
  - Location (sea, river, inland, local climate)
  - Surrounding
    - industry, cities, rural area
    - nature, recreation
- Focused on process (footprint reduction)
- Minimize wastewater to be treated
- Zero liquid discharge (when it makes sense)



# Initiatives and results achieved

- Water reuse examples in Terneuzen (NL) and Tarragona (Spain)
- Regional cooperation on raw materials, waste, by-products, and energy
  - Transfer of hydrogen between Dow and Yara
  - Pilot projects among chemical and steel to reuse CO, CO<sub>2</sub>, H<sub>2</sub> for producing a new generation of feedstocks



## Smart Delta Resources





# Robust & Reliable operation

“Cooling Water Mgmt is like pole vaulting”

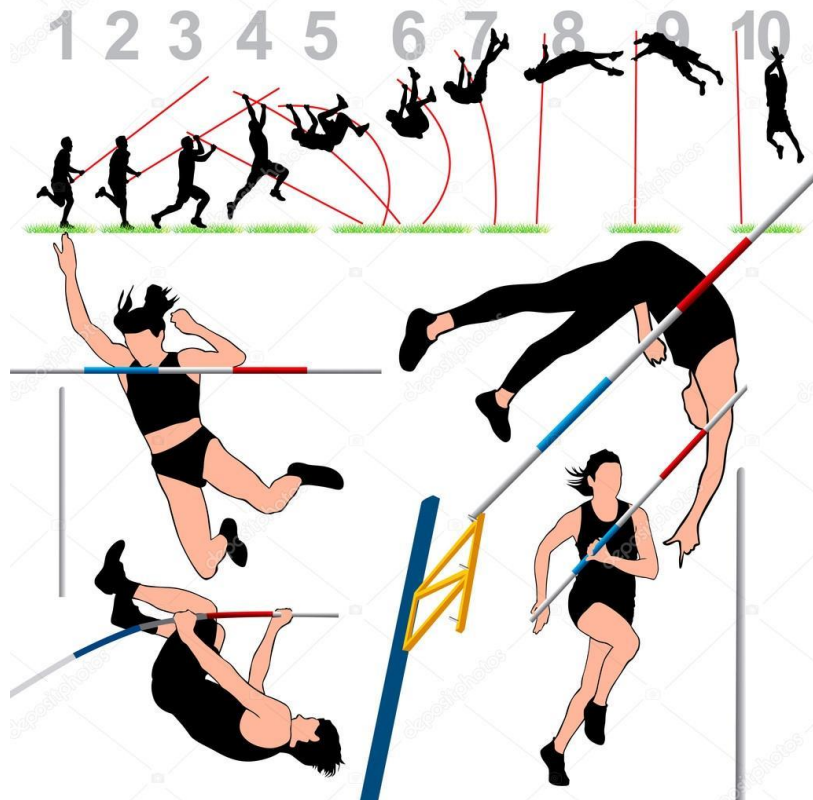
***Everything needs to fit perfectly to prevent failures (risk sensitive)***

## Challenges on performance and reliability

- Heat transfer (clean exchangers), regulatory trends, health & safety (legionella)
- Turnaround planning (8-10 years cycle), no exchanger constraints during cycle, uninterrupted supply of make-up water, achieve 20-30 yr exchanger lifetime

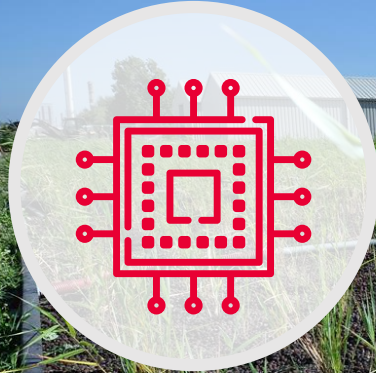
## Requiring first class

- System design
- Feedwater quality
- Water treatment
- Regulatory compliance
- O&M – turnaround planning



## **Dow's Water Strategy – what's next**

# THE PATH AHEAD



**Technology and  
Innovation**



**Partnerships and  
Collaboration**



**Governance and  
Policy Engagement**

### **CEO Water Mandate (by 2050)**

- Net Positive Water Impact
- Water Resilient Value Chain
- Global Leadership



Focus on water basin resilience

Measures taken collectively to raise resilience

Requires intensive collaboration with stakeholders in all functions

# WATER CIRCULARITY

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Collaboration in WBCSD initiative on circular transition indicators (CTI)

Metrics on sourcing, internal (re)use and discharge circularity

## Working Group and Advisors

**Member Working Group**  
Steer development of the WCM:

- ABInBev
- AptarGroup
- BP
- The Coca-Cola Company
- Diageo
- Dow
- Heineken
- Veolia

**Stakeholder Advisory Group**  
Provide input and guidance throughout development

- Columbia Water Center
- LimnoTech
- World Resources Institute
- Global Reporting Initiative
- Isle Utilities
- International Reference Centre for the Life Cycle of Products, Processes and Services (CIRAIG)

# **Terneuzen strategy & regional collaboration**



**DOW TERNEUZEN**

**NO WATER TO WASTE**

*Engineering with nature*

# Dow, being a good neighbour

- Focus on safety and environment
- Stimulating economic growth and prosperity





# I-Parc Dow Terneuzen

## Quick Facts

- Second biggest Dow site globally
- 440 hectares
- 3,200 employees
- 17 Plants incl. 3 Ethylene crackers
- 800+ different chemicals and plastics
- 85% of products exported
- **Located in a Water Stressed Delta**
- **Fresh Water Annual Use is 22 million m<sup>3</sup>**



Zeeuws-Vlaanderen

- 1-2 Million M<sup>3</sup> water locally sourced
- Most water sourced remotely: pipeline ~120km
- Surface & Ground water mildly **brackish**





# Split between saline and fresh wastewater (2001)



WWTP

Fresh wastewater

Saline wastewater



Cooling Tower supply 50% recycle water from Dow's  
WWTP – 2.5 million m<sup>3</sup>/year (as of 2001)



# Integrated urban & industrial watercycle WWTP with MBR to feed industrial RO (2010)

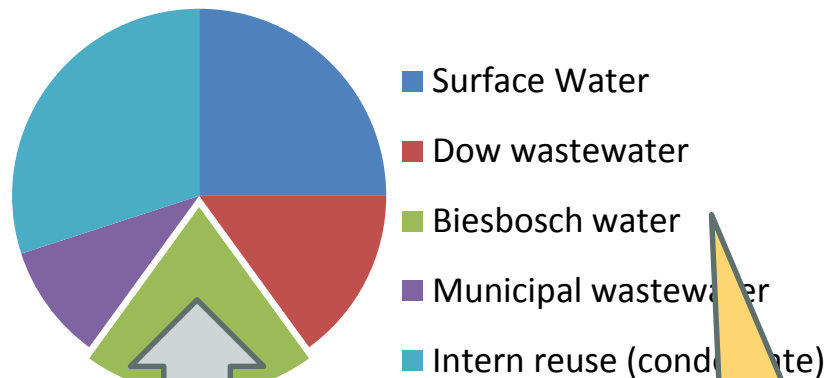
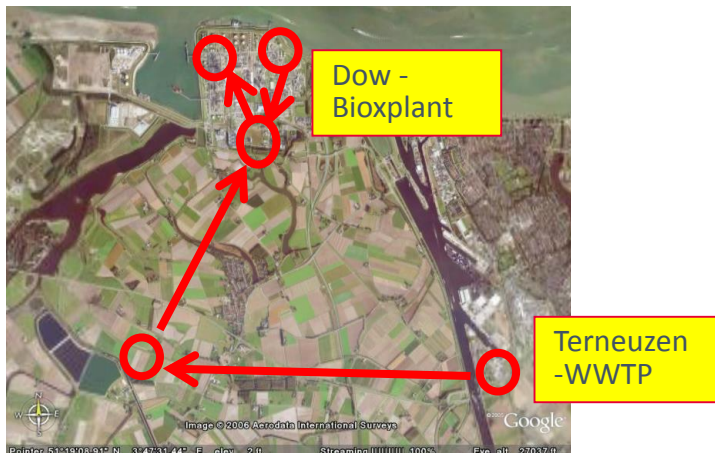


# Terneuzen Water Management – annual water use ~20 million m<sup>3</sup>

## 75% reuse is realized → 100% by 2024 (SG #7)



Fresh water supply – 120 km



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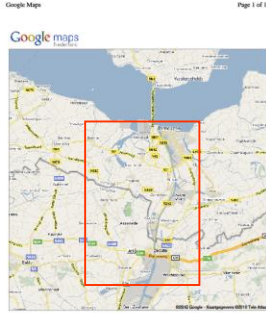
- rainwater
- Dow wastewater
- municipal ww

We don't want to compete for potable water sources

→ reduce Dow's water footprint

→ self provisioning region



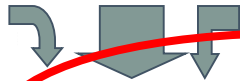


# Regional Robust Water system (multi stakeholder project)

## Key attributes

- Surplus of 100 million m<sup>3</sup> of mildly brackish water is discharged annually
- Save scarce potable water sources by using local alternatives
- Nature, landscape and recreation will benefit.

(treated) waste water,  
diffuse discharges, rain water

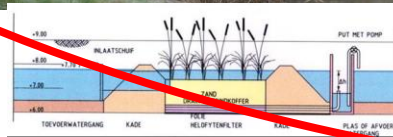


Influent buffer



Treatment wetlands

Removal of nutrients and  
suspended solids



**E4Water**

Hydraulic buffering



Agricultural usage

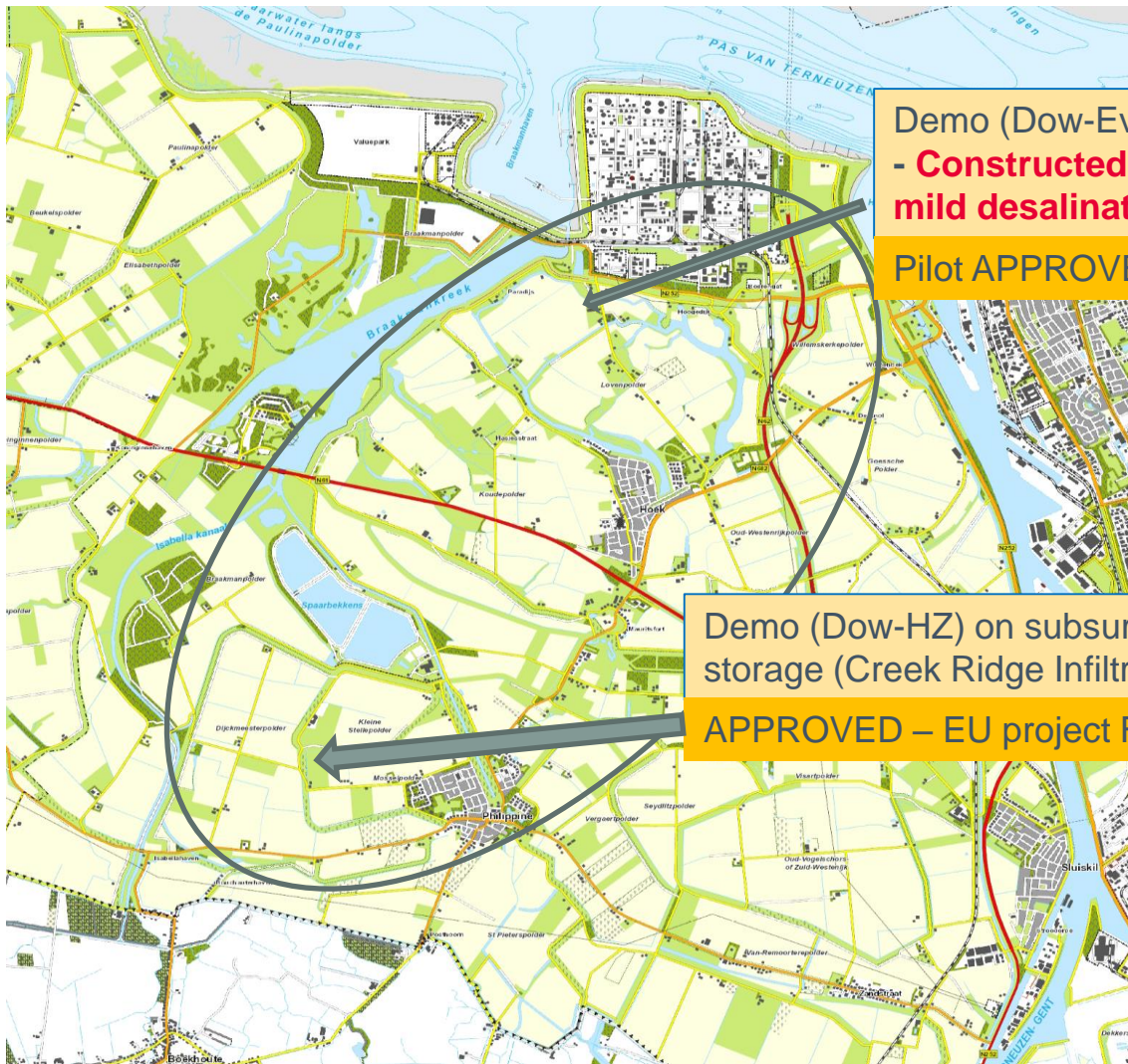
**Mild desalination**

Industrial use



JDA with Evides





Demo (Dow-Evides-Waterboard)  
- **Constructed wetland connected to mild desalination plant**

Pilot APPROVED – Dutch Delta Fund

Demo (Dow-HZ) on subsurface freshwater storage (Creek Ridge Infiltration)

APPROVED – EU project FRESH4Cs

# Water Contract

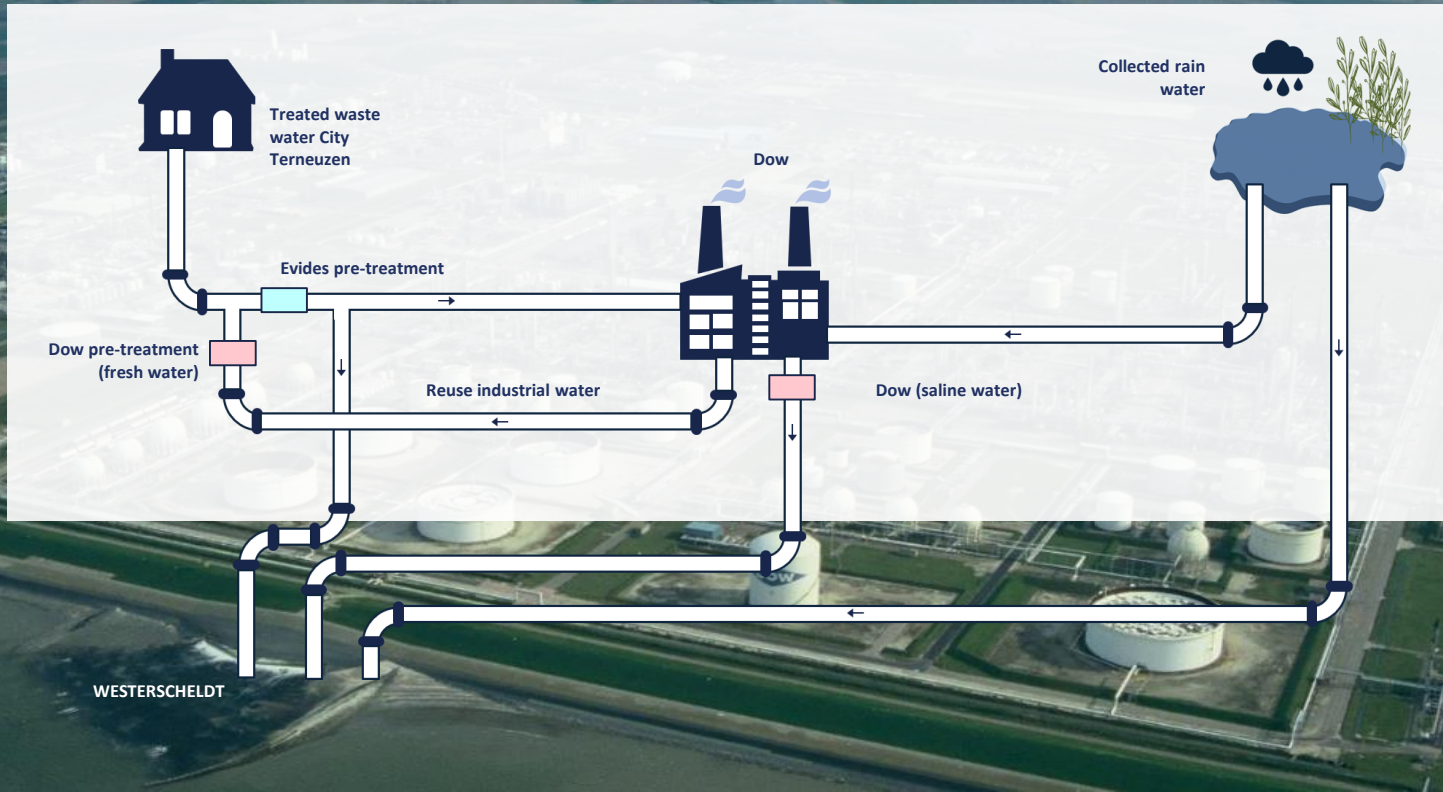


# Realization as part of new 20-yr water supply contract with Evides Industriewater

## Technical concept characteristics

- Addressing the need for **higher degree of reliability** and robustness, meeting **future water quality** objectives
- High quality CT make-up water represents an **excellent business case** for downstream facilities
- **Collected experience** of DW&PS SME's, Dow sites and external, current Evides water plant and preceding E4Water (EU study) results
- Wetlands for feed stream equalization and biological stabilization
  - Cost savings vs. alternatives (BACF) in chemicals, energy, and O&M
  - Adds to Nature Goal (hybrid between green and gray)
- Details for full scale implementation being developed with Evides in JDA (Joint Development Agreement)

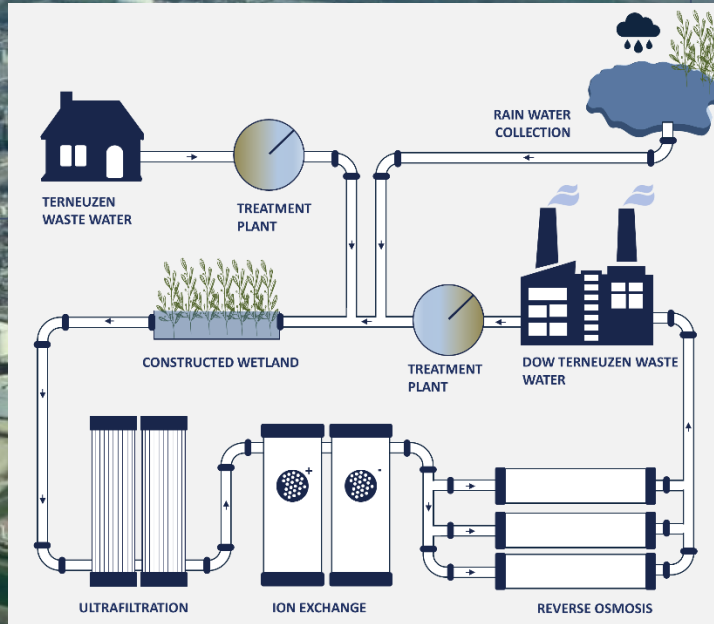
# THE WATER LOOP NOW



# CLOSING THE WATER LOOP

Reuse of three different sources:

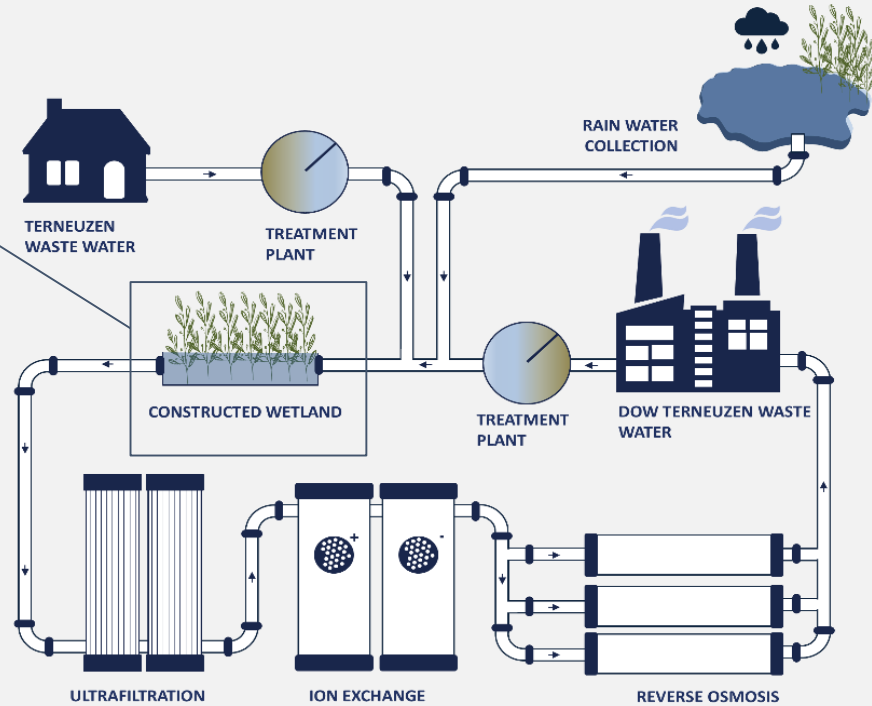
- **WWTP-effluent Dow** (increase from 2 to 4 million m<sup>3</sup>/y)
- **Municipal effluent** (increase from 2.5 to 3.5 million m<sup>3</sup>/y)
- **Collected rainwater** (0.5 million m<sup>3</sup>/y)



2025

# CLOSING THE WATER LOOP

Biological system based on green infrastructure as pretreatment to reduce downstream biological fouling with minimum use of chemicals and energy



2025



# A STEP FURTHER: ENGINEERING WITH NATURE



## Why WETLANDS?

**Save potable water sources by using local alternatives**

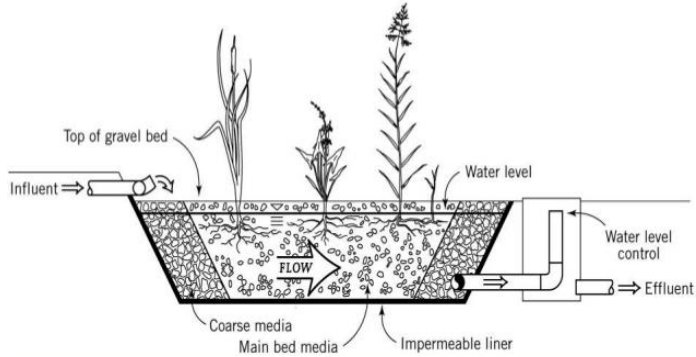
**Reduce Dow's water footprint**

**Self sufficing region**

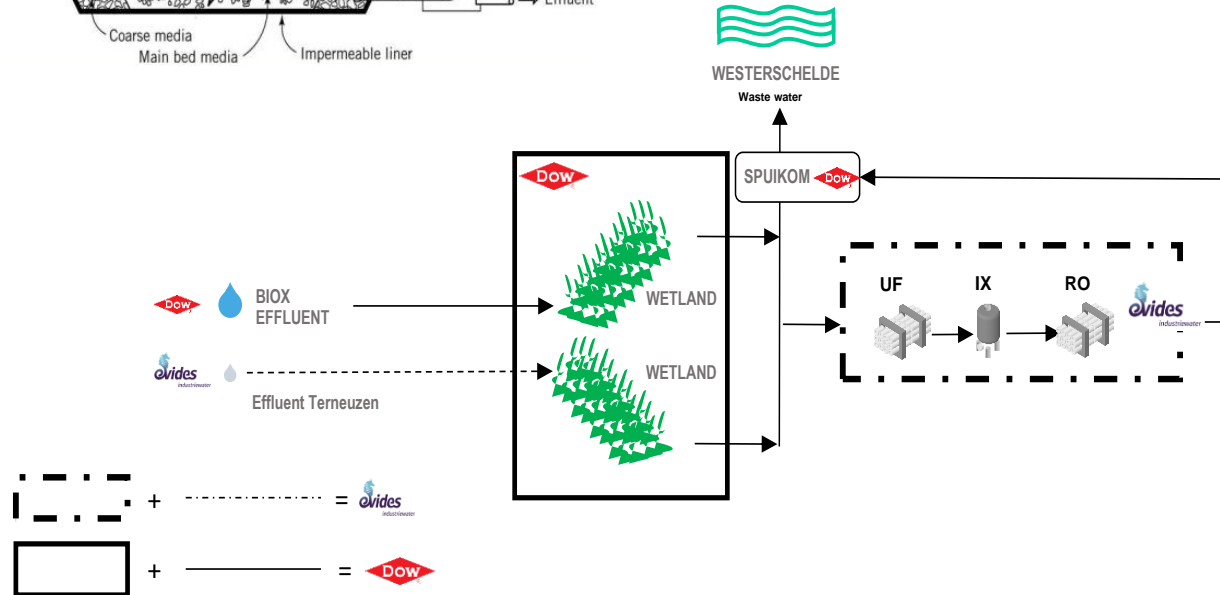
**Reduce use of chemicals and energy in conventional treatment systems**



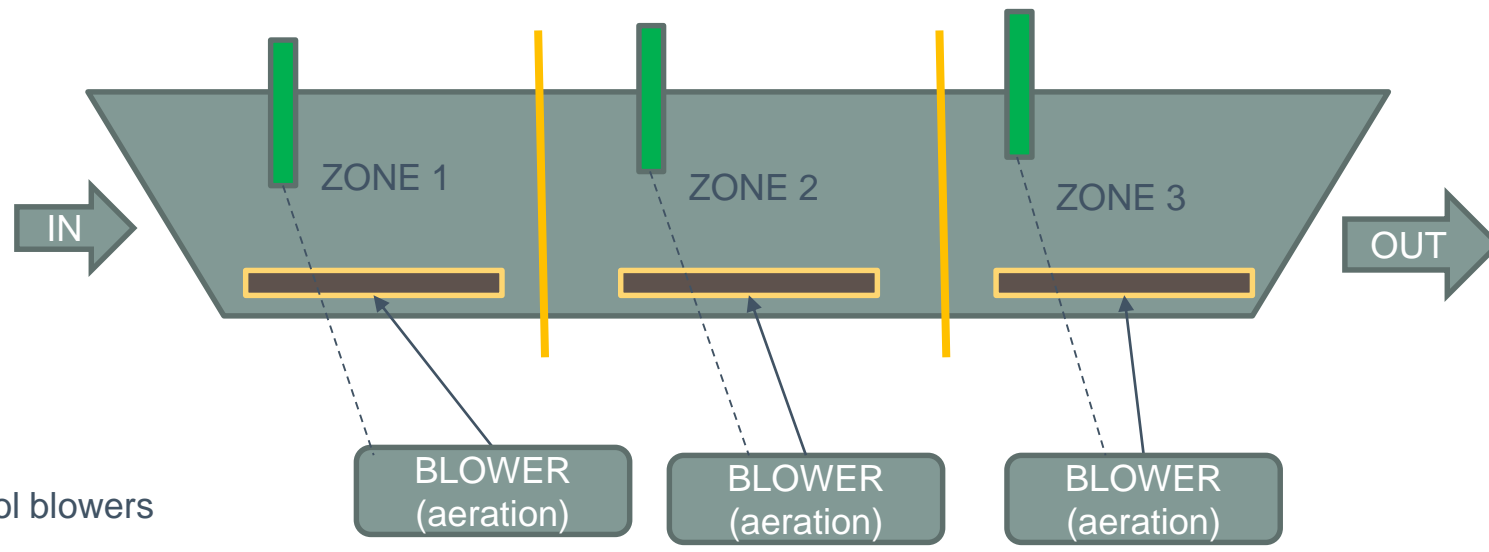
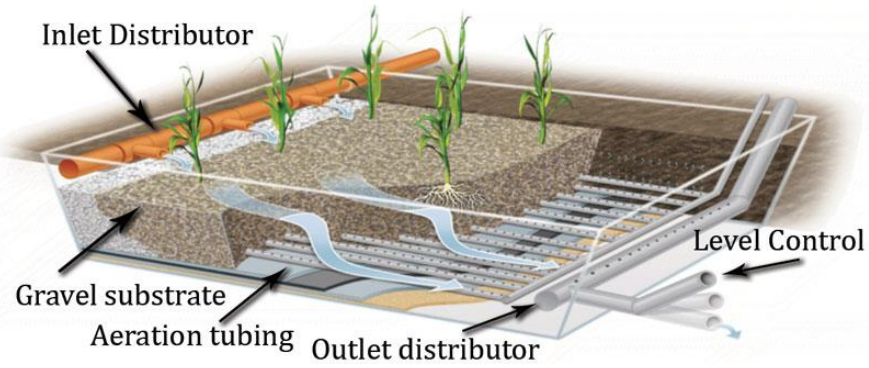
# Pilot set-up



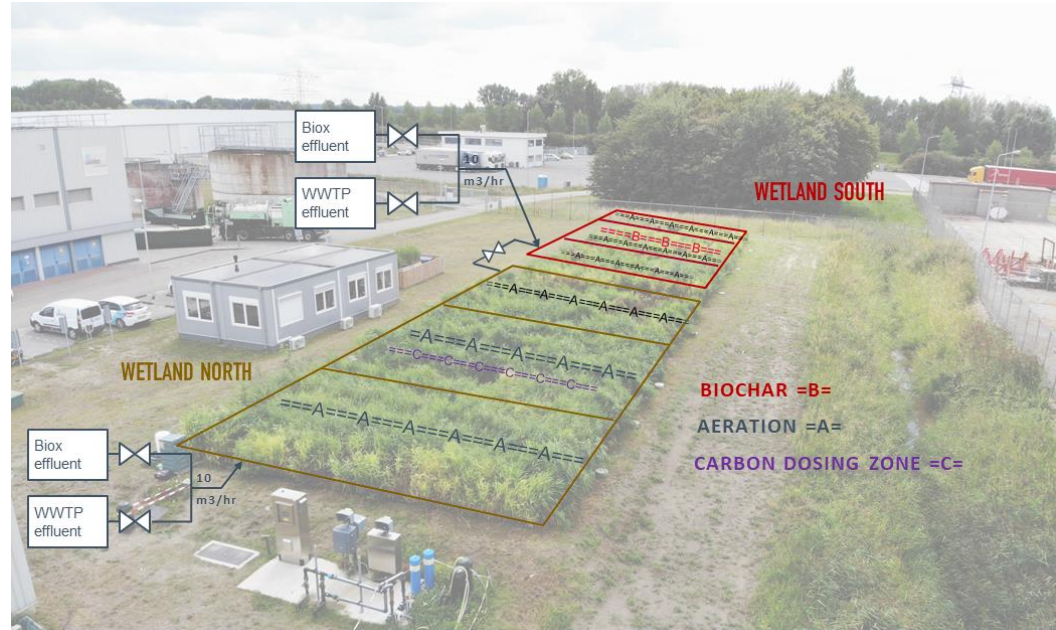
- Two major streams (10 m<sup>3</sup>/h each) feeding (facultative aerated) horizontal flow constructed wetland (750 m<sup>2</sup> – 12 h RT)
- Consecutive brackish water desalination (5-7 m<sup>3</sup>/h throughput)
- At least all seasons to be covered once to collect scale up design parameters
- Two year pilot



# PRINCIPLE AERATED WETLAND



# Configuration



## CONFIGURATION:

- Each wetland is 350m<sup>2</sup>, with a depth of 1.1m
- Each wetland has 3 zones with aeration in each zone
- Carbon dosing in CW north and biochar in CW south
- Filled with Argex clay grains
- Wetlands can be connected in series or parallel

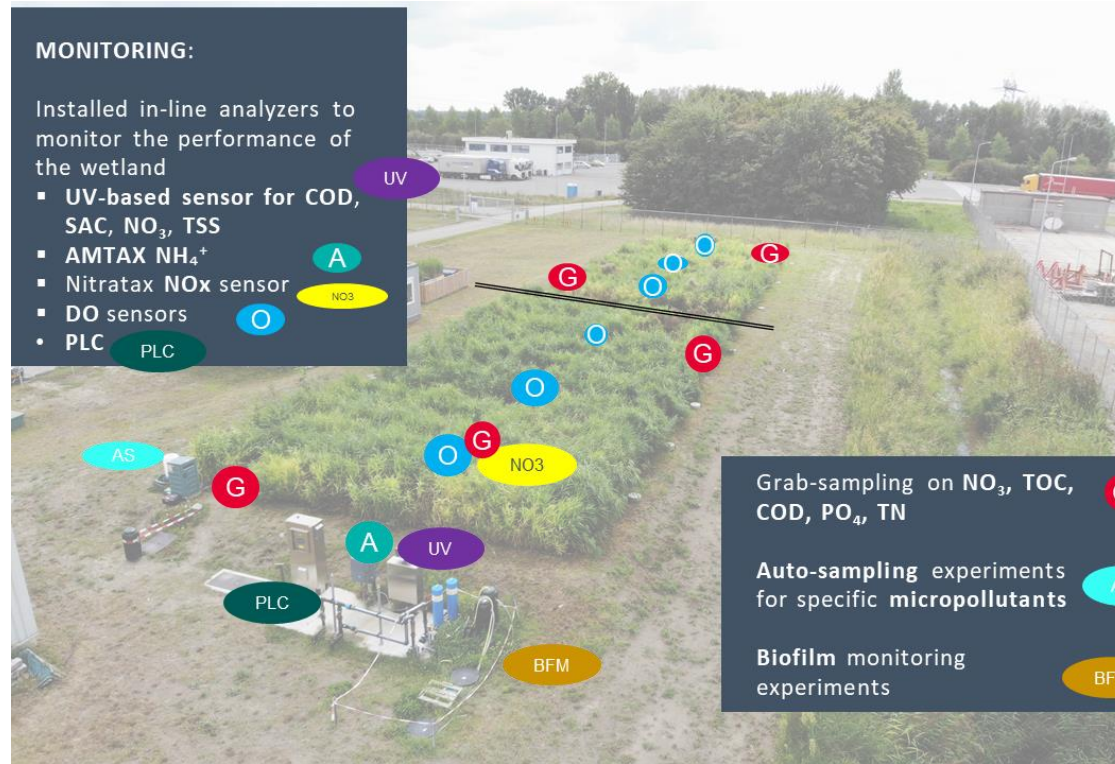


# Wetland operation and control

## MONITORING:

Installed in-line analyzers to monitor the performance of the wetland

- UV-based sensor for COD, SAC,  $\text{NO}_3$ , TSS
- AMTAX  $\text{NH}_4^+$
- Nitratax  $\text{NO}_x$  sensor
- DO sensors
- PLC



Grab-sampling on  $\text{NO}_3$ , TOC, COD,  $\text{PO}_4$ , TN

Auto-sampling experiments for specific micropollutants

Biofilm monitoring experiments

# "A high tech wetland"



## Wetland operation and control



Blowers



UV Sensor



Nitratax  
sensor



Amtax sampler  
measuring  
ammonium



DO and  
temperature probes

# DIFFERENT PHASES & RESEARCH PERIODS OF THE PROJECT

**The project has been divided into three phases:**

Phase 1: Planning and construction of the CW and start-up (completed in June 2019)

Phase 2: Optimization CW in stand-alone mode (completed in October 2020)

Phase 3: Monitoring and optimizing the coupled CW-UF/IX/RO system (From November 2020 till June 2021)

Research plan comprises:

Nitrification at different DO settings

De-nitrification with and without C-dosing

COD removal at different DO settings

COD & NO<sub>3</sub>-N removal in South with and without biochar

Biofilm monitoring → microbiology and fouling tendency

Micro-pollutant removal (chemical, pharmaceutical, agriculture)

# Biofilm monitoring

After 1 week



Influent North



Effluent North



Effluent South

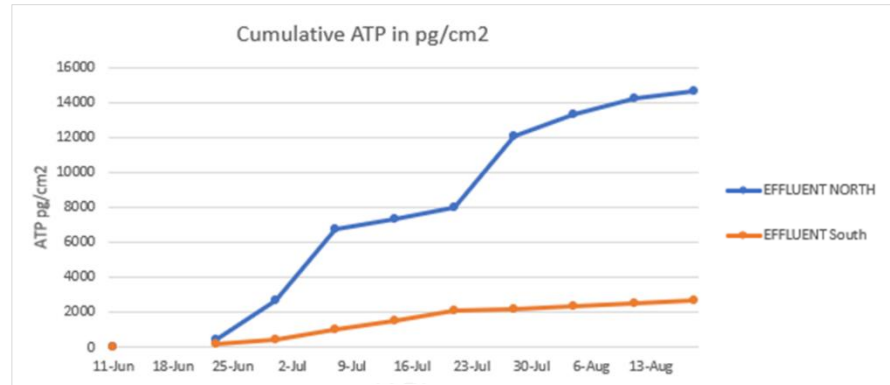
After 10 weeks



Effluent North

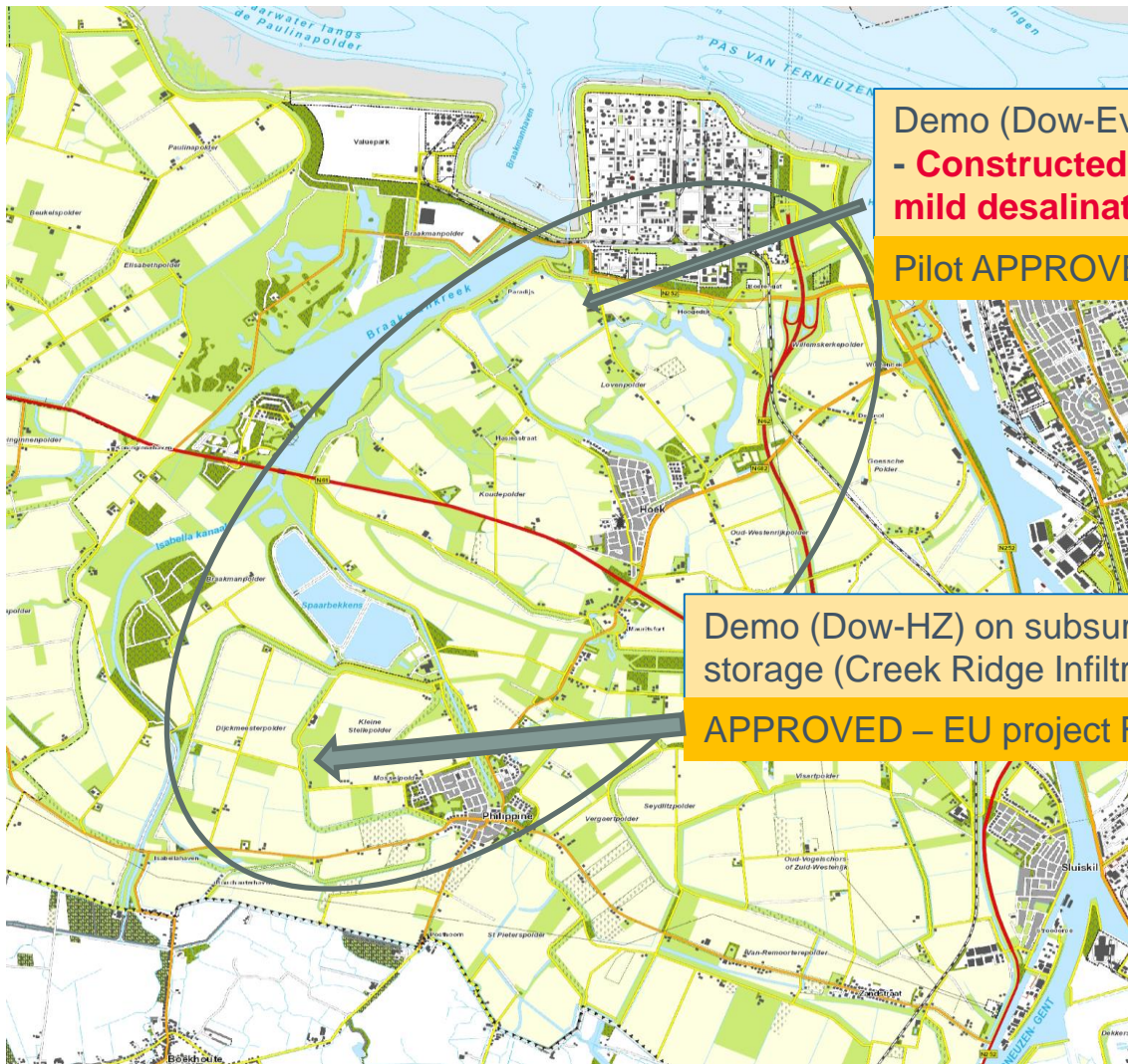


Effluent South



## In Summary

- Wetland – Desalination pilot (2019-2021)
- Full scale implementation (2021-2024)
  - Wetland – desalination
    - Dow wastewater reuse (from 2 → 4 million m<sup>3</sup>/y)
    - Municipal wastewater (from 2.5 → 3.5 million m<sup>3</sup>/y)
    - Reclaimed rainwater (0.5 million m<sup>3</sup>/y)
- Result
  - 100% use of recycled or reclaimed water
  - Regional self sufficiency



Demo (Dow-Evides-Waterboard)  
- **Constructed wetland connected to mild desalination plant**

Pilot APPROVED – Dutch Delta Fund

Demo (Dow-HZ) on subsurface freshwater storage (Creek Ridge Infiltration)

APPROVED – EU project FRESH4Cs

# Interreg



## 2 Seas Mers Zeeën

### FRESH4Cs

European Regional Development Fund



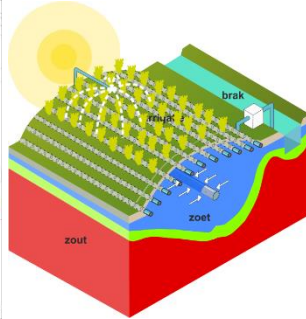
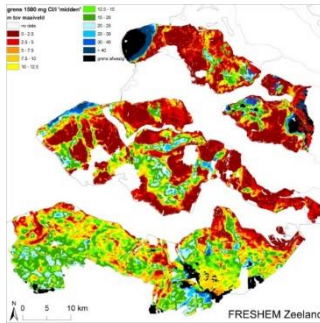
FRESH4Cs aims for sustainable **alternative water resources** for all users in **coastal areas** through the demonstration and replication of technologies for **water buffering** and **water reuse**.

Project partners:



[www.fresh4cs.eu](http://www.fresh4cs.eu)

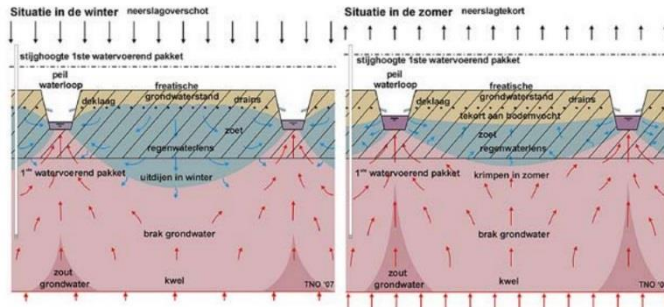
# Deltares



**Sustainable fresh water supply using subsurface**



**Creek ridge infiltration System opportunities**

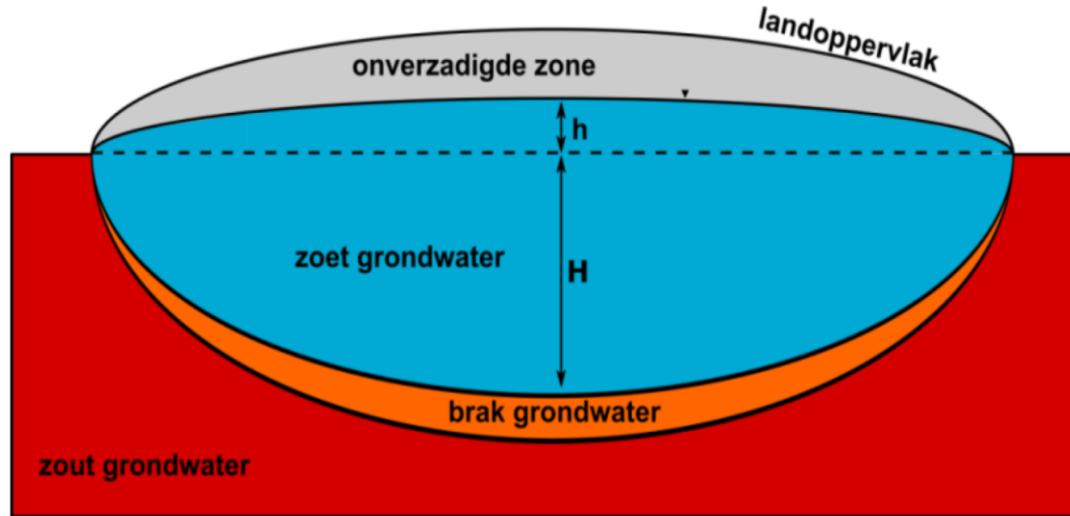


Tobias Mulder  
Vince Kaandorp





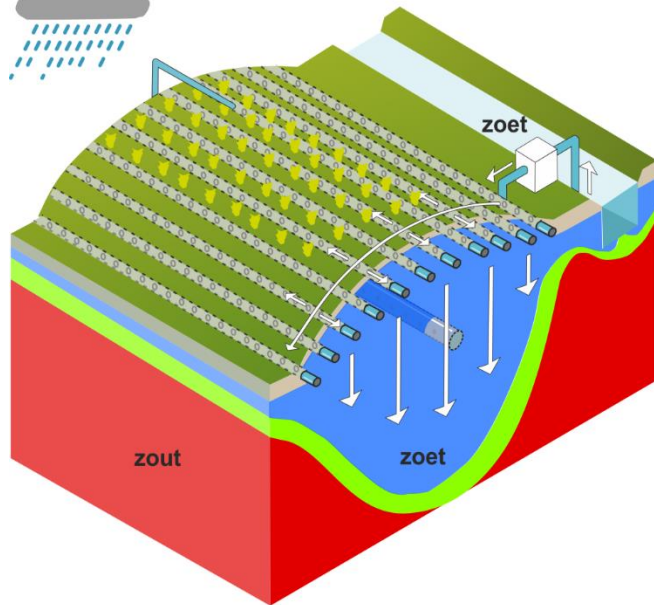
# Fresh water lens - principle



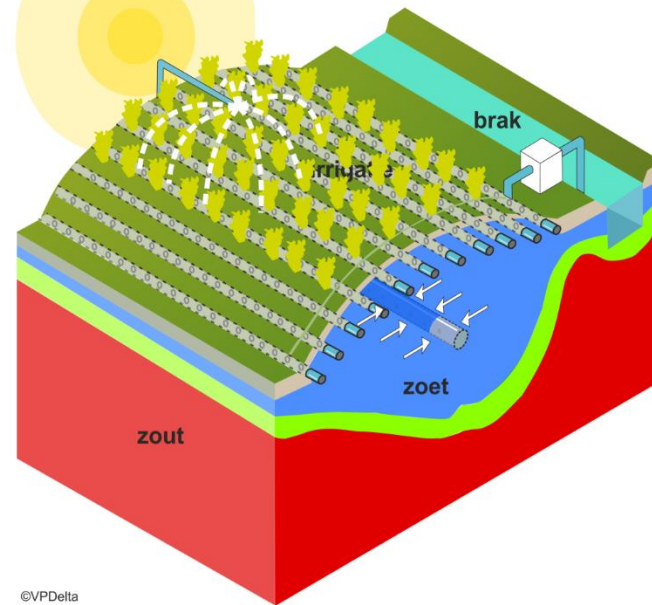
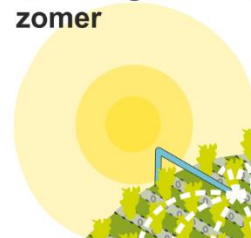
0.1m raise in groundwater enables 4m growth of freshwater lens



### Kreekrug Infiltratie System winter



### Kreekrug Infiltratie System zomer



# Suitability Criteria

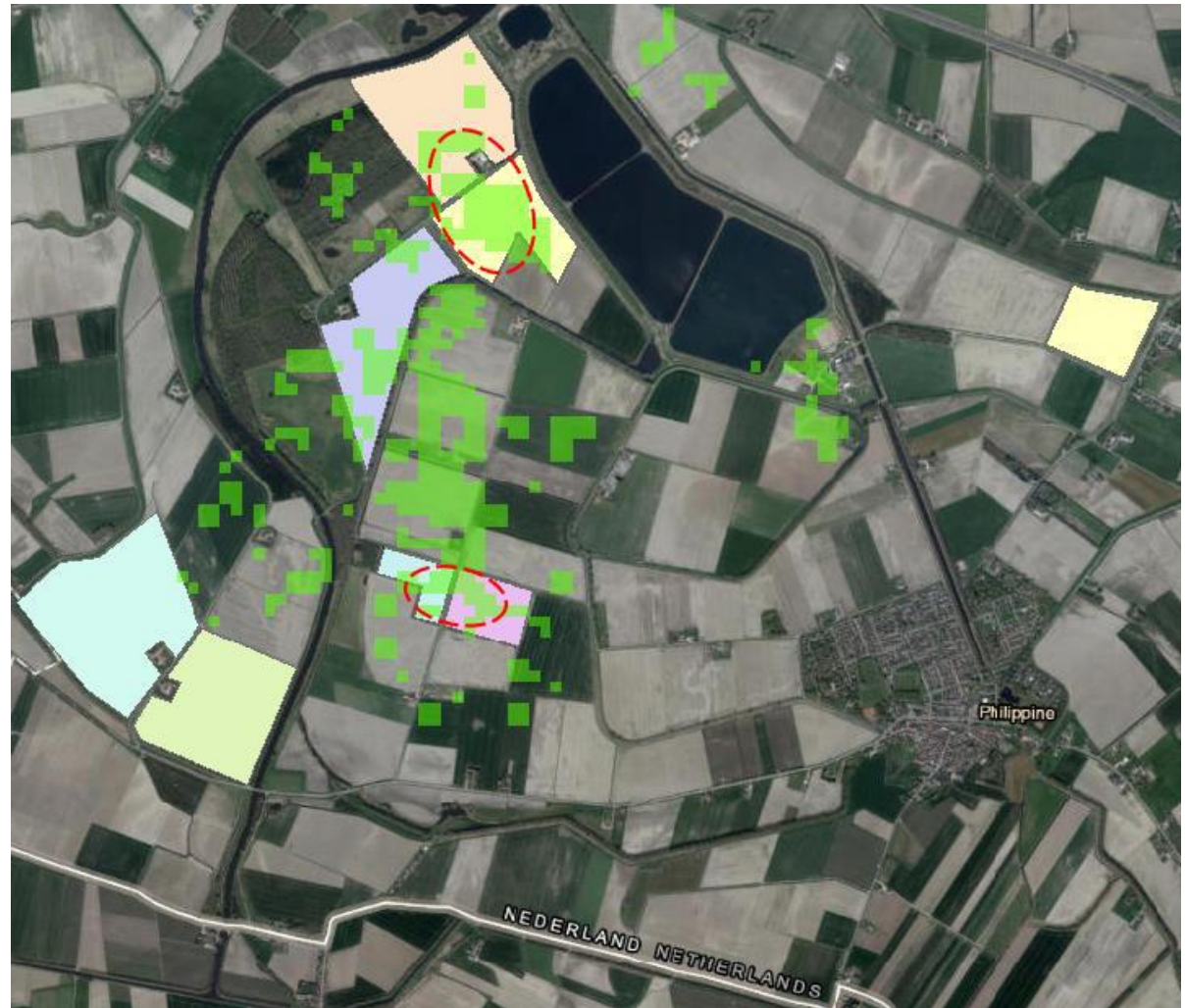
- Sandy creek ridge
- Presence of a fresh water lens in saline area
- Growth opportunities (sandy layers underneath)
- Agricultural land use
- Natural infiltration (no seepage)
- Groundwater level sufficiently low (unsaturated zone available)

## Map of suitable areas for CRI

- green areas fulfill all criteria for CRI
- dashed areas identified for field measurements and demo in 2021/2022

**Collaboration with agriculture, so that also farmers can benefit in periods of drought**

Target 0.5 – 1 million m<sup>3</sup>



# NEXT STEPS



1

2019

PILOT UNIT -1.7 MM\$



Evides

0.8 MM\$ from the Government

Balance between Dow, Evides and Water Board

2

2021

3

2024

FULL SCALE  
PLANT



Terneuzen

4

2025  


**100%**  
Circular Water Use  
by **2025**





## 2025 sustainability goals

We have embarked on the third stage of our sustainability journey with our ambitious 2025 Sustainability Goals. We are collaborating with like-minded partners to advance the well-being of humanity by helping lead the transition to sustainable planet and society.

Project vision aligned with Dow's current sustainability goals and beyond



### Leading the Blueprint

We will help lead the transition to a sustainable planet and society, including the development of societal blueprints that integrate public policy solution, science and technology, and value chain innovation.

[Learn More →](#)



### Safe Materials for a Sustainable Planet

We envision a future where every material we bring to market is sustainable for our people and our planet.

[Learn More →](#)



### Delivering Breakthrough Innovations

We will deliver breakthrough sustainable chemistry innovations that enhance the well-being of humanity.

[Learn More →](#)



### Engaging for Impact: Communities, Employees, Customers

Our people worldwide will directly apply their passion and expertise to advance the well-being of people and the planet.



### Advancing a Circular Economy

We will advance a circular economy by delivering solutions that close the resource loops in key markets.

[Learn More →](#)



### World-Leading Operations Performance

We will maintain world-leading operations performance in natural resource efficiency, environment, health, and safety.

[Learn More →](#)



### Valuing Nature

We apply a business-decision process that values nature, which will deliver business value and natural capital value. We are committed to projects that are good for the company—and better for ecosystems.

[Learn More →](#)



## Concluding remarks

- The chemical industry embraces water sustainability objectives and make them happen
- Over the fence collaborations are excellent vehicles to create benefits for multiple stakeholders
- Be transparent (metrics, circularity) to do the right things (and do them right!)
- Go for quality rather than short term success



You can spend your money only once...

**Make the right choices**



## REFERENCES & ACKNOWLEDGEMENT

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- All partners and co-workers
- Dow Water & Process Solutions (currently Dupont)
- Deltares ([www.deltares.nl](http://www.deltares.nl))
- Evides Industriewater ([www.evides.nl](http://www.evides.nl))
- WBCSD ([www.wbcd.com](http://www.wbcd.com))
- Funding by Deltafonds, Topsector Water, EU Horizon 2020, EU Interreg





*Connects  
Chemistry & Water  
with passion!*

Water

Each drop counts!



**Seek**

**Together™**