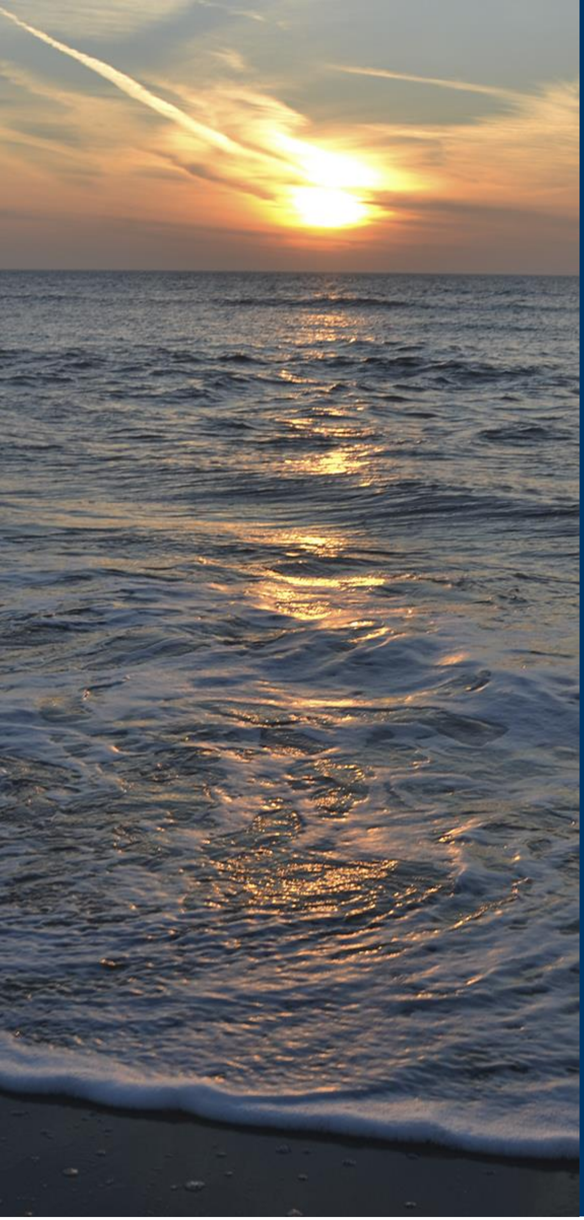

Impact of DOC on biological stability in drinking water distribution systems

Emmanuelle Prest

November 6th, 2018

Mayflower Water Treatment Works, Plymouth

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Drinking water distribution without residual disinfectant in the Netherlands

Historical background

- Years 1970: discovery of disinfection by-products and health effects
- Years 1990-2000:
  shift of main water disinfection step from chlorine to ozone and UV in NL
  distribution without maintaining residual disinfectant
- 2006: implementation of strict DBP regulations in the Netherlands:
  TTHM < 25 µg/L

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Implications for drinking water distribution

How to limit bacterial growth during water distribution without residual disinfectant?

- Requires to produce biological stable water using extensive water treatment:

⇒limit available nutrients for bacterial growth:

- C source: part of DOC can be consumed by bacteria for growth
- N source: e.g. NH_4, NO_3, N-bound organic compounds
- P source: e.g. PO_4, P-bound organic compounds

⇒ Limit release of particles in the distribution system

- Requires well-designed systems and good maintenance of distribution systems

⇒ avoid recontamination, long residence times, and temperature hot-spots

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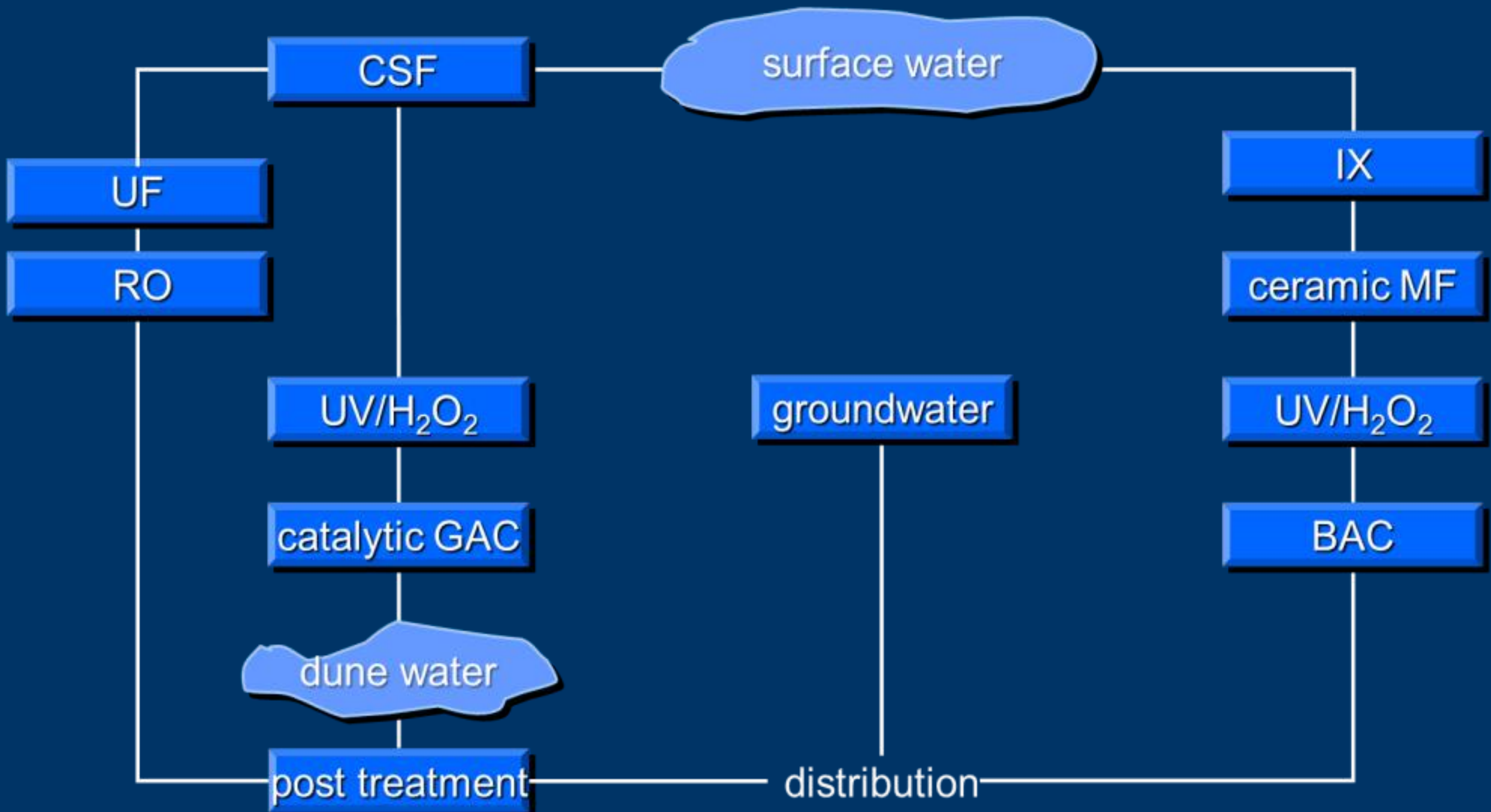
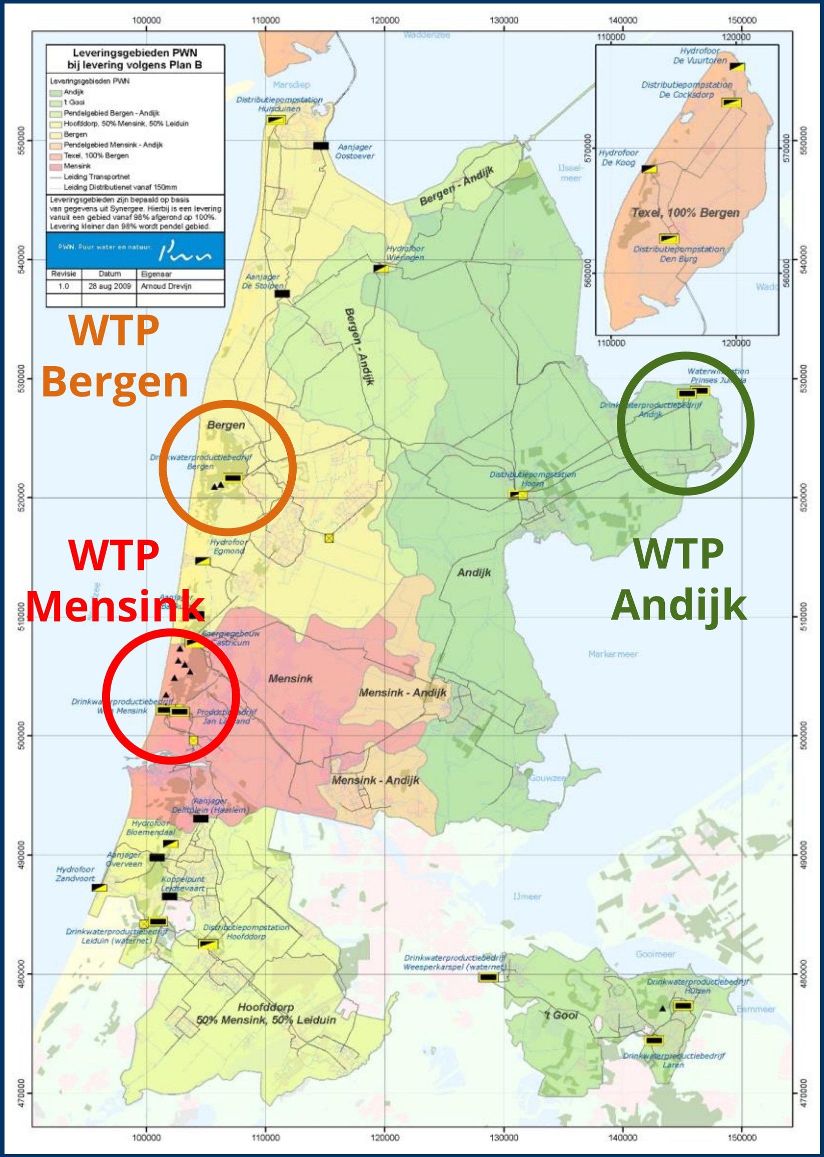
PWN advanced water treatment concept



ClO_2 dosage: ~0,01 mg/L at WTP effluent
Not maintained in distribution

PWN treatment plants and distribution areas



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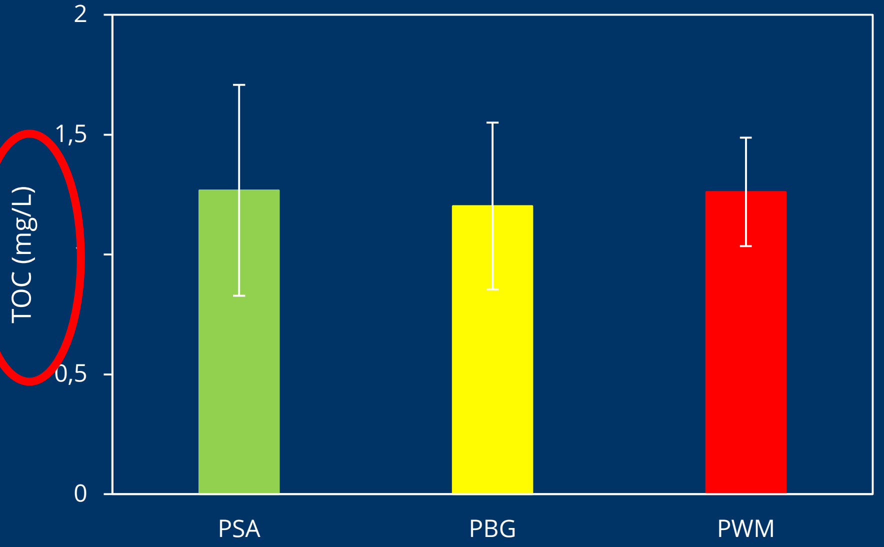
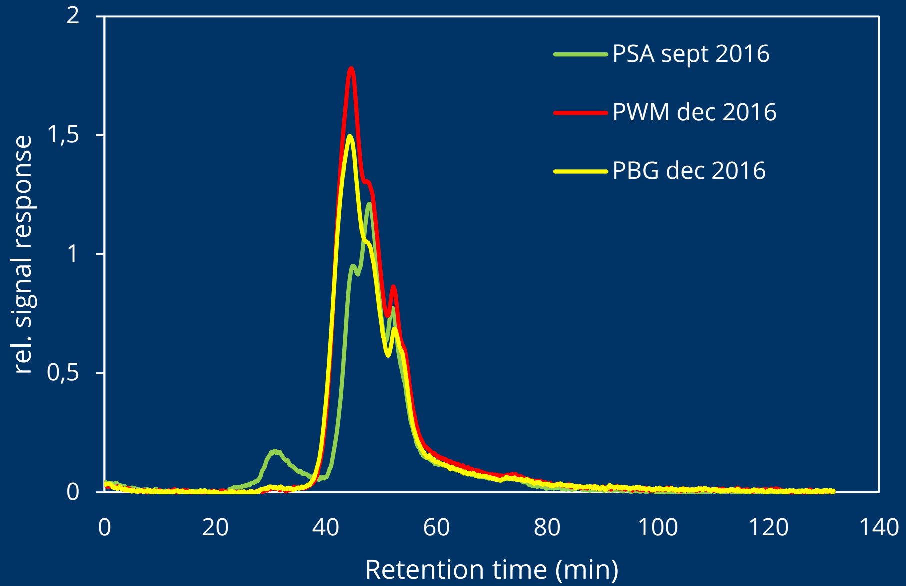
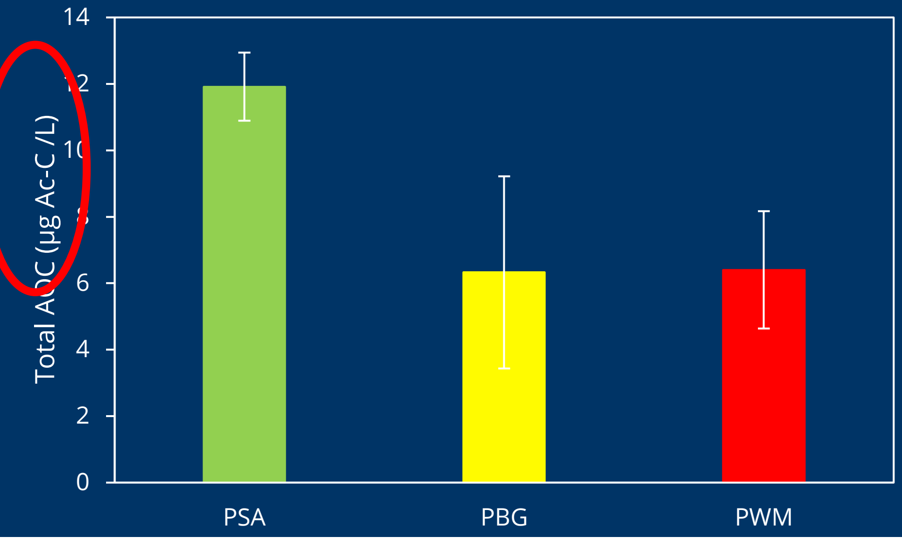
Characteristics of NOM in the 3 WTPs



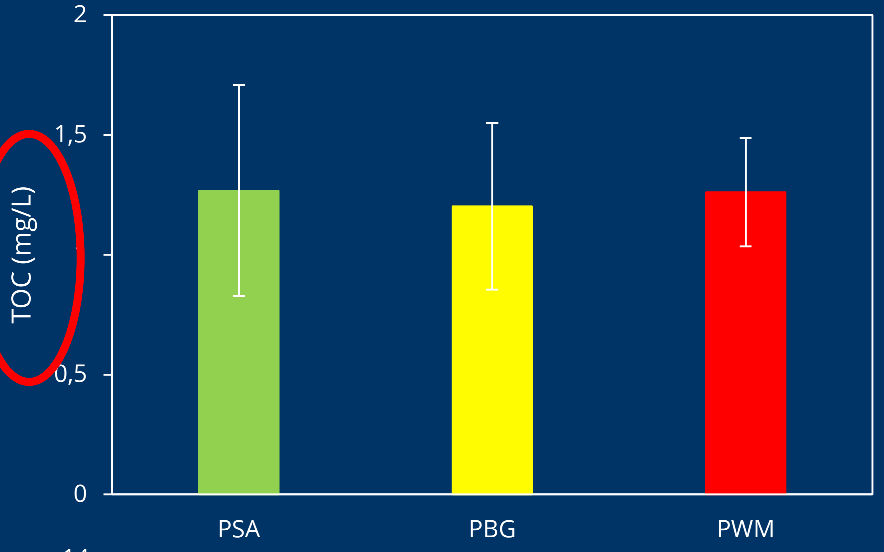


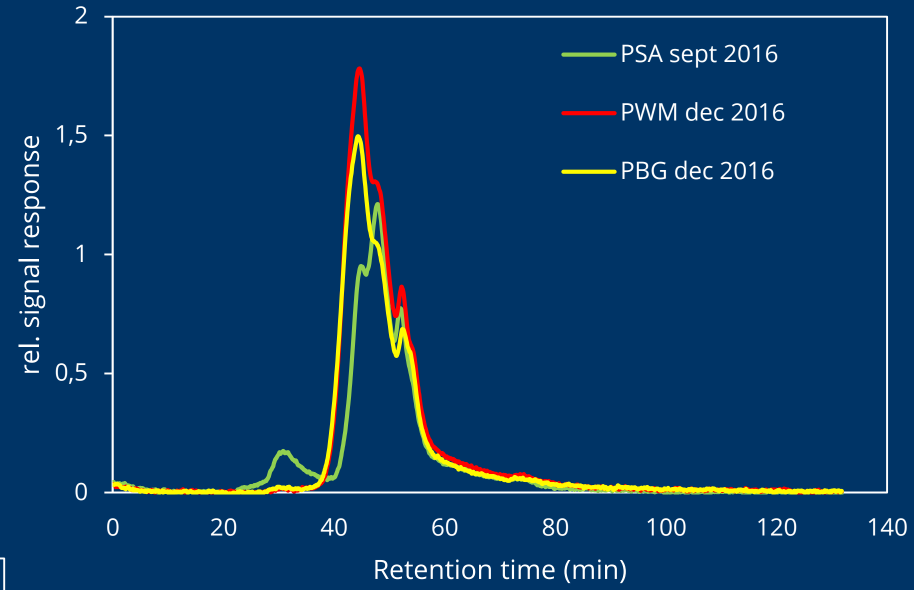


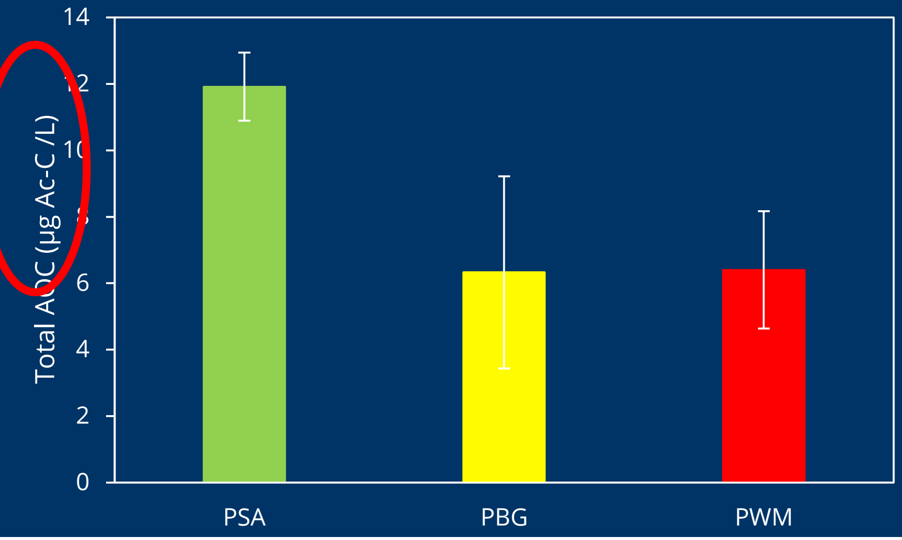
Assimilable organic carbon (AOC) is a tiny fraction of TOC.

This is the fraction that bacteria can use for growth

Characteristics of NOM in the 3 WTPs







The 3 WTPs produce water with same TOC but

- different NOM composition
- different AOC concentration

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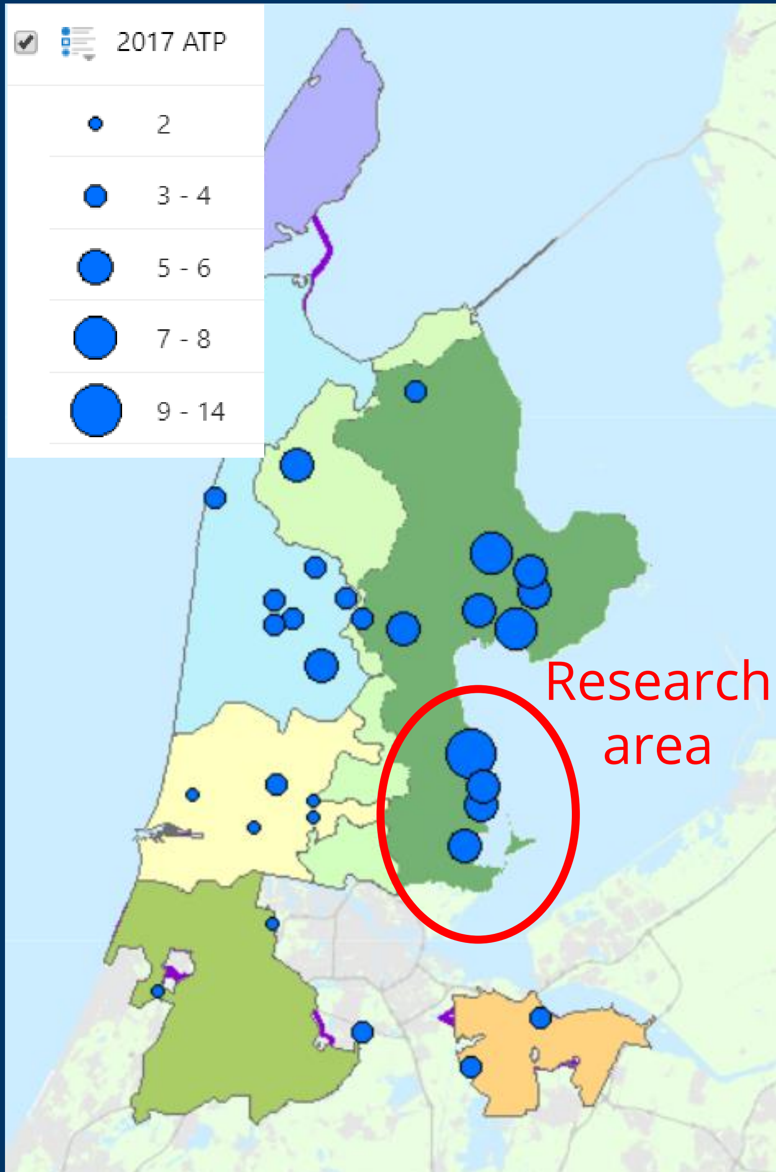


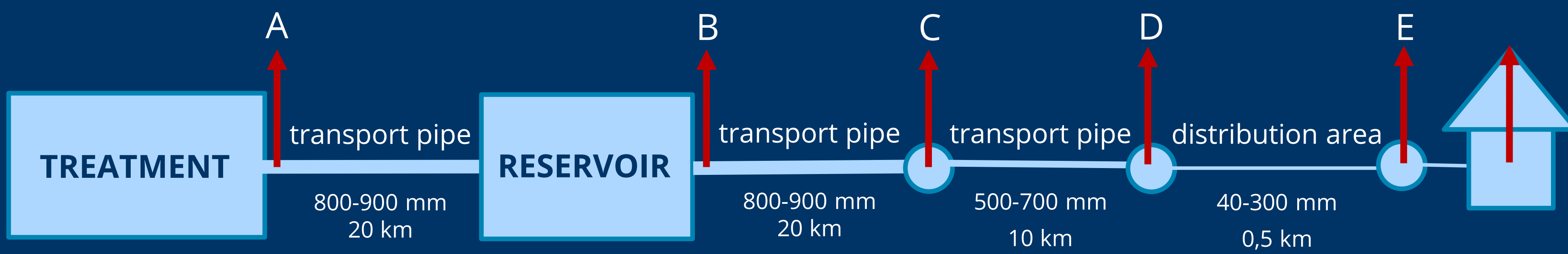
Detection of priority areas

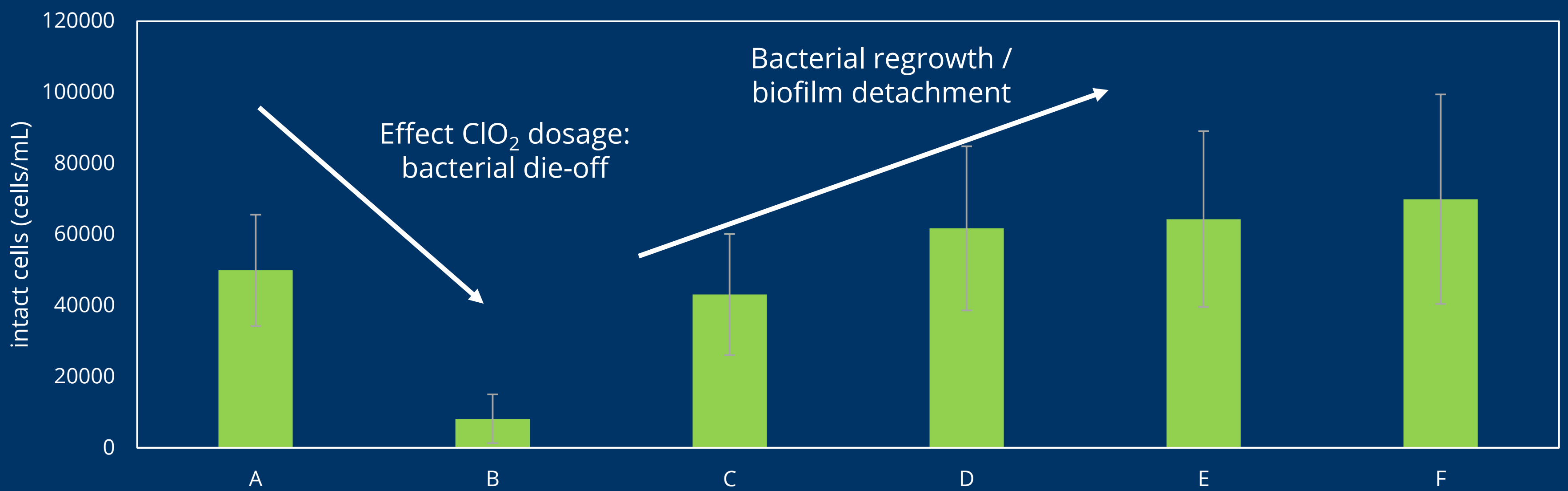
Highest ATP values in area supplied by WTP Andijk, especially in specific area

⇒ Confirms known problems:

- past customer complaints on turbid water
- need for regular flushing program

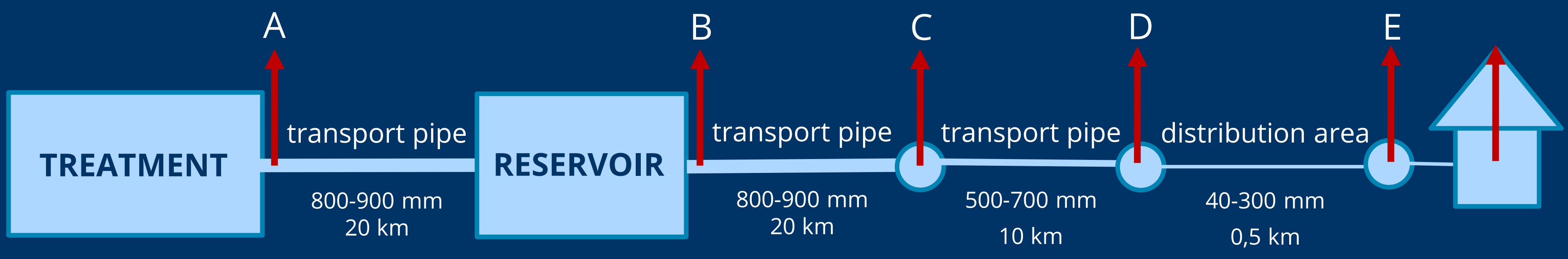
Microbial regrowth during water distribution

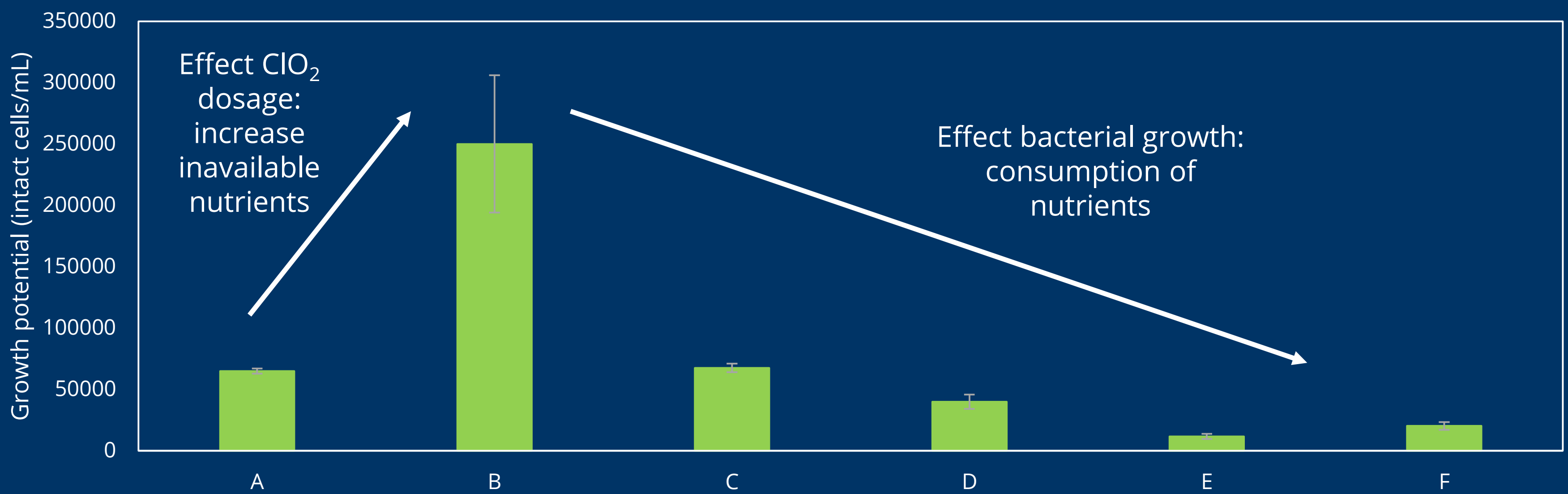




progressive regrowth in transport sections when disinfectant not available

Nutrients availability during water distribution





Clear link between available nutrients and bacterial growth

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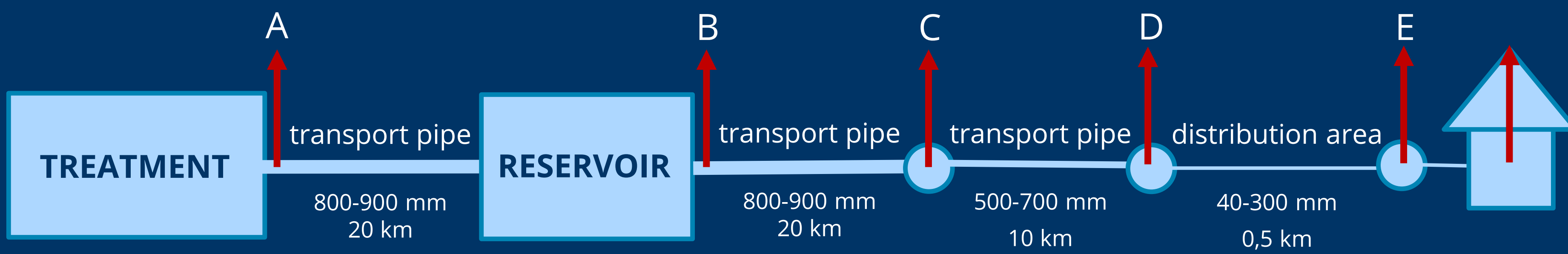
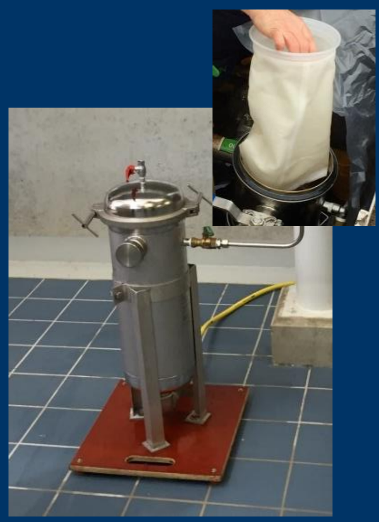
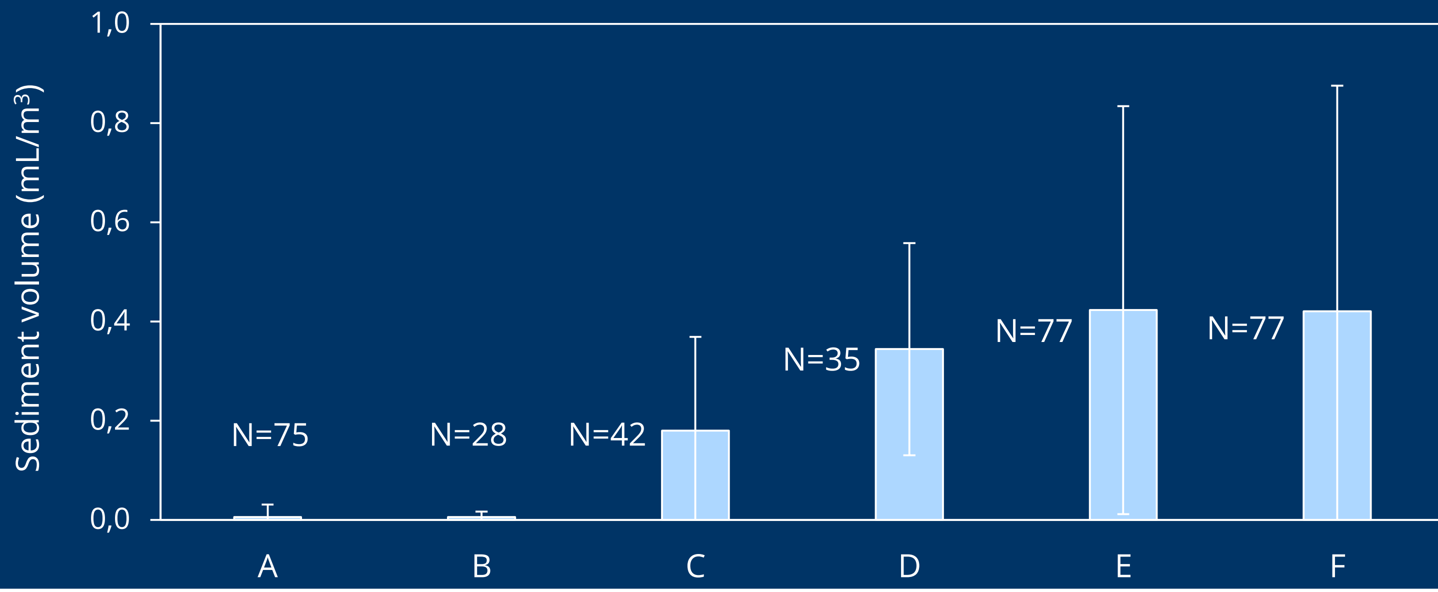
Sediments build up during water distribution







Not only bacterial growth in bulk water, but also build-up of sediment occur during water transport and distribution

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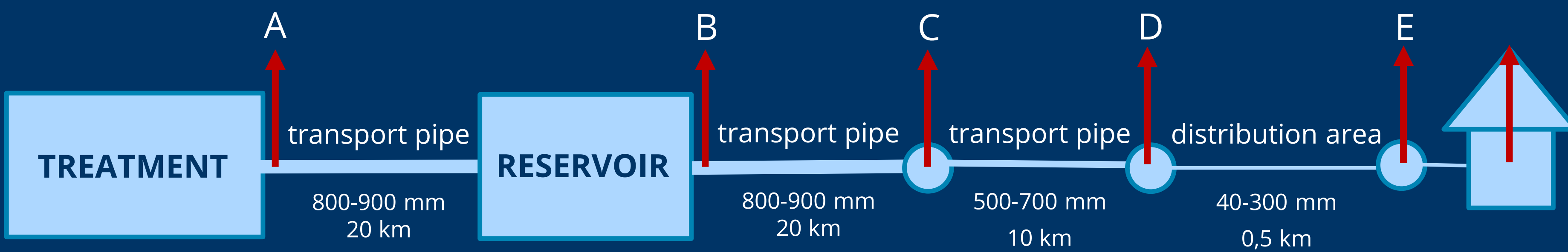

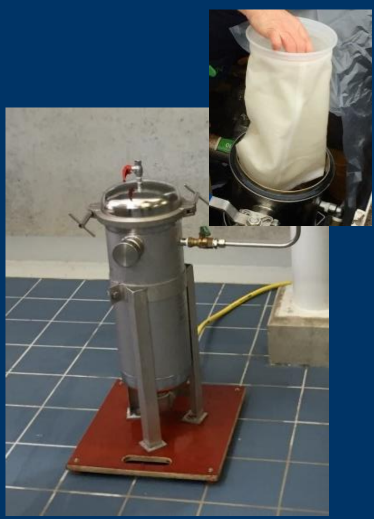

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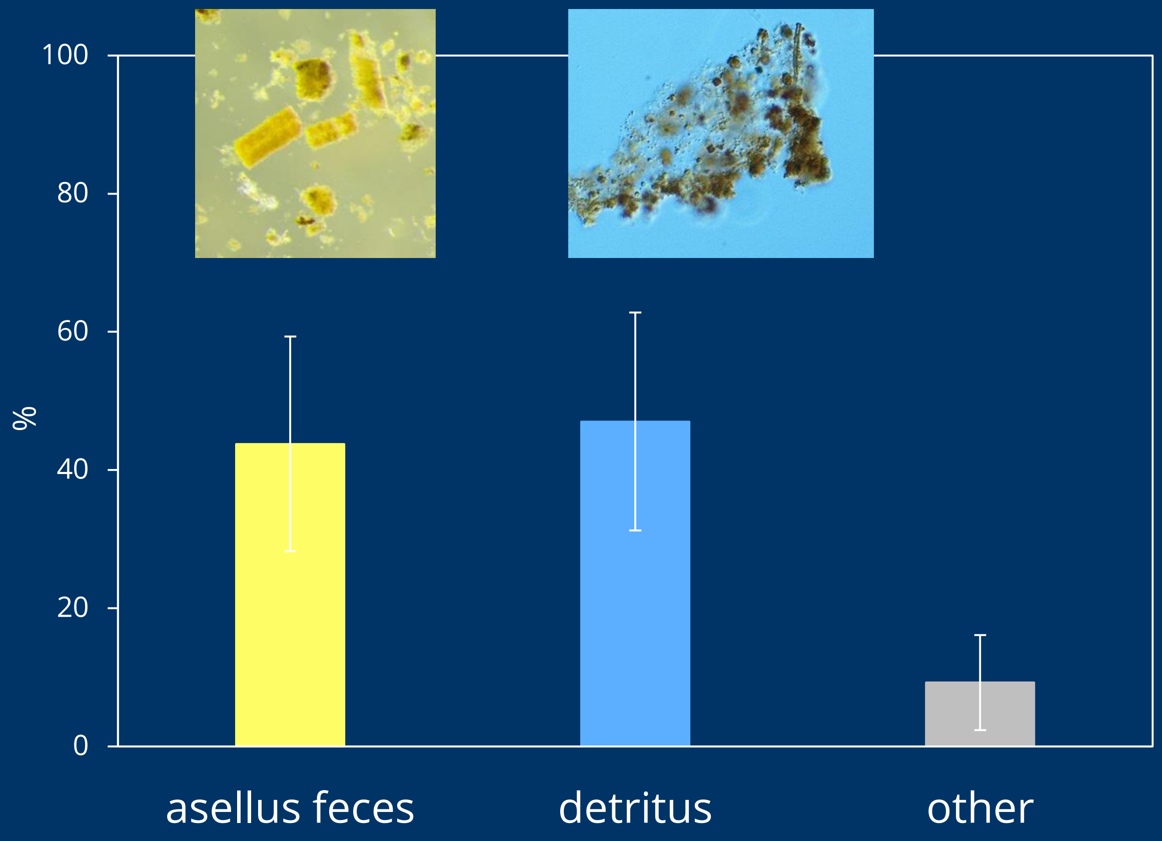
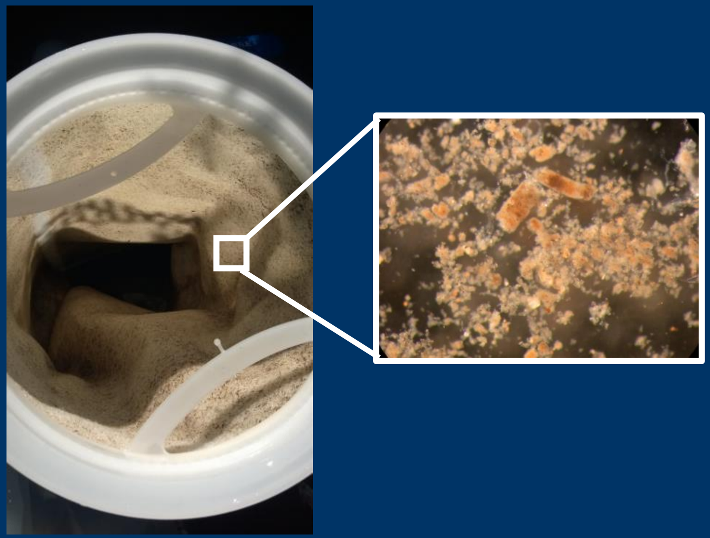
Sediment composition in distribution system

Sediment composition (location E)





sediments composed at
80-90%
of organic material

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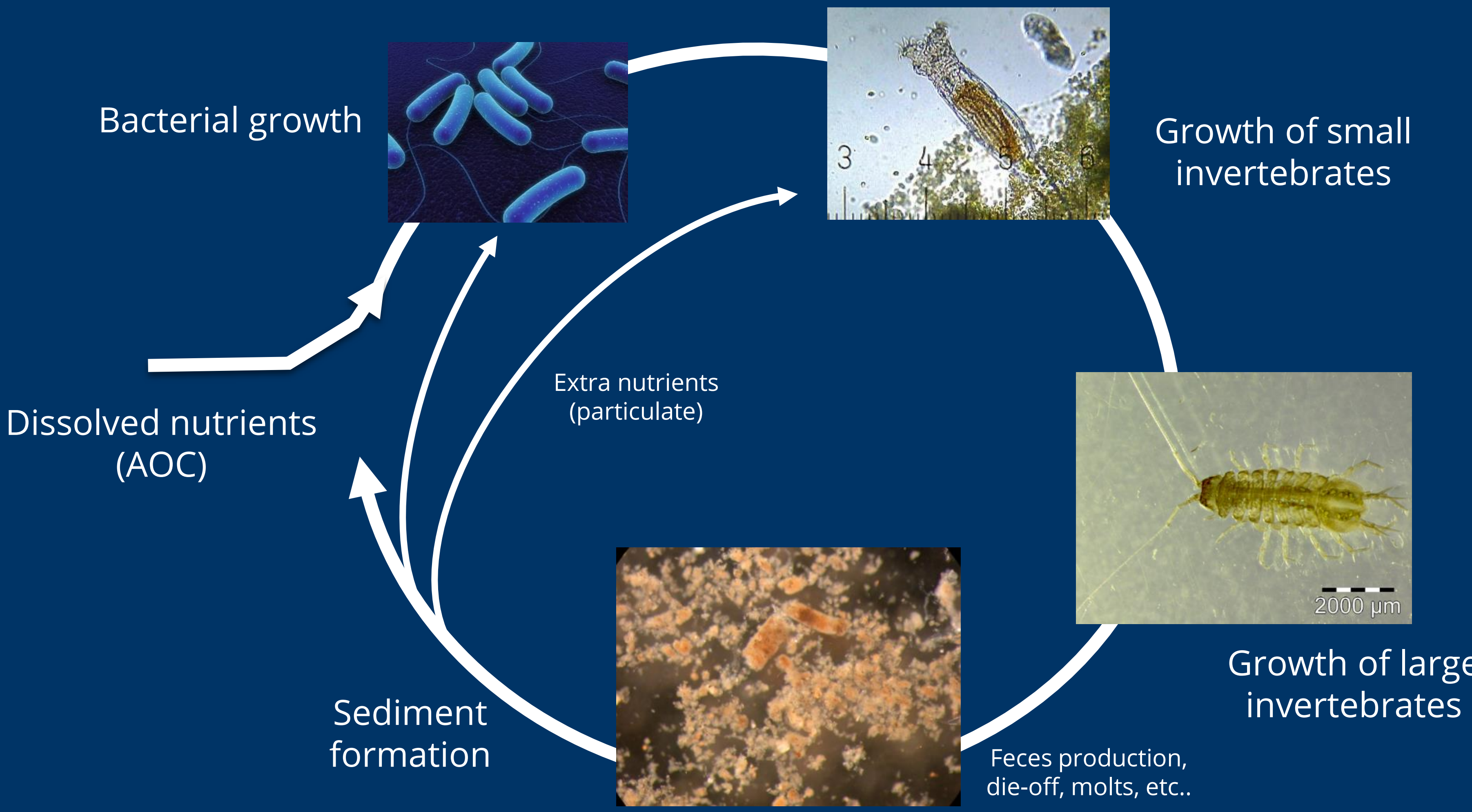
Food chain in distribution systems



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conclusions

- Organic matter in drinking water have impact on bacterial growth in drinking water distribution system
- The type and composition of different NOM compounds is determining factor for growth
- The exact dissolved and particulate compounds playing a role in bacterial growth and sediment build-up are still unknown and unexplored.
- Dissolved nutrients initiate food chain, which results in production of particulate nutrients and further promote sediment build-up.

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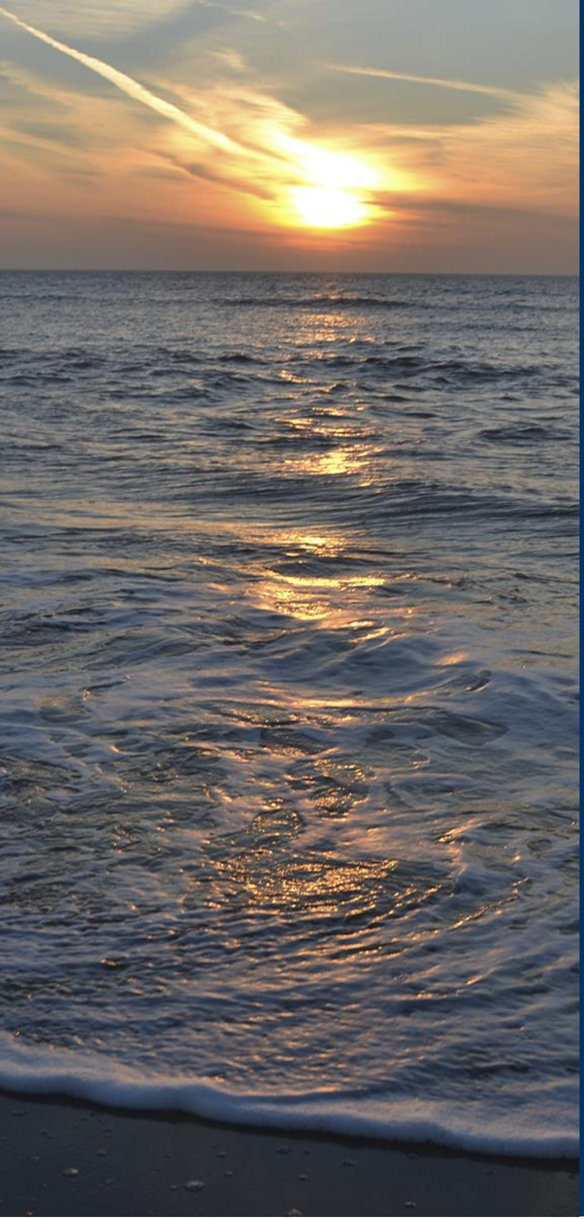

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