



## Vandsymbiose

Det handler ikke om vandets historie, Det handler om vandets kvalitet

Rygaard, Martin

*Publication date:*  
2014

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*  
Rygaard, M. (2014). Vandsymbiose: Det handler ikke om vandets historie, Det handler om vandets kvalitet. Sound/Visual production (digital)

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

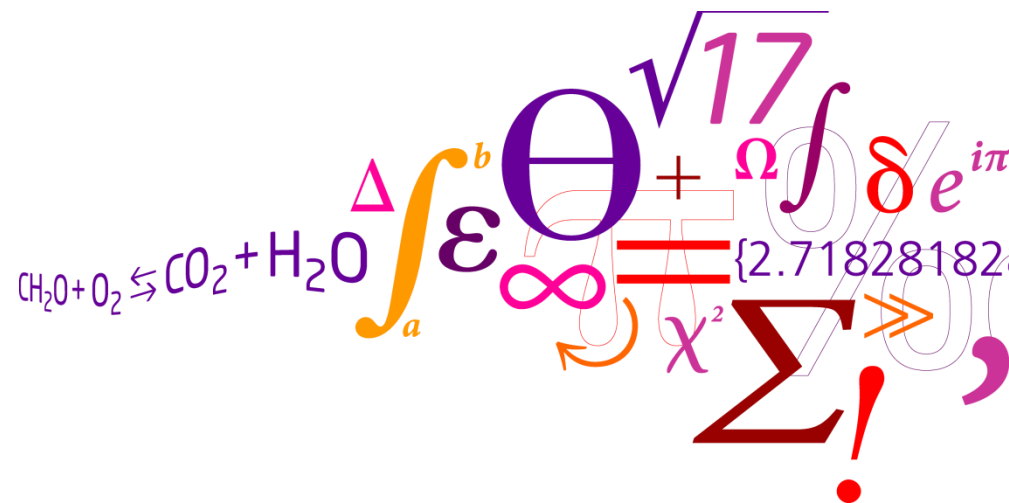
- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Vandsymbiose

Det handler ikke om vandets historie

Det handler om vandets kvalitet



Når "spildevand" bliver til "brugt vand"

# **INTERNATIONALE TENDENSER**

Et kritisk punkt

nråder

Aust

"For  
there.  
reache  
up aga

was

ing

06)

**Water Online**  
 Drinking Water Wastewater Stormwater Utility Management WEFTEC 2013  
**WATER QUALITY**  
 VIRTUAL CONFERENCE November 6  
 LEARN. CONNECT. ENGAGE.

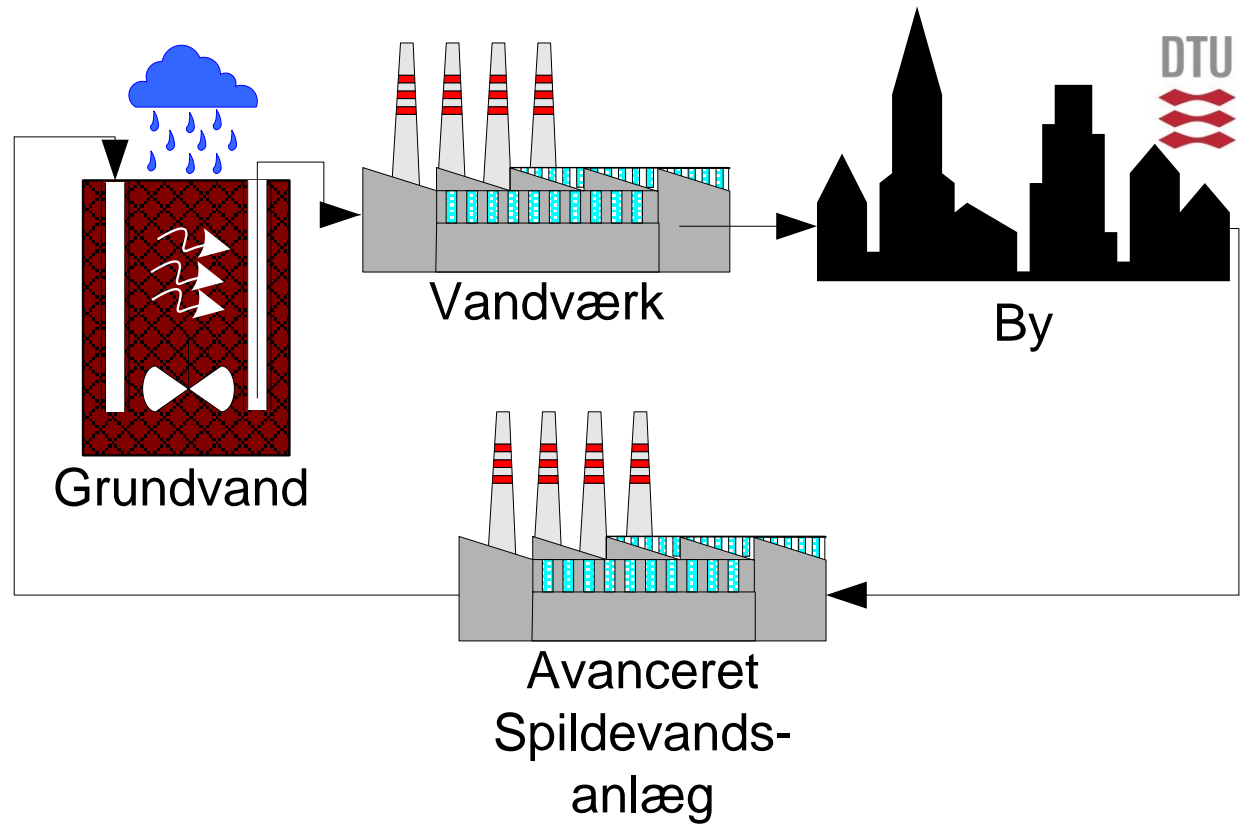
News Feature | October 18, 2013

## California Introduces Over A Dozen New Water Laws

By Sara Jerome

California is awash in new laws aimed at water issues.

This month, Governor Jerry Brown "signed more than a dozen bills aimed at improving access to water in the state, where drought is common and tension is high over the competing needs of residents, agriculture and the environment," Reuters reported.



Der er højt til loftet

# **GENINDVINDING TIL DRIKKEVANDSKVALITET**

Gammans effluent



# Goreangab Reclamation facility



# Risici og vandkvalitet

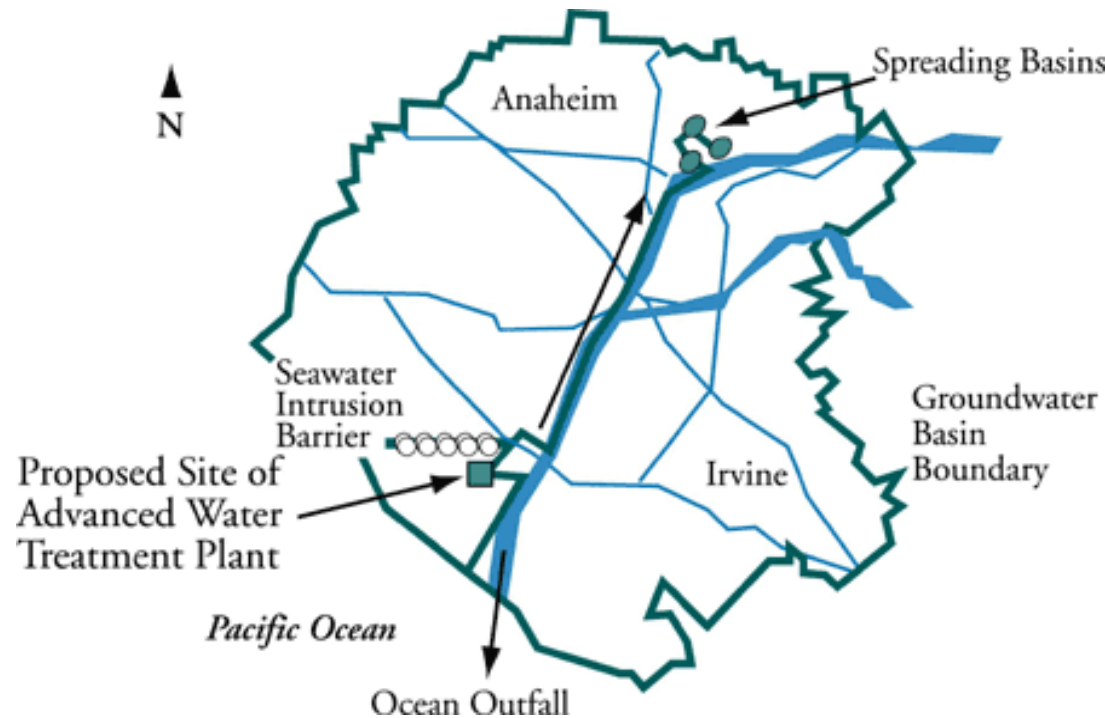
- At overholde kvalitetskriterier er ingen udfordring. Udfordringen ligger i de "ukendte ukendte" (Prof. Shane Snyder)
- Der findes mange eksempler hvor direkte recirkulering af spildevand leverer bedre vandkvalitet end "naturlige" drikkevandsressourcer, eller ikke-planlagt (de facto) recirkulering (Shane Snyder and others)
- Desinfektionsbiprodukter DBPs er (i USA) den absolut største kilde til uønskede forureninger af drikkevand. Og de er ikke engang begyndt at kigge på Ozonering og UV. (Shane Snyder)





# Recirkulering Orange County, USA

- 2,3 mio. indb. 900 km<sup>2</sup>
- Recirkulering siden 1975 (21 mio. m<sup>3</sup>/år)
- Fra 2007: 97 mio. m<sup>3</sup>/år
- Infiltreres/injiceres til akvifer hvorfra der oppumpes 333 mio. m<sup>3</sup>/år
- Vandbank – gemmes billigt, sælges dyrt
- Ca. 2,5 kr./m<sup>3</sup> recirkuleret vand



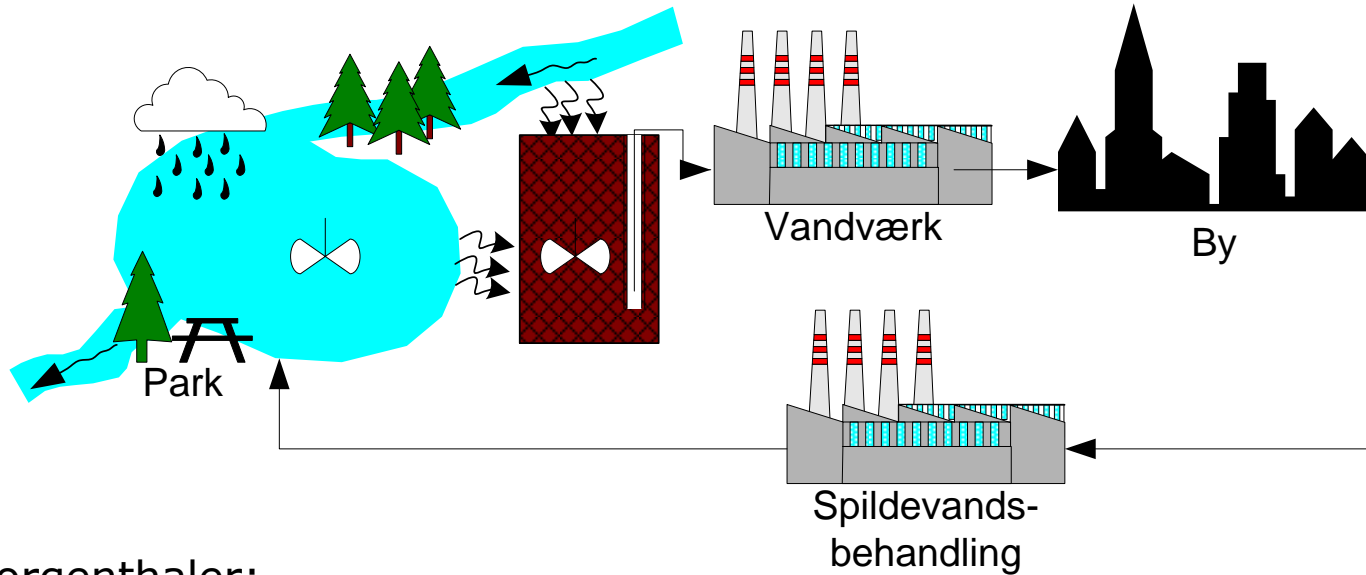
[www.gwrsystem.com](http://www.gwrsystem.com)

Når det ualmindelige er ualmindeligt almindeligt

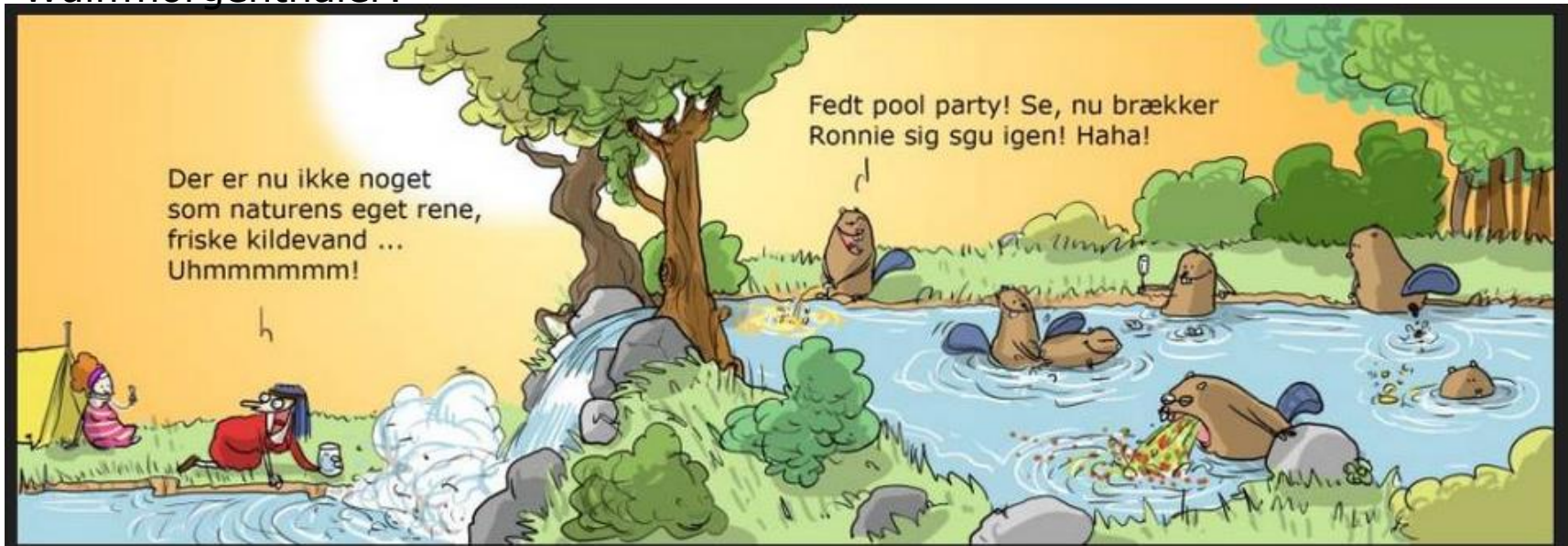
**“DE FACTO”**

**GENINDVINDING**

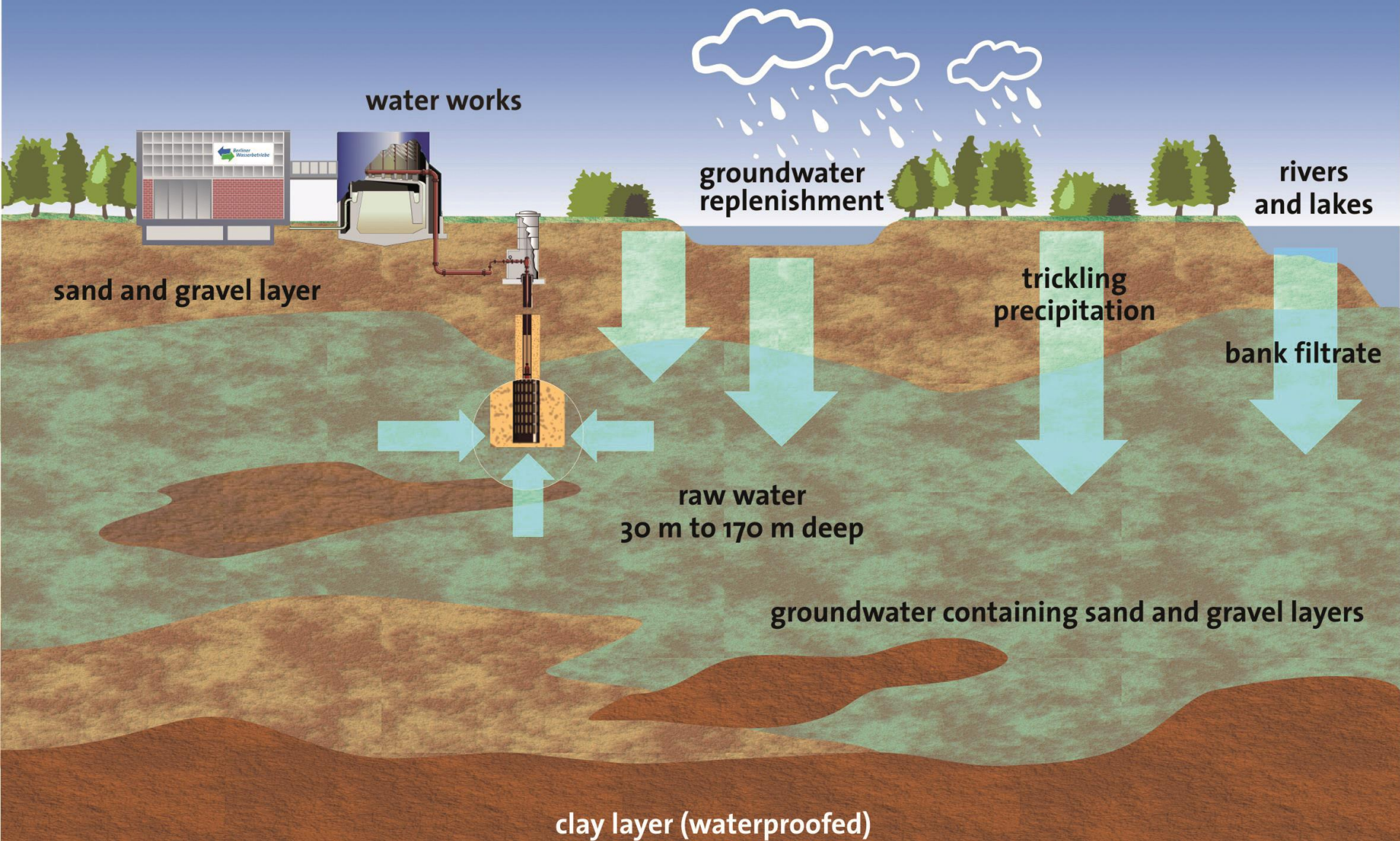
# Ikke planlagt (de facto) indirekte recirkulering, pga. opstrøms spildevandsudledning



## Wulffmorgenthaler:



Kunstig infiltration, Berlin



# De facto reuse ved grundvandsindvinding i bynære områder?

*“Even when cased through an aquitard into a confined aquifer, wells sited in in urban environments are more vulnerable to virus contamination than often believed.” (Bradbury et al. 2013)*

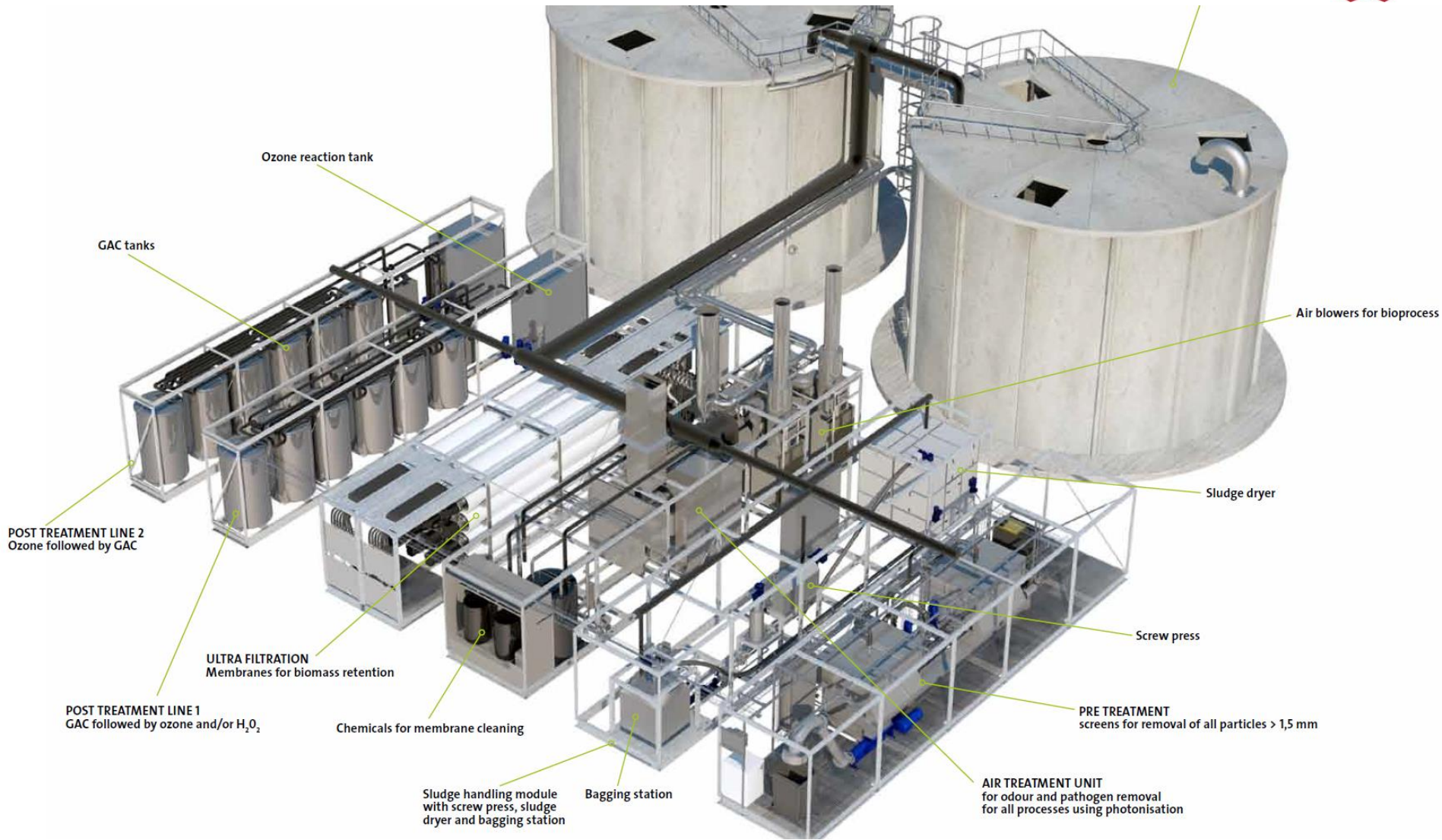
dx.doi.org/10.1021/es400509b | Environ. Sci. Technol. 2013, 47, 4096–4103

| Sample round           | 1         | 2         | 3         | 4         | 5         | 6         | 7         | 8         | 9         | 10       | 11          | 12        | 13        | 14        | 15        | 16        | 17        | 18       | 19        | 20       | 21        | 22       | 23        | 24        | 25        | 26        |        |        |  |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|----------|-----------|----------|-----------|-----------|-----------|-----------|--------|--------|--|
| median sample date     | 14-Sep-07 | 24-Oct-07 | 26-Nov-07 | 19-Dec-07 | 24-Jan-08 | 26-Feb-08 | 24-Mar-08 | 28-Apr-08 | 27-May-08 | 7-Jul-08 | 28-Jul-08   | 25-Aug-08 | 17-Sep-08 | 29-Sep-08 | 13-Oct-08 | 27-Oct-08 | 10-Nov-08 | 2-Dec-08 | 16-Dec-08 | 7-Jan-09 | 23-Jan-09 | 3-Feb-09 | 16-Feb-09 | 11-Mar-09 | 31-Mar-09 | 27-Apr-09 |        |        |  |
| viruses in sewage      | Adeno41   | orange    |           | orange    |           | orange    |           |           | orange    |          | not sampled | orange    | orange    |           |           | orange    | orange    | orange   | orange    | orange   | orange    | orange   | orange    | orange    | orange    | orange    | orange |        |  |
|                        | Adeno31   |           |           |           | cyan      |           |           | cyan      | cyan      | cyan     |             |           | cyan      |           | cyan      | cyan      | cyan      | cyan     | cyan      | cyan     | cyan      | cyan     | cyan      | cyan      | cyan      | cyan      | cyan   | cyan   |  |
|                        | Adeno2    | yellow    | yellow    |           |           | yellow    |           | yellow    |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           |           |           | yellow |        |  |
|                        | Echo3     |           | red       |           |           |           |           |           |           |          |             | red       |           |           |           |           |           |          |           | red      | red       | red      |           |           |           |           |        |        |  |
|                        | Echo30    |           |           |           |           |           |           |           |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           | red       | red       |        |        |  |
|                        | Adeno7    |           |           |           |           |           |           |           |           |          |             | green     |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | Echo11    |           | blue      | blue      |           |           | blue      |           | blue      |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | CoxA16    |           |           |           |           |           |           |           |           |          |             | black     |           | black     |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | CoxB3     |           |           |           |           |           |           |           |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | CoxB4     |           |           | green     |           |           |           |           |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           | green     |           |        |        |  |
| viruses in groundwater | Adeno41   | orange    |           | orange    | orange    |           | orange    |           |           | orange   |             |           | orange    | orange    | orange    | orange    | orange    | orange   | orange    | orange   | orange    | orange   | orange    | orange    | orange    | orange    | orange | orange |  |
|                        | Adeno31   |           |           |           | cyan      |           |           |           |           | cyan     | cyan        | cyan      |           |           | cyan      |           | cyan      |          |           |          |           |          |           | cyan      |           |           |        |        |  |
|                        | Adeno2    | yellow    |           | yellow    | yellow    | yellow    |           |           |           | yellow   |             |           | yellow    |           |           |           |           |          |           |          |           |          |           |           |           |           | yellow |        |  |
|                        | Echo3     |           | red       |           |           |           |           |           |           | red      | red         |           |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | Echo30    |           |           |           |           |           |           |           |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           | red       | red       |           |        |        |  |
|                        | Adeno7    | green     |           |           |           | green     |           |           |           |          | green       | green     |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | Echo11    |           | blue      | blue      |           |           |           | blue      |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | CoxA16    |           |           |           |           |           |           |           |           |          | black       | black     |           |           |           |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | CoxB3     |           |           |           |           |           |           |           |           |          |             | cyan      |           |           | cyan      |           |           |          |           |          |           |          |           |           |           |           |        |        |  |
|                        | CoxB4     |           |           |           |           |           |           |           |           |          |             |           |           |           |           |           |           |          |           |          |           |          |           |           | green     |           |        |        |  |

Nye krav til udledninger?

# **NÅR KRAVET ER (NÆR) DRIKKEVANDSKVALITET**

# Grundfos Biobooster Herlev Hospital



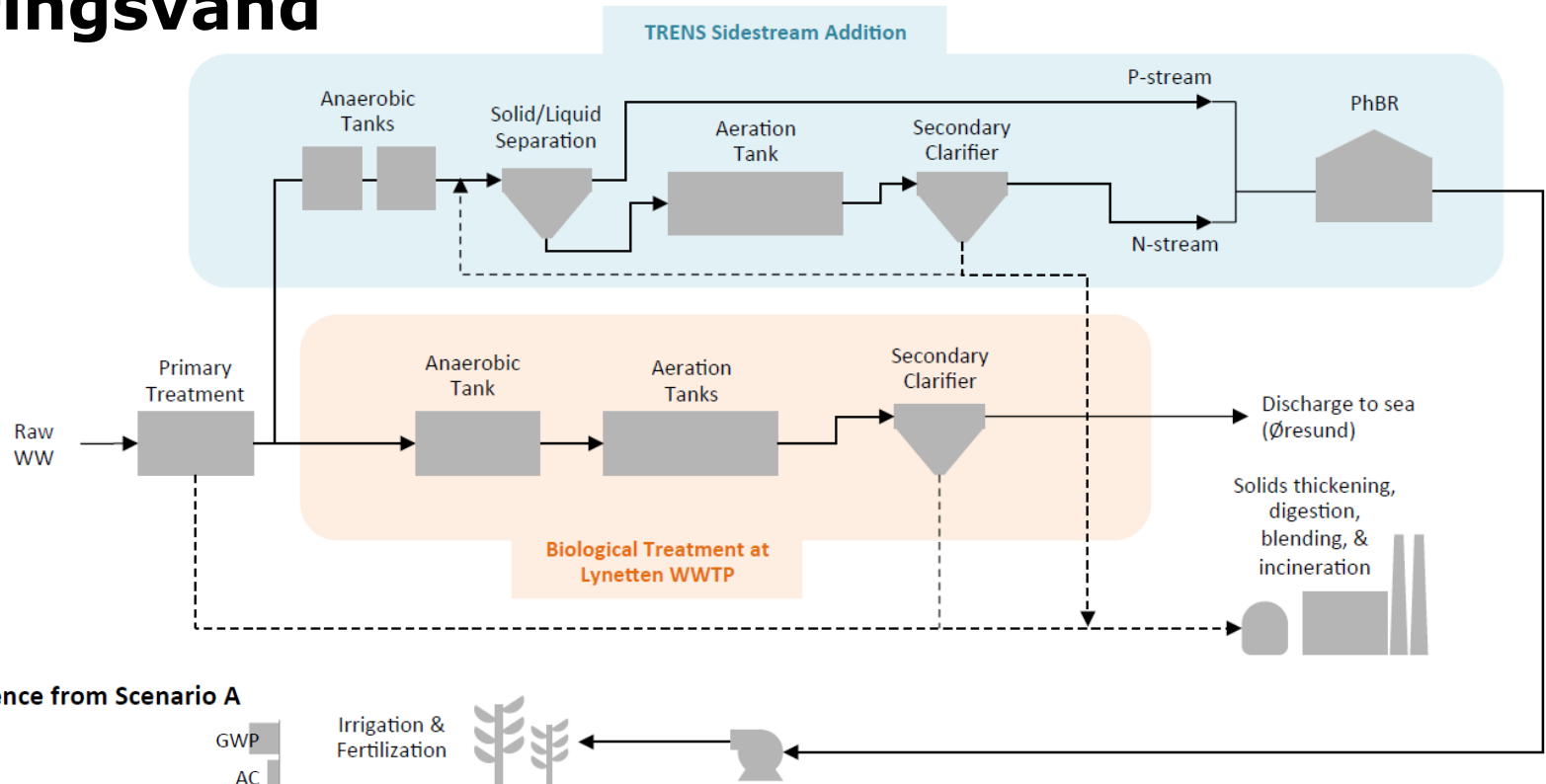
**Når nu vi alligevel producerer drikkevand...**

# Hvilke behandlingstrin indgår, og hvad er de rettet mod?

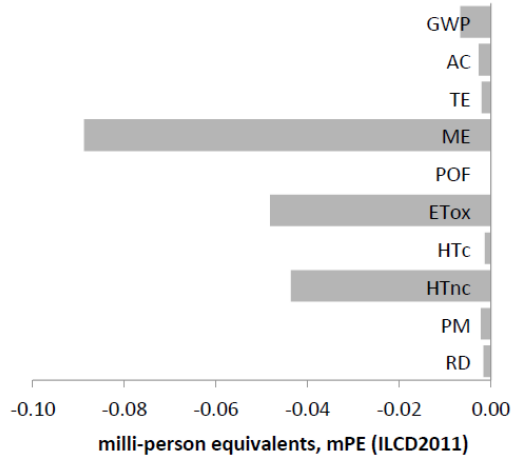
| Behandlingsmetode            | Suspenderet stof | Organisk forurening | Uorganisk forurening | Patogener | Windhoek, Namibia | Orange County, USA | Newater, Singapore | Herlev Biobooster |
|------------------------------|------------------|---------------------|----------------------|-----------|-------------------|--------------------|--------------------|-------------------|
| Konventionel Spildevandsværk | X                | X                   | X                    | X         | X                 | X                  | X                  | X                 |
| O <sub>3</sub> -oxidation    |                  | X                   |                      | X         | X                 |                    |                    | X                 |
| Flokkulering                 | X                | X                   | X                    |           | X                 |                    |                    |                   |
| Aktivt kul                   |                  | X                   |                      |           | X                 |                    |                    | X                 |
| Mikrofiltrering              | X                | X                   |                      | X         |                   | X                  | X                  |                   |
| Ultrafiltrering              | X                | X                   |                      | X         | X                 |                    |                    | X                 |
| Nanofiltrering               | X                | X                   | X                    | X         |                   |                    |                    |                   |
| Omvendt osmose               | X                | X                   | X                    | X         |                   | X                  | X                  |                   |
| UV                           |                  | X                   |                      | X         |                   | X                  | X                  | X                 |
| Klorering                    |                  | X                   |                      | X         | X                 | X                  | X                  |                   |
| Infiltration                 | X                | X                   | ?                    | X         |                   | X                  |                    |                   |
| Vandværk                     | X                | X                   | X                    | X         |                   | X                  | X                  |                   |



# Næringsvand



Scenario B - difference from Scenario A



# Recirkulering – ikke drikkevand



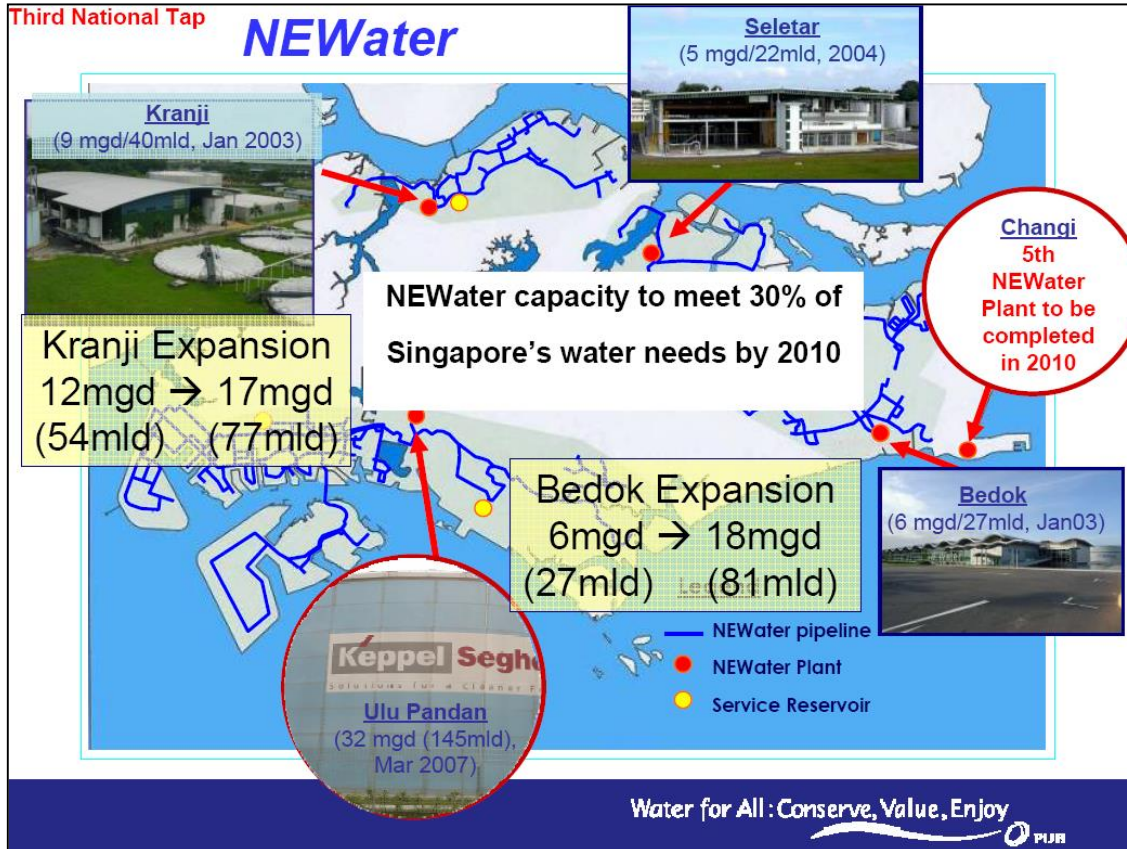
Costa Brava:

Sekundær vandforsyning til by/land og naturgenopretning

I alt 6,3 mio. m<sup>3</sup>/år



# Erfaringer fra Singapore



Fra Seah, PUB 2008

- Efterspørgslen på recirkuleret spildevand større end forventet
  - Bedre kvalitet
  - Stabil kvalitet

# Afrunding

- Genindvinding af vand fra brugt vand foregår i vid udstrækning. Planlagt såvel som "de facto". Mange internationale erfaringer.
- Mikroforureningsstoffer er en udfordring, men avancerede behandlingsmetoder står klar til at hjælpe
- Borgerens og politikerens accept kræver tillid til forsyningen. Dette forudsætter åbenhed om beslutningsgangen, involvering og oplysning
- I lyset af nye krav til udledninger, de facto recirkulering mv. bør det brugte **vand bedømmes på kvaliteten – ikke historien**