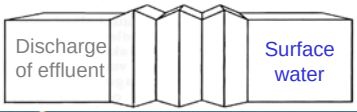
Use of Treated Wastewater for Nature:

The Waterharmonica

Sustainable Solution

Alternative for Separate Drainage and Treatment



Leading-Edge Technology

LET2004, Prague, Czech Republic
WW5, 3 June 2004, 9:00

The Waterharmonica:
a tool to convert used water into surface water

Ruud Kampf
Waterboard
Hollands Noorderkwartier

Theo Claassen
Wetterskip Fryslân

9.00

This presentation:

- Black, White and Grey
- ***why is treated waste water not surface water??***
- constructed wetlands to make a "living water" from waste water
- Texel:
  - the Everstekoog constructed wetland
  - the "kwekelbaarsjes" in De Cocksdorp
- other examples and plans in The Netherlands
- food chains and the Waterharmonica

The Waterharmonica:
the link between treated waste water and surface water

Thursday morning 9.00

The morning after the conference dinner……

Thank you for coming
so early in the morning

Separation of water flows

- **White** - rain
- **Black** - faeces and urine
- **Grey** - washing and rinsing, kitchen
- **Mixed** - do not mix??

Separate drainage is not new

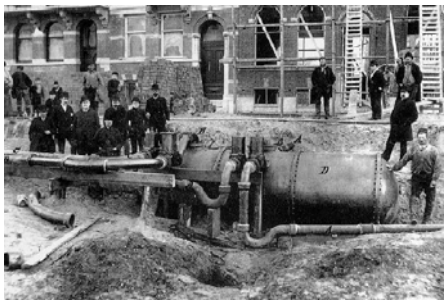
The Boldoot car: Honey buckets in Amsterdam

Steam mobile with air pump used by Liernur

http://www.bronnenuitamsterdam.nl/weergave.asp?ID=16

Around 1900

The vacuum sewage system of Charles T. Liernur (1828 - 1893)



With thanks to Adriaan Mels (LeAF, Wageningen UR), based on Thesis Van Zon, 1986

Practical use of Liernur system in:

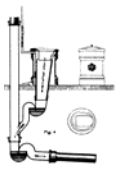
- Leiden 1200 people; 1870-1915
- Dordrecht 800 people; 1872-1887
- Amsterdam 1700 people; 1872-1912

- St. Petersburg 22.000 people

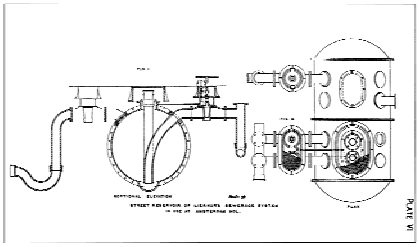
Prague 10.000 soldiers

Liernur collection of black wastes for reuse in agriculture

- Underground iron sewer
- Vacuum transport of faeces and urine



•iron toilets



Liernur: profitable production !!

- manure or “poudrette”
- ammonium sulphate

In Amsterdam profitable from 1897 - 1915 !!

Disappeared:
- Waterclosets
- Ahead of time?

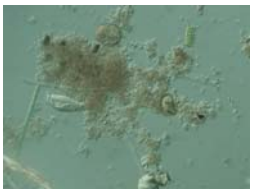
Sewer systems

- Already available on a big scale
- Relatively cheap
- Long life span

- But……..

Treated wastewater

- improvements: C, N, P
- regional STP's
- influence at effluent discharge:
  - sludge particles, flocs
  - loose bacteria
  - odor, foam
  - low O_2



⇨"Dead water", not satisfied with quality

Is a sewer system clever ??!!

Per inhabitant per year:

50 l faeces, 500 l urine plus 100 l kitchen wastes

+ 15.000 l drinking water, mainly for "transport"

+ 15.000 l rain

Ú large and expensive sewers

NB: faeces and urine = 80 % N, 75 % P and 100 % of pathogens

But every **disadvantage** has his own **advantage**

Typical effluent quality oxidation ditch STP

- BOD: 2 - 3 mg/l
- NH4: 0.1 - 1 mg/l
- NO3: 3 mg/l

- Suspended solids: low

Better than many surface waters !!!

But for example faecal coli: 400 - 800 per ml !

"Clear effluents"

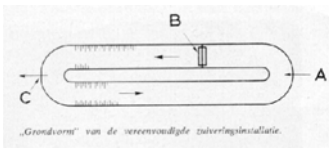
It used to be the finest water we had:

it originates from drinking water and rain water

- Above that:
  - Â regional STP's
  - Â concentrating effluents from a region

Oxidation ditch

developed in the Netherlands, A. Pasveer 1909 - 2001



basic idea:

just a normal ditch with an aerator, no sludge retention

only later:

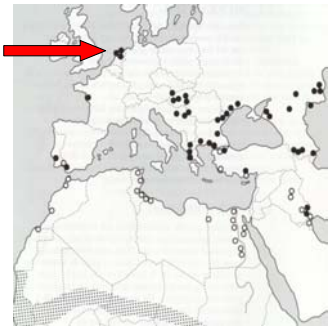
the "race track" shape with activated sludge

0.05 kg BOD per p.e. per day

1 kg dry sludge/p.e and 250 - 300 l/ p.e. volume

Spoonbills in Europe

The Netherlands



- simple
- but still modern
- good effluent

Spoonbills

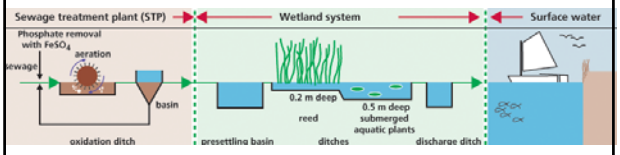
Texel

- Is a beautiful island
- A tourist resort
- A bird island
- Still a strong agricultural stronghold

Water on Texel

- Scarce
- Drinking water from mainland
- Masterplan Water Texel
- Projects like effluent diversion, etc

From wastewater to surface water



STP Oxidation Ditch

Constructed wetland

Surface water

A constructed wetland to make a "living water" from treated waste water

Everstekoog

Aerial view STP Everstekoog

sewage treatment plant

presettling basin

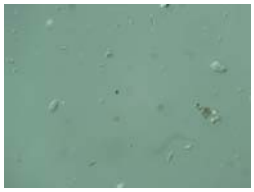
9 ditches with reed/cattail and aquatic plants

discharge ditch

Research project 1995 - 1999

After constructed wetland different water

- Natural oxygen regime
- No odour
- Less sludge particles lead to desinfection
- More, but different suspended solids
- Living water:
  - algae, daphnia
  - all kind of "waterlife"
  - fish
  - birds



Process technology constructed wetlands

- Oxidation ditch / carrousel:
  - like polluted surface water
- Constructed wetland for effluent polishing:
  - like cleaner surface water
- Processes are comparable
  - settling, adsorption, (photo katalytic) biofilms, diffusion, growth, decay, etc.

➔ combination van (bio)procestechnology, agriculture, biology, etc.

[EcoEng-online]

➔ ecological engineering: www.IEES.CH

Texel

Learning the process by doing

Resulted in a lot of knowledge and ideas!!

well treated wastewater
can be a good source of life!

More sustainable, natural water systems

“Kwekelbaarsjes”

growing **Daphnia** on treated wastewater of the STP De Cocksdorp

to grow **Sticklebacks**

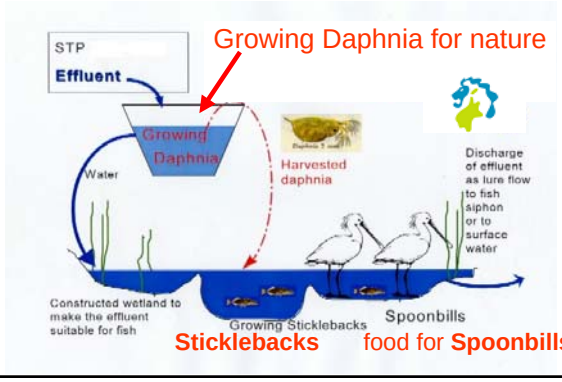
as food for **Spoonbills**

Fish in the Everstekoog constructed wetland

- in first pond no fish
- fish in ditches:
  - but only after 3 days retention time
  - after 10 days a lot of fish

up to 15 Stickleback per m^2

“Kwekelbaarsjes system”



Sticklebacks

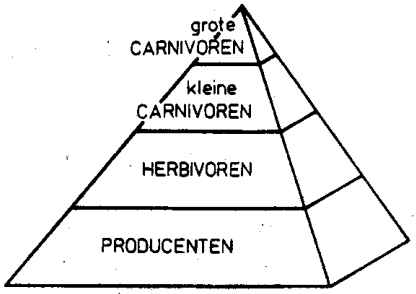
Research from 2001

- 4 mesocosms 2 m^3
- 4 ponds 25 m^3

- modelling
- food studies
- harvest methods

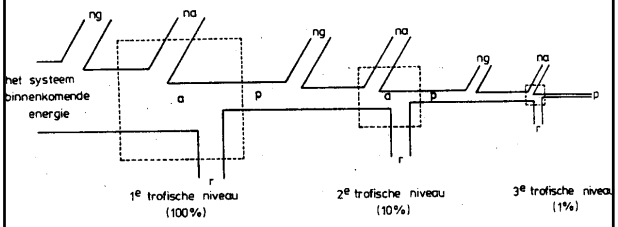
Experimental set-up

Conclusions: Food chain!



Harvesting Daphnia for research

Conclusions:
Food chain + energy flows



Kwekelbaarsjes ?

"Spoonbills and treated waste water"

- Feasible on Texel
  - growing Daphnia: Daphnia feed on sludge particles
  - bring Sticklebacks to the constructed wetland
  - it attracts Spoonbills
- Also on other places attractive!!
- **It fits in the EU Water Framework Directive**

Conclusions

A more natural constructed wetland:

different, living water

desinfection

nutrient removal

natural values

After treatment of waste water
or
pre treatment of surface water?!

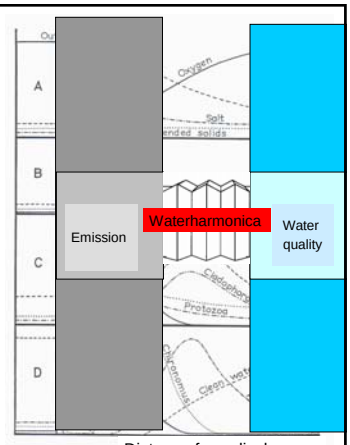
Schematic effect of discharges of wastewater

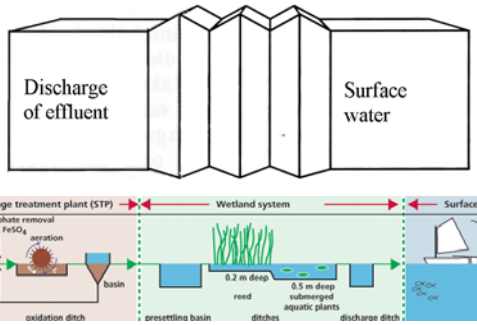
A physical – chemical

B nutrients

C micro-organisms

D macro-organisms





www.waterharmonica.nl

Two separate worlds

Emissions	Surface waters
reduction discharges	quality standards
black lists pollutants	aquatic ecosystems
best available techniques most feasible techniques	water systems
action programmes / regulations	general directives
legislation control	integrated water management
	master plan consensus involvement

The Waterharmonica project

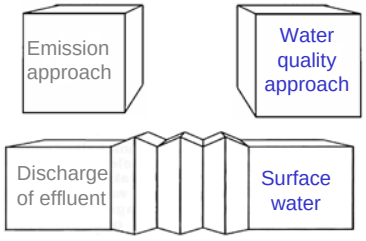
- winning idea in 1996: 25 years celebration Dutch Foundation for Applied Water Research (STOWA) by Theo Claassen

Ongoing STOWA project 2003-2004:
research and implementation

- see project site www.waterharmonica.nl for reports, papers conferences, etc

stowa WETTERSKIP FRYSLÂN Hollands Noorderkwartier ROYAL HASKONING LeAF

Waterharmonica as linkage-system



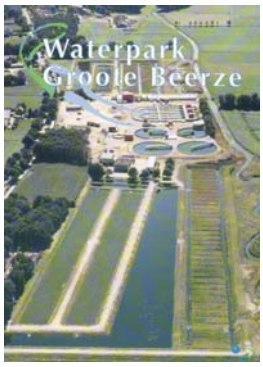
accordion, concertina, harmonic corridor

Increasing interest in The Netherlands for constructed wetlands for effluent polishing

Realised:
- Land van Cuijk, *Waterboard De Maaskant*
- Waterpark Groote Beerze, Hapert, *De Dommel*
- Efteling, Kaatsheuvel, *West-Brabant*
- Sint Maartensdijk, *Zeeuwse Eilanden*

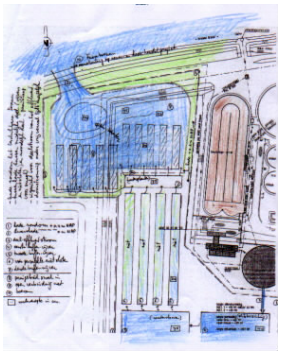
In preparation:
- Waterpark Schoonbroek, Apeldoorn, *Veluwe*
- Grou and Ameland, *Friesland Water Authority*
- Ootmarsum, *Regge en Dinkel*
- Wervershoof, Geestmerambacht, De Cocksdorp, *our waterboard*

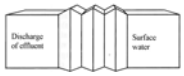
Water park Groote Beerze



STP Hapert De Dommel

Waterharmonica STP Grou?!



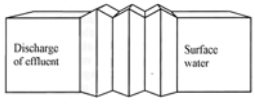


- Effluent polishing
- Spawning area for fish
- Fish ladder to polder water

UTRECHT 2004
INTECOL 7th INTERNATIONAL
Wetlands conference
Universiteit Utrecht

THE 7th INTECOL INTERNATIONAL WETLANDS CONFERENCE
UTRECHT, THE NETHERLANDS

25 - 30 JULY 2004



Session 10:
The Waterharmonica,
a logical natural chain between well treated waste water
and a "healthy and useable" surface water

29 July 2004, 14.45 – 18.00

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