State of the art – 29 years of experience

WITH FOCUS ON:

- **METHOD**
- **QUALITY OF FILTRATE WATER (P – RETENTION) AND SLUDGE RESIDUE**
- **EMPTYING AND RECYCLING**
- **TRIAL SYSTEM**
- **ENVIRONMELTAL MPACT**


Photo: Orbicon

WETPOL 2017
7th. International Symposium
on Wetland Pollutant Dynamic and Control.
21th to 25th August, 2017 - Montana, USA

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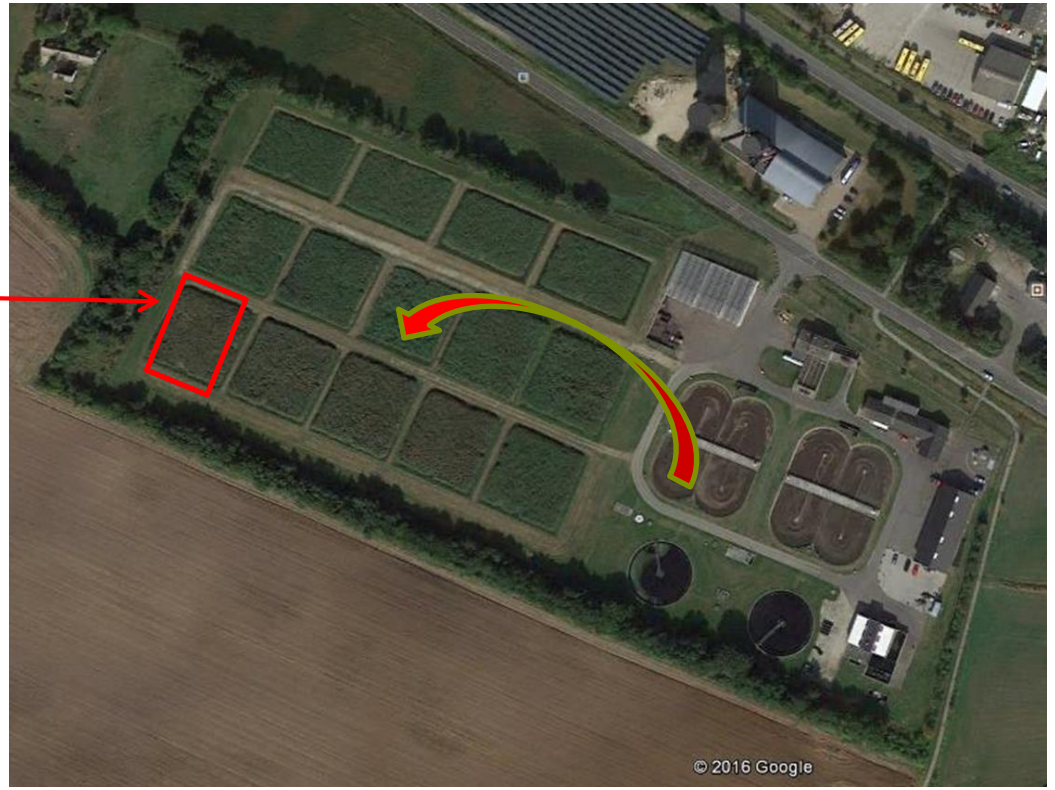
Helsinge Sludge Treatment Reed Bed Systems (STRB) – Denmark (1996 – 2017)

- 630 tons ds - activated sludge per year
- 14 Basins and Greenhouse stock pile area
  - 10 Basins (1996 into service)
  - 4 Basins (2013 into service)

OPERATION!

- STRB´s are devided into a number of basins
- A ”loading cycle” for a basin consists of a loading period + a resting period
- One basin is loaded at a time, the remaining basins rests
- A bed is emptied after 8-15 years



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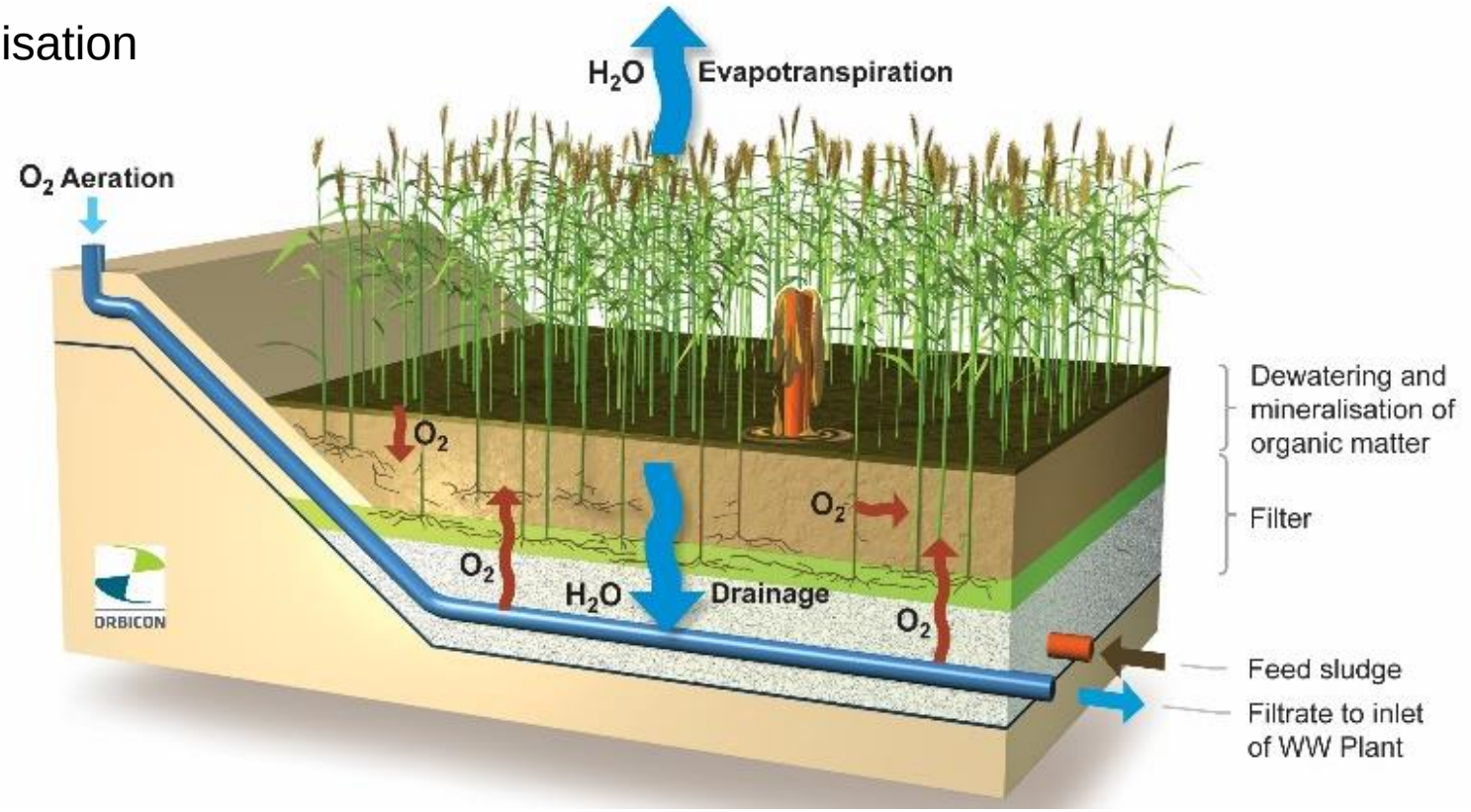
Long-term sludge reduction in reed beds
Overall funtionality

- Dewatering
  - Draining
  - Evapotranspiration
- Aeration
- Mineralisation



System Proces and Product


Photo: Orbicon

Photo: Orbicon


Photo: Orbicon

Photo: Orbicon


Photo: Orbicon

Fredensborg STRB (Denmark): 2005- 2015
Quality of the reeds

August 2014


Photo: Orbicon


Photo: Orbicon


Photo: Orbicon


Photo: Orbicon


Photo: Orbicon

Loading pipes


Photo: Orbicon


Photo: Orbicon

Photo: Orbicon

Aeration Pipes

Photo: Orbicon

Photo: Orbicon

Pump capacity

- Sludge distribution (hole surface)
- Batch size
- Quota
- Basin area (no. of loading pipes)


Photo: Orbicon

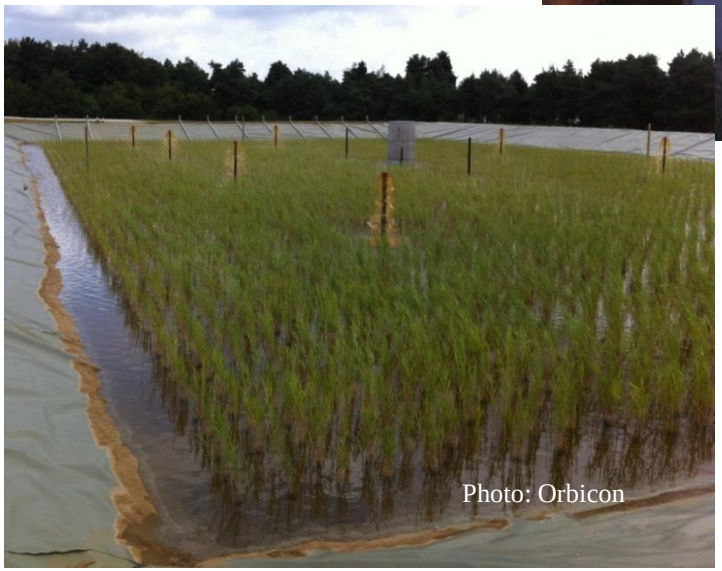


Photo: Orbicon

Buffer tank


Photo: Orbicon

- The operation of WWTP
- The distance
- Mix more than one type of sludge

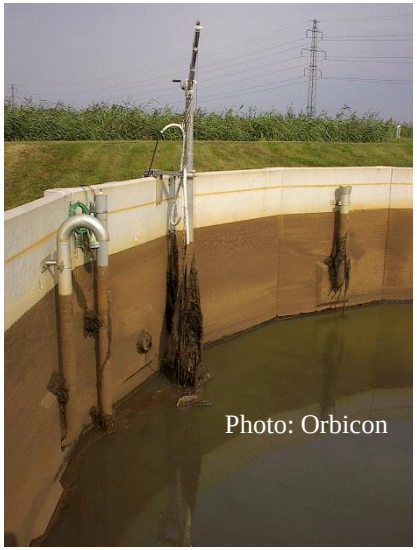
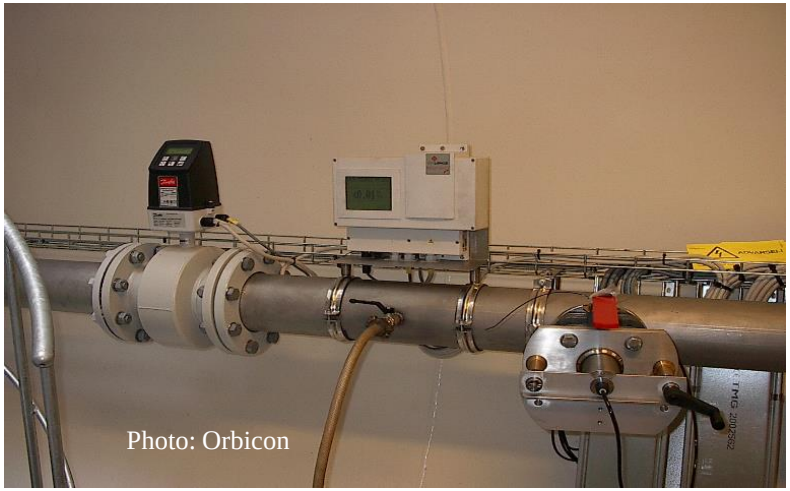
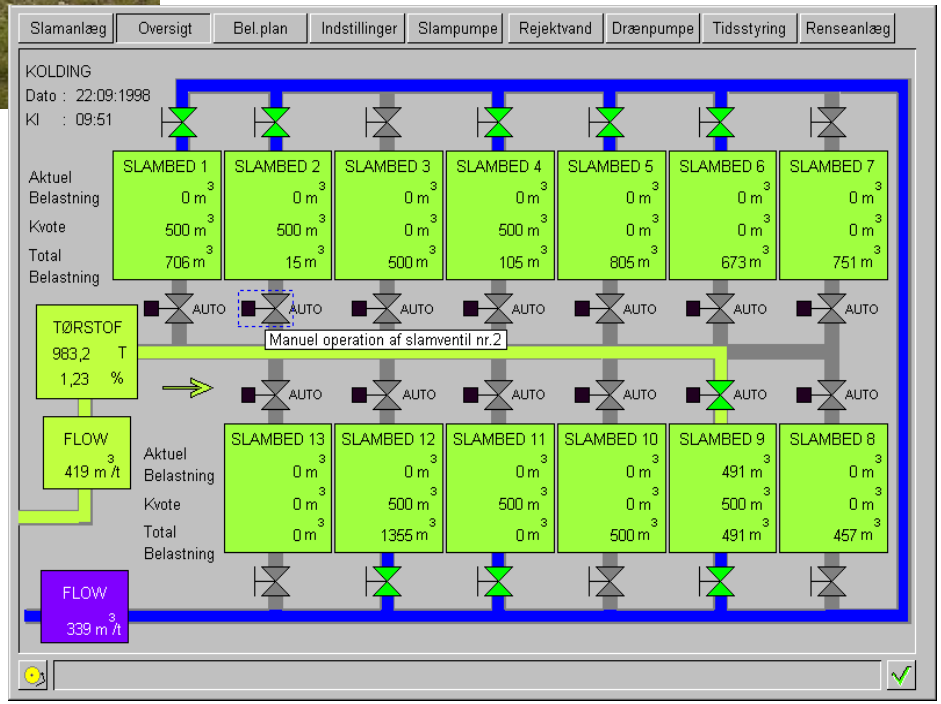


Photo: Orbicon


Photo: Orbicon

Operations and Control





Quality of the filtrate after “treatment”

Sludge types and filtrate qualities


Photo: Orbicon


Photo: Orbicon

?


Photo: Orbicon

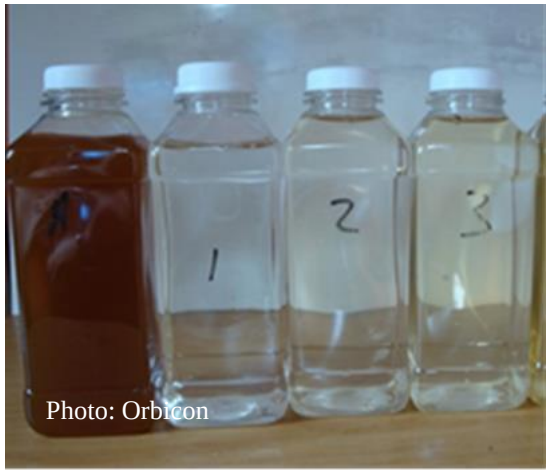


Photo: Orbicon

Quality of the filtrate water depend on the status of the system, the dewatering efficiency and of sludge residue quality


Photo: Orbicon


Photo: Orbicon

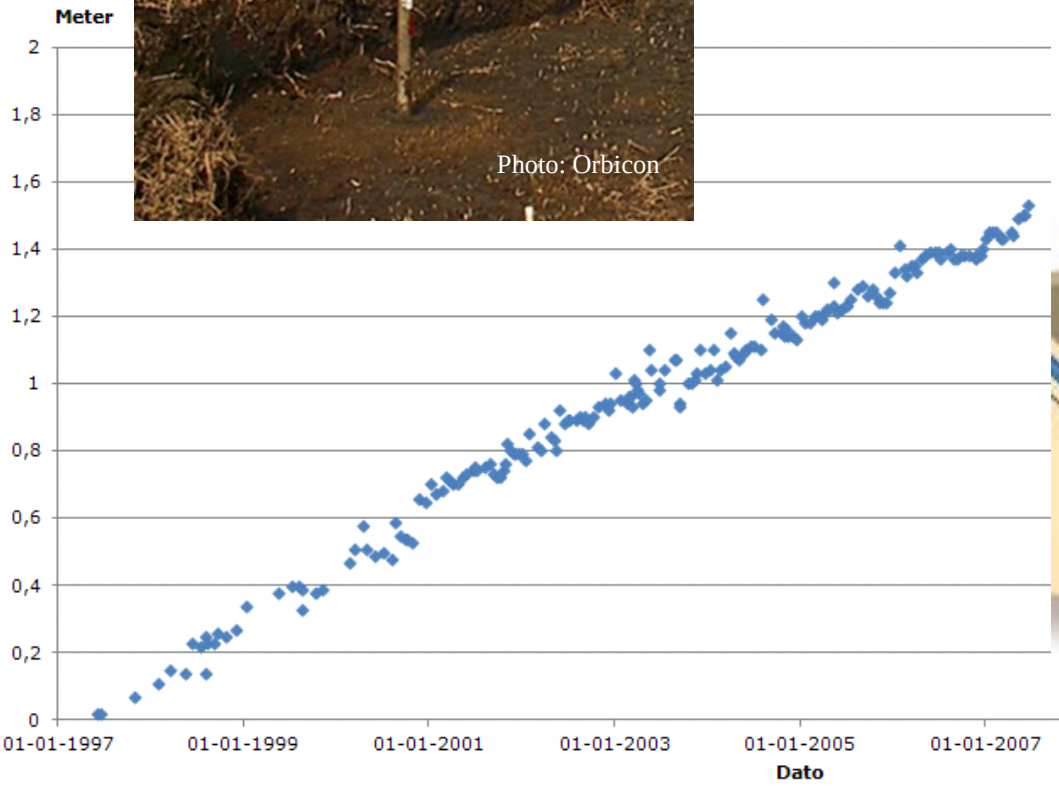

Photo: Orbicon

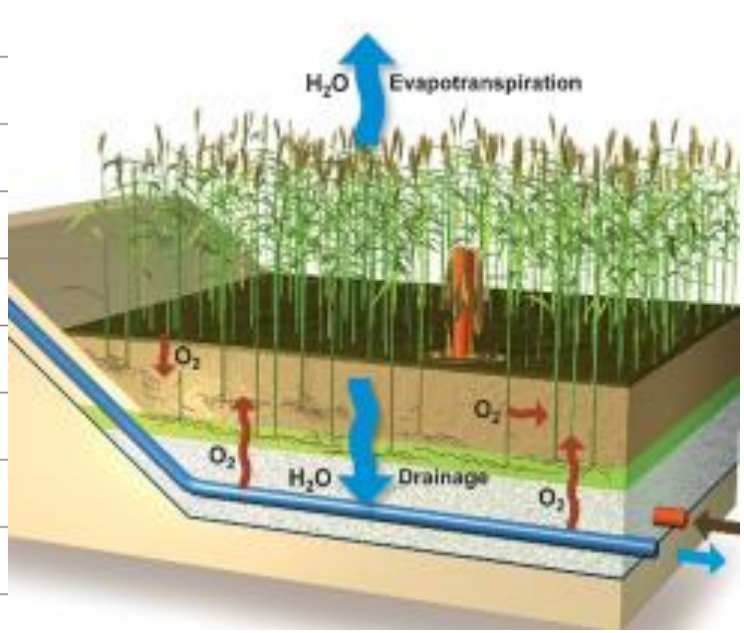

Photo: Orbicon


Photo: Orbicon

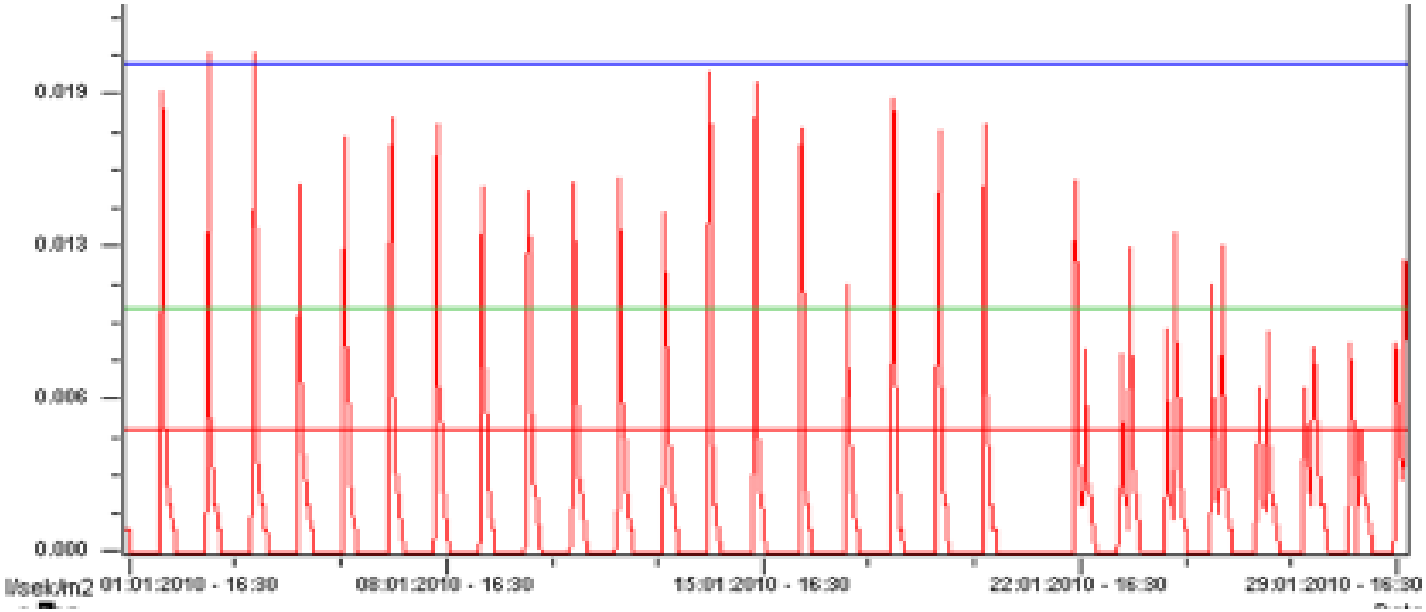
The growing Sludge residue increase the cleaning of the filtrate

Helsinge STRB/Basin #1
Yearly growth of 13-15 cm
(1997 – 2011)





Filtrate runn of (l/sec./m2) – Helsinge STRB



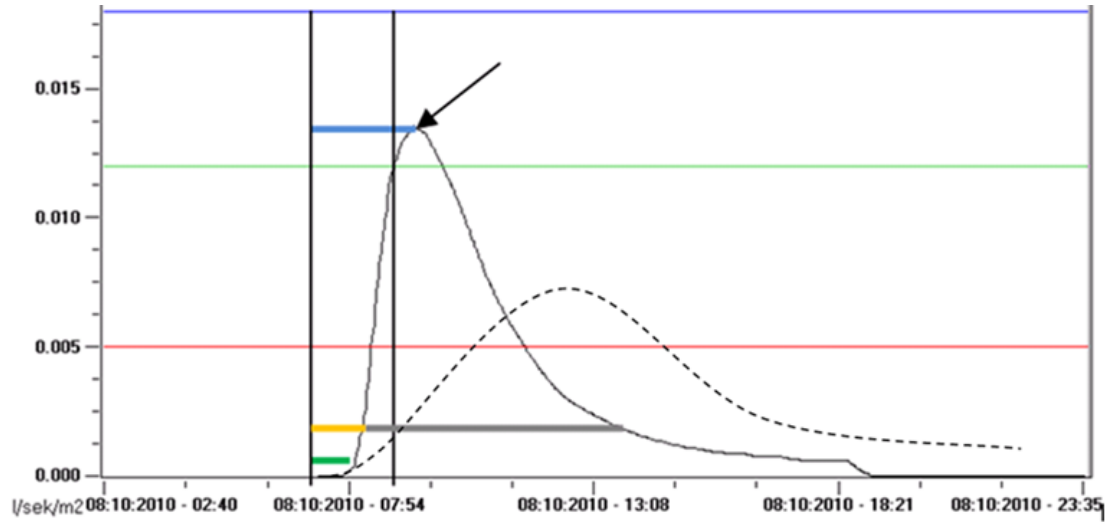



Photo: Orbicon

Filtrate water from dewatering of Water Works sludge – Turbidity (NTU)


Photo: Orbicon

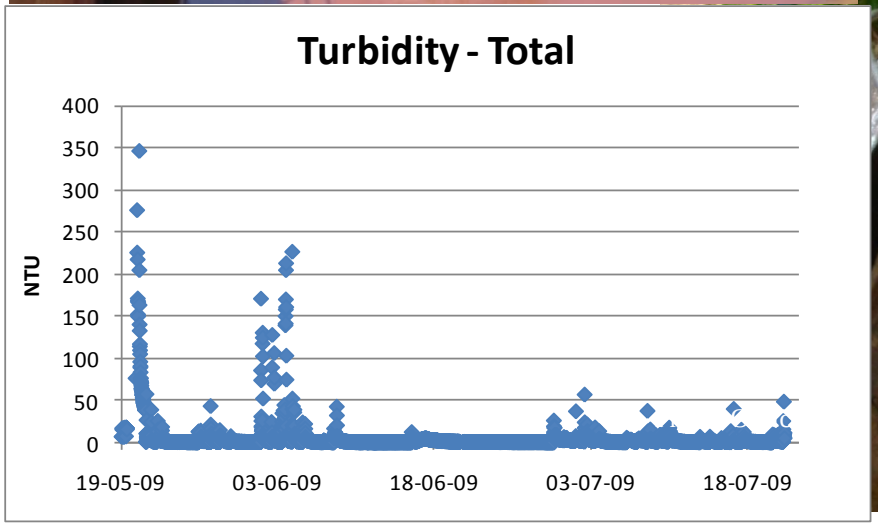
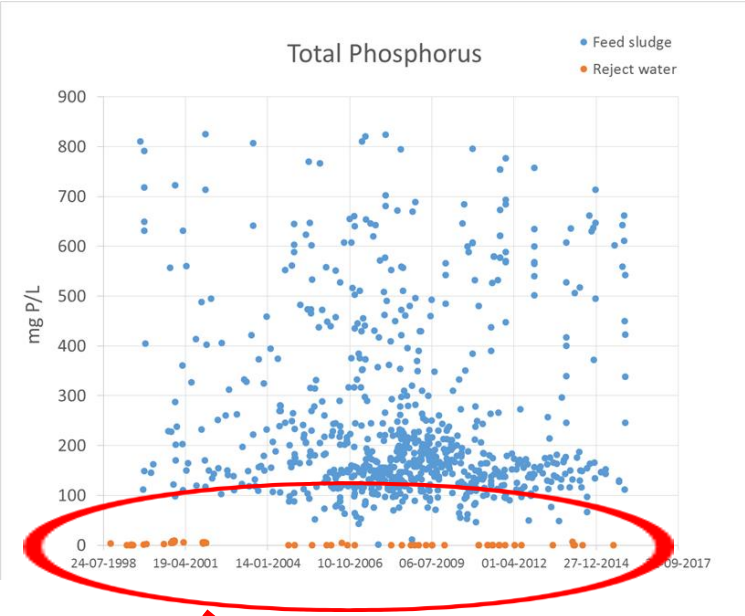
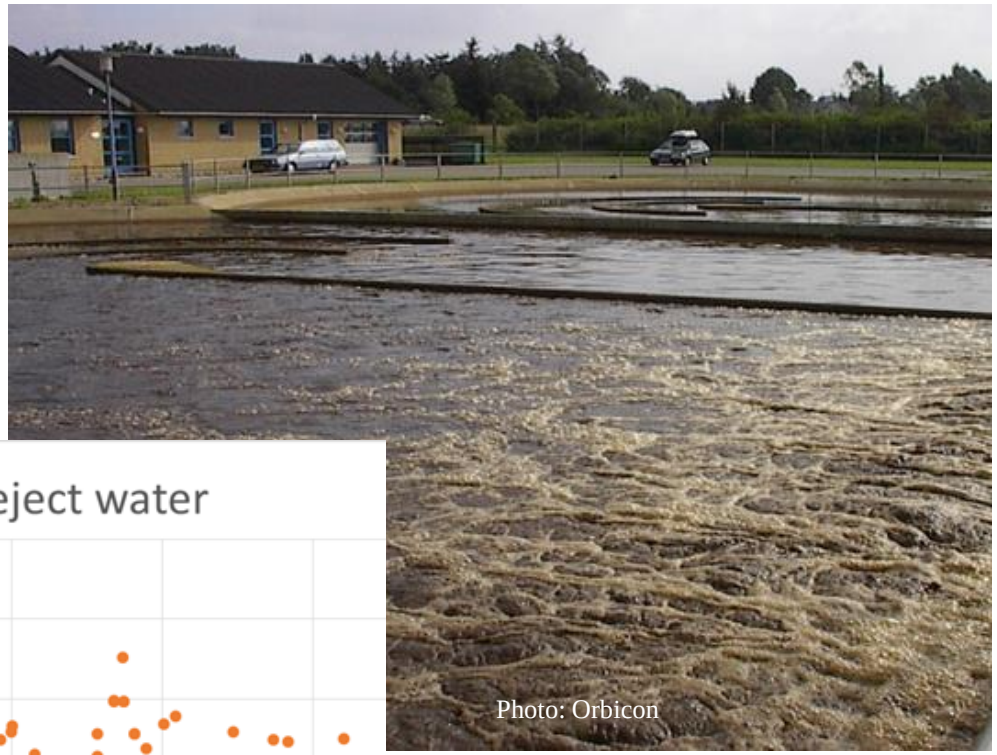
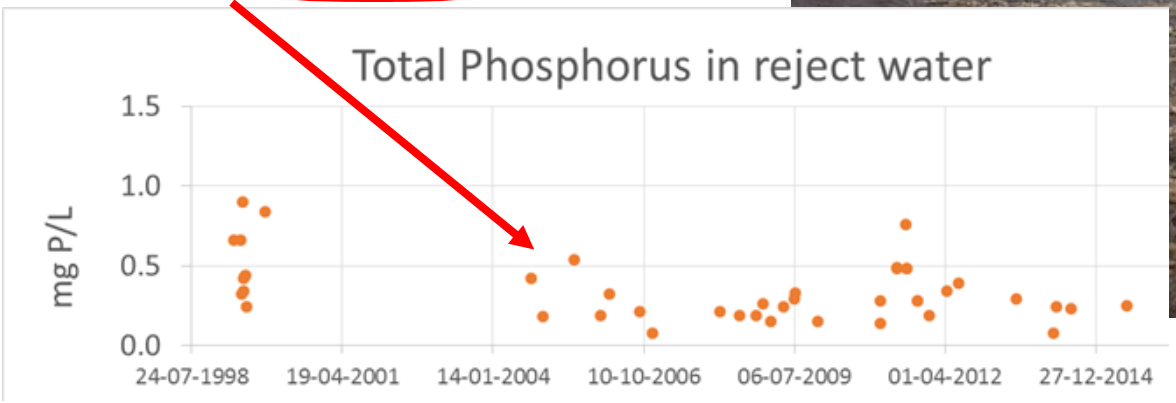



Photo: Orbicon

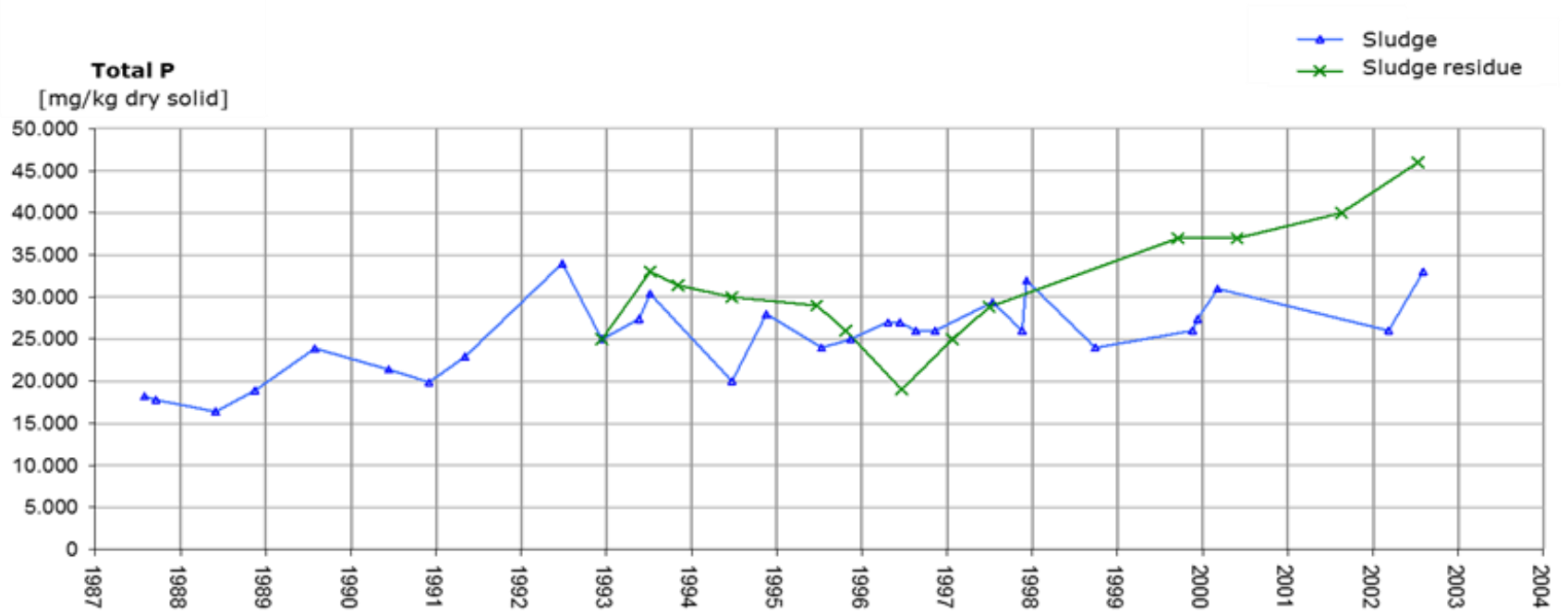
Filtrate quality (Total P) from STRB systems treating activated sludge (1998 – 2017) – Chemical P removal (Ferric Sulfate)





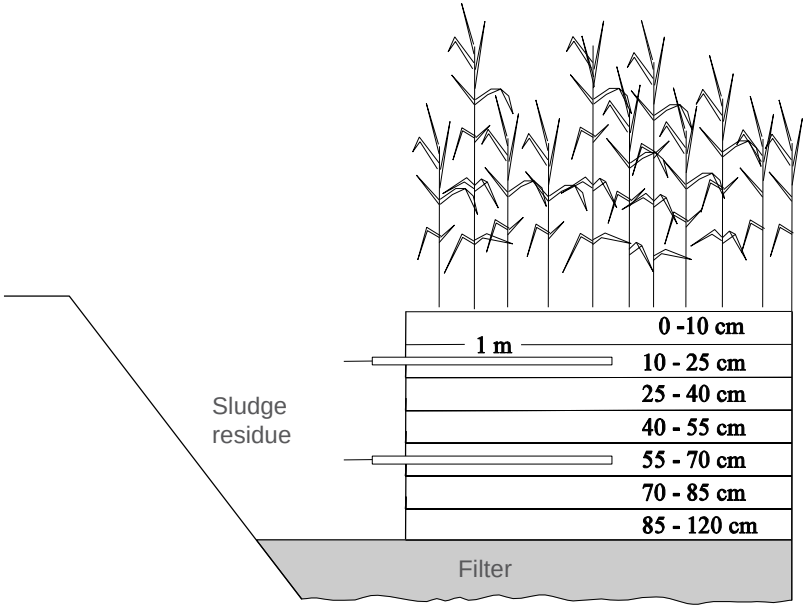


Accumulation of Total P in the Sludge residue (1997 – 2004)

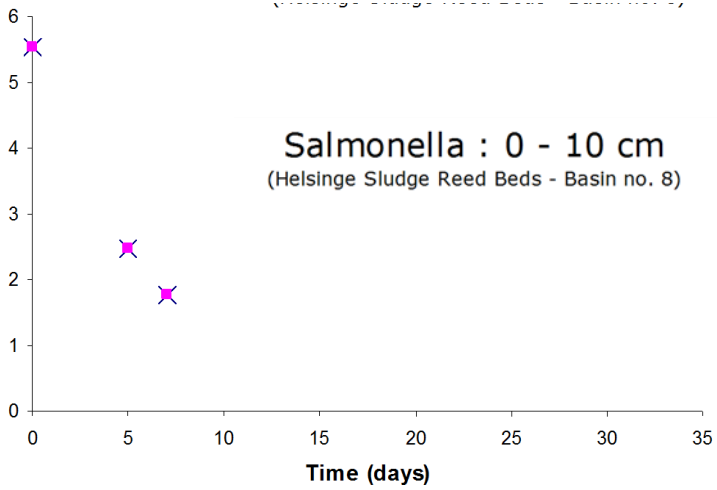


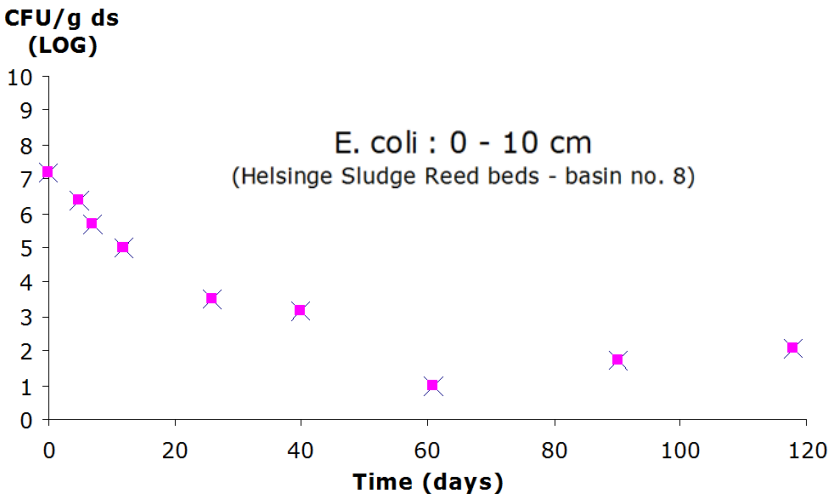
Quality of the sludge residue after treatment

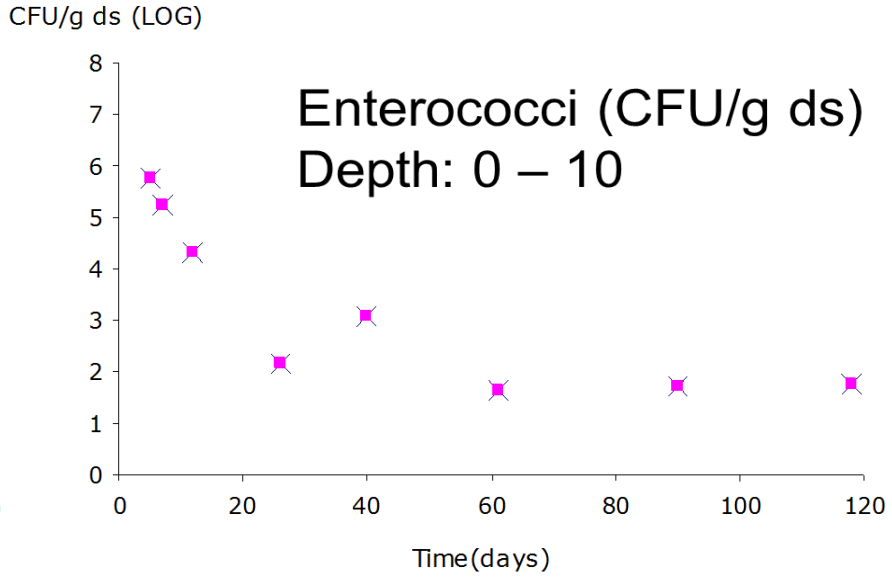
Reduction of pathogenic micro-organisms
Section of sludge residue and sampling sites



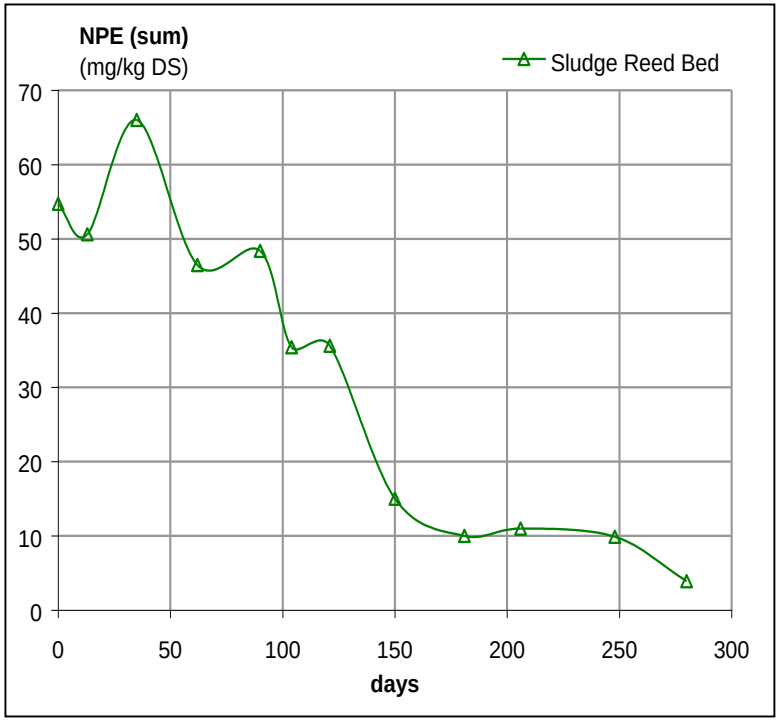
Reduction of pathogenic micro-organisms





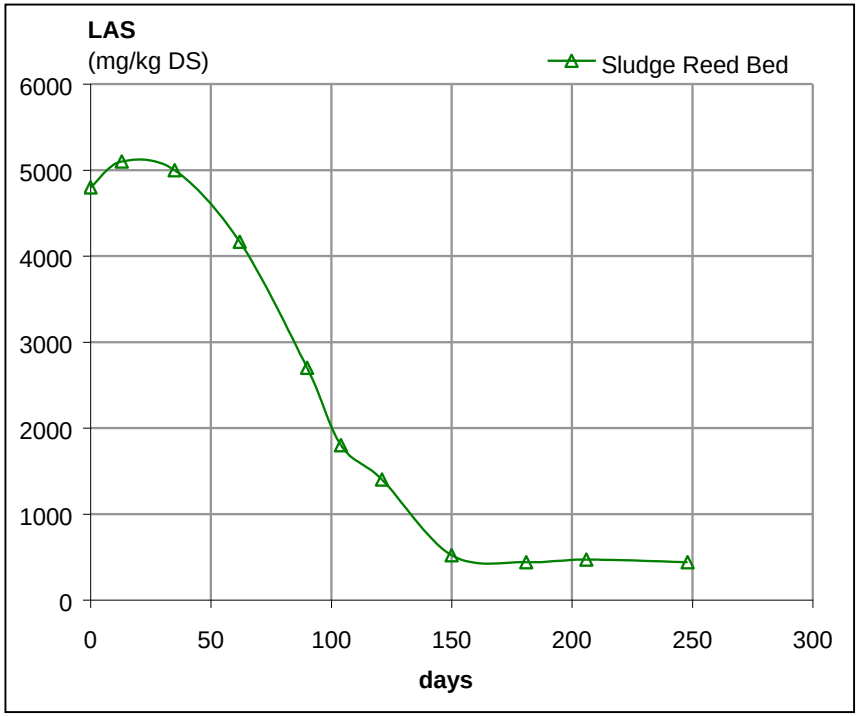


Mineralisation of digested sewage sludge Kallerup STRB (Denmark)



NPE (Nonyl Phenol Ethoxylate)

- Loaded mass (kg) 0.3
- Remaining mass (kg) 0.02
- Reduction (%) 94



LAS (Linear Alkylbenzene Sulfonate)

- Loaded mass (kg) 24.5
- Remaining mass (kg) 0.4
- Reduction (%) 98

Emptying
Re-generation of the reeds recycling/reuse

Rudkøbing and Nakskov STRB (Denmark) Emptying


Photo: Orbicon


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Photo: Orbicon


Photo: Orbicon


Photo: Orbicon


Photo: Orbicon

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Skovby STRB (Denmark): 1995 - 2015

Emptying and Regrowth

Helsinge STRB (Denmark): 1996 - 2017

1. Emptying (02.09.2005)

Sludge Residue (1996 - 1997)

1. Regrowth (05.10.2005)

Helsinge STRB (Denmark) : 1996 - 2017

Sludge Residue (1996 - 1997)

2. Emptying (05.05.2015)

2. Regrowth (21.06.2015)

Helsinge STRB (Denmark) – Green house
Solar drying of sewage sludge from STRB (2016 and 2017)

Nordborg STRB (Denmark) – Stock pile area
Solar drying of sewage sludge from STRB (2012 - 2017)

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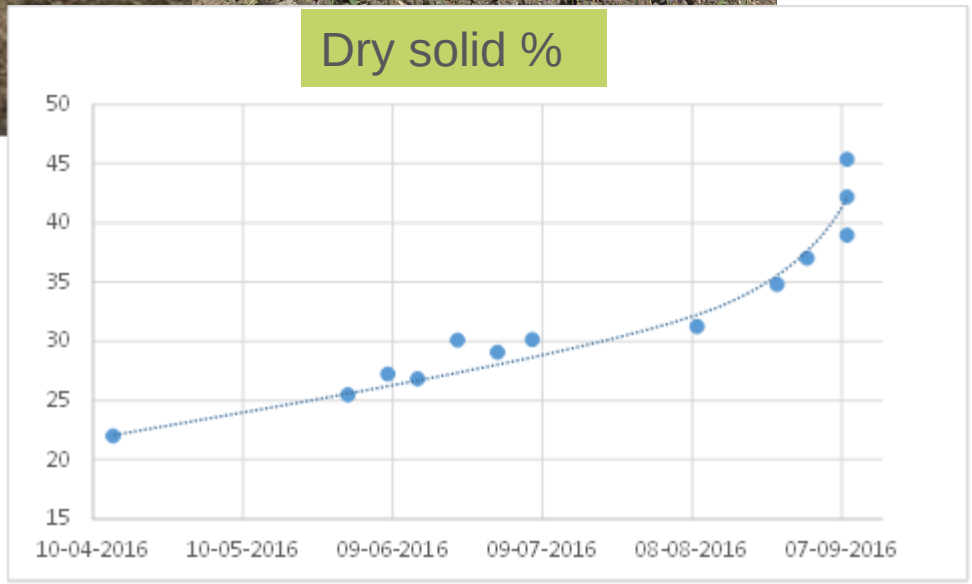
Helsinge STRB (Denmark) – Green house
Solar drying of sewage sludge from STRB (2016 and 2017)

Photo: Orbicon



Helsinge STRB (Denmark) – Stock Pile area Recycling in August/September 2015


Photo: Orbicon

More than 30 systems and 200 basins have been emptied

Over 130,000 tonnes of biosolids from STRBs have been spread onto nearly 10,000 hectares of Scandinavian agricultural land over the past 20 years.

No reports of disturbances to natural wildlife, fauna or agriculture (no regrowth of reeds)


Photo: Orbicon


Photo: Orbicon

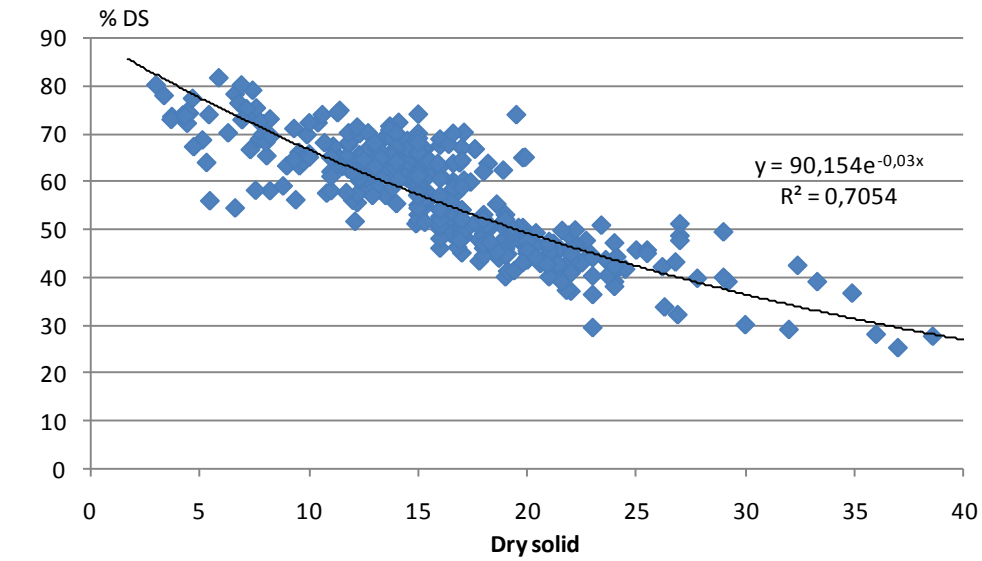

Photo: Orbicon

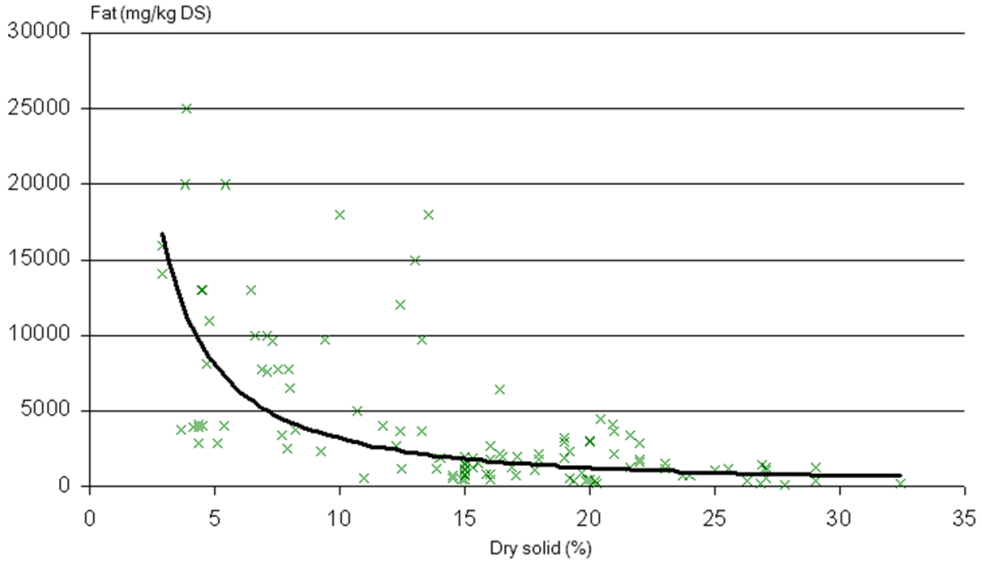
Steen Nielsen - smni@orbicon.dk
28/09/2017

Operations Problems

Category 1: Sludge Quality
Category 2: Design and dimensioning
Category 3: Construction
Category 4: Operation

Sludge quality - Loss on ignition - Fat





Systems treating sludge with contents of:

Fat (over 5,000 mg/kg ds)
Oil (over 2,000 mg/kg ds)

With loss on ignition:
over 65 % contents
of organic solids

Overloading:

Overloading can be caused by:

- Too high areal loading in relation to:

  Sludge type/ quality including organic content
- Too few basins (Insufficient resting periods)

Overloading and insufficient draining of the residual sludge results in:

- Poor growth of reeds
- Insufficient root and rhizome development in the residual sludge layer leading to anaerobic conditions.

Incorrect operation

Operations, maintenance and emptying


Photo: Orbicon


Photo: Orbicon


Photo: Orbicon

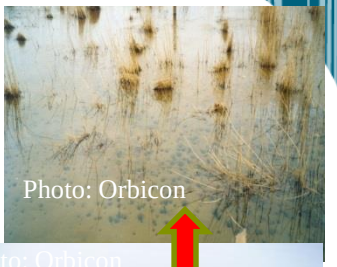

Photo: Orbicon

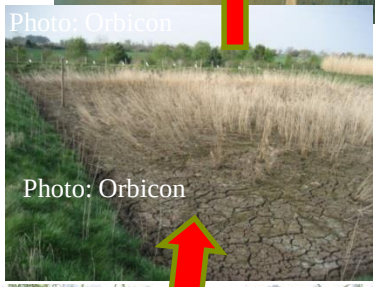

Photo: Orbicon


Photo: Orbicon

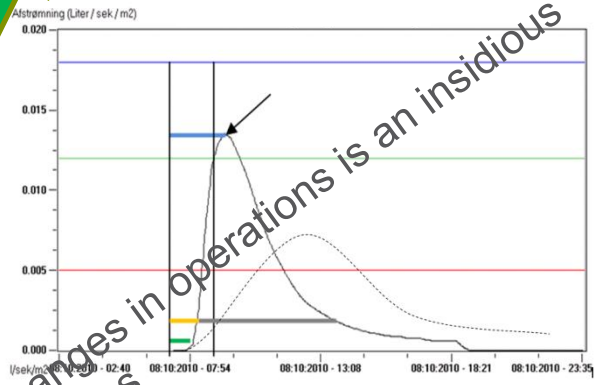
Fredensborg STRB (Denmark)
Operationsproblem and reconstruction 2014-2015

Hidden and sneaking operation Problems





Running in



Changes in operations is an insidious process

3. End of no return
System Collaps
Emptying necessary

Test system

Sludge qualities

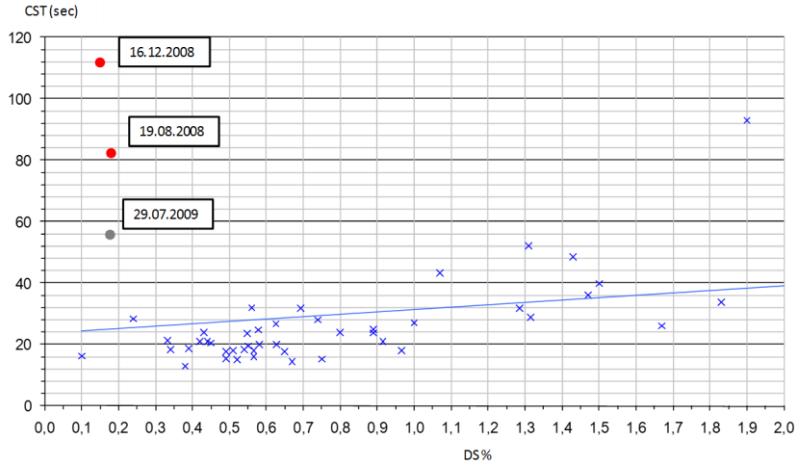
Test purposes (Phase 1)

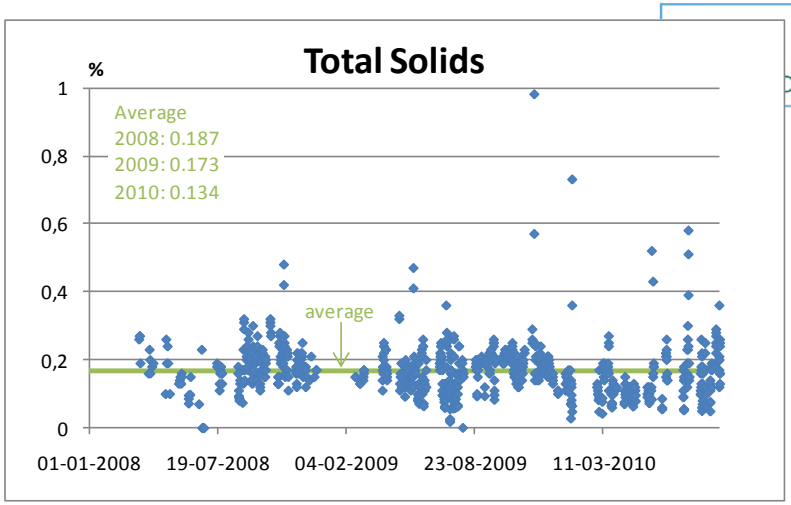
The main purpose:

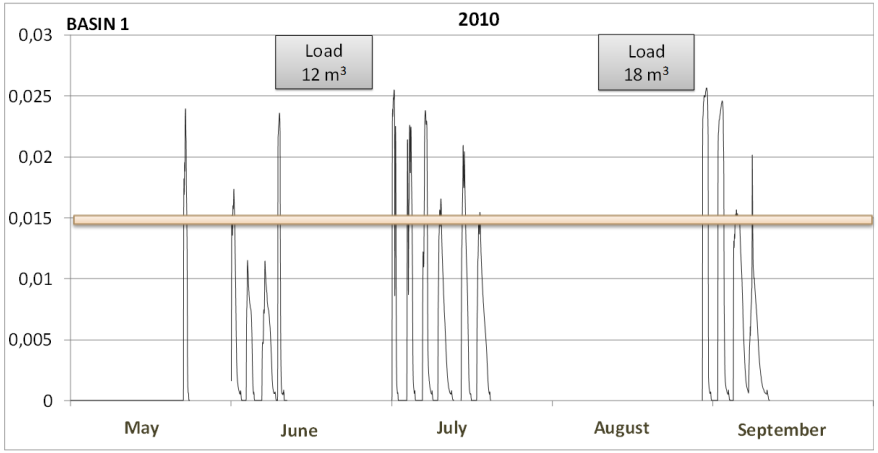
Is to test whether the sludge would be suitable for further treatment in a STRB.

- To determine sludge quality and characteristics?
- How will the sludge behave (dry/crack up) in a trial bed?
- Is it possible to get the vegetation to grow in the sludge/Fertilizer?
- To ascertain the sludge residue characteristics including reaction after each loading period and any cumulative effects of sludge loading?
- To ascertain the dewatering efficiency of the sludge (l/sec./m^2)?
- To identify if there are any adverse or undesirable effects which would impact upon reed health/growth rates

Feed Sludge quality - (CST and Dry solid)





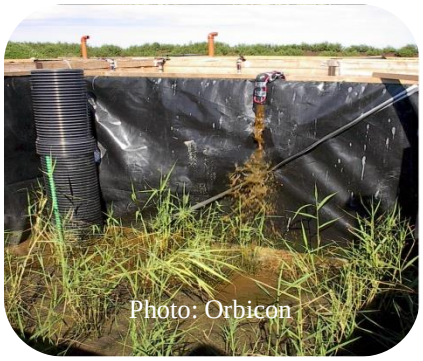


Regstrup and Allerslev (Denmark)
Full scale Test STRB (1988 – 1992)


Photo: Orbicon


Photo: Orbicon

Skagen Trial (Denmark) – 9 basins



- Fish industri
- Digested Sludge
- CST > 2000 sec
- 1,500 ton DS per year
- 45 kg DS/m^2/year ?
- 33,333 m^2?

Kristianstad STRB (Sweden) – Trial System (2005 – 2008)


Photo: Orbicon

Photo: Orbicon


Photo: Orbicon


Photo: Orbicon

Lumley (England) – Alum Sludge (2009-2010)

Pre-Test - Sludge Treatment Reed Bed System


Photo: Orbicon


Photo: Orbicon


Photo: Orbicon

Photo: Orbicon

Whitacre (England) - Pre-test system (2015)

Wacol Trial (Australia) Sludge residue (2016 – 2017 - ?)

Trial –Treatment of fish farm sludge

Photo: Orbicon

Photo: Orbicon

Hanningfield Water Work (England)
2008 – 2013, Trial (Water Works sludge - Iron)

Photo: Orbicon

6 basins / total 120 m²

(Planted in February 2008)


Photo: Orbicon


Photo: Orbicon

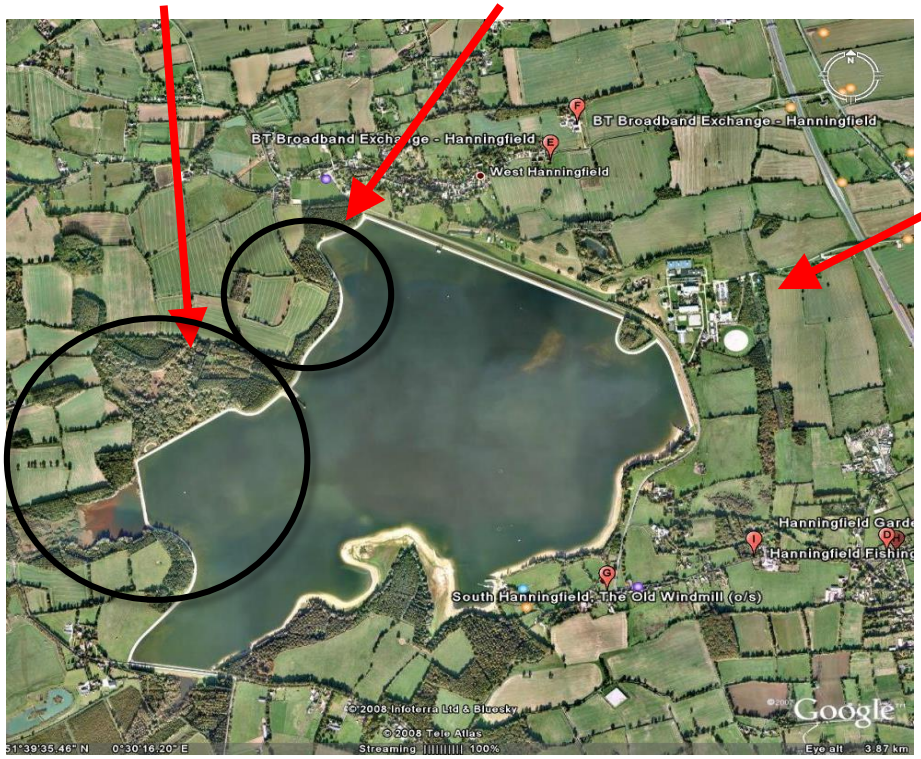
Treatment of Water Works sludge

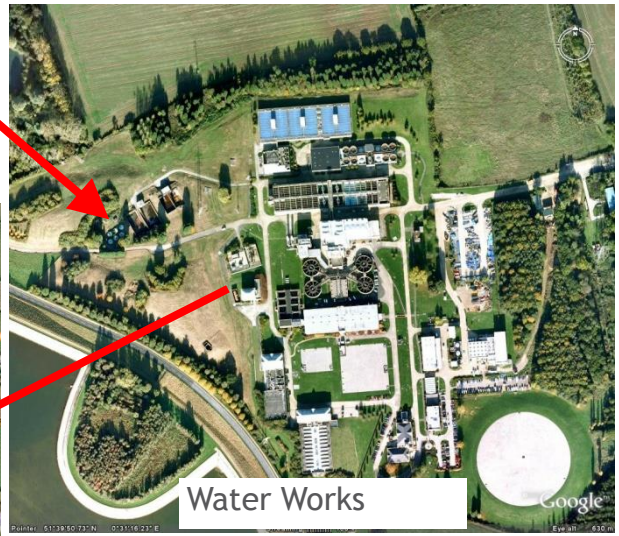
Hanningfield Water Works and the water works sludge lagoon (United Kingdom)

Sludge Treatment Test System

Old sludge lagoons

Area for Reed Bed System





Reservoir Facts

- Capacity : 27 billion litres/year
- Maximun depth : 17 metres
- Surface area : 354 hectares

Water Works Facts

- Water production : 150 million litres/day
- Producton of sludge : 1,275 tones ds per year

Hanningfield STRB (United Kingdom)
1,275 tonnes of dry solids per year (16 basins (4.2 Ha)

Photo: Orbicon

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Hanningfield (England – Water Works Sludge)
Sludge treatment Reed bed System

Parameters	Unit	Basin 1	Basin 2	Basin 3	Basin 4	Basin 6
Dry solid	%	39 (21)	40 (18)	44 (28)	42 (4)	31 (6)

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GLOBAL WETLAND TECHNOLOGY

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Hanningfield (England – Water Works Sludge) Sludge treatment Reed bed System

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Sludge Treatment Reed Beds Systems

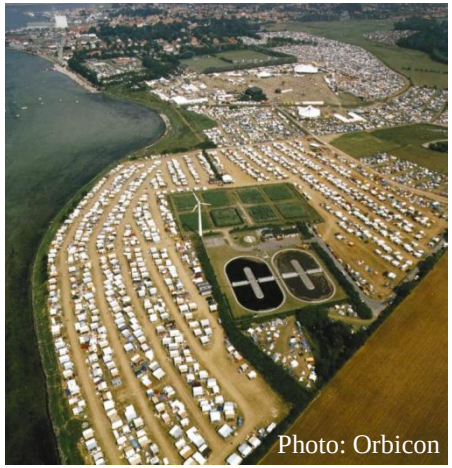
References

29 Years of experience with Sludge Treatment Reed Bed Systems

Kolding (1998)
2000 tonnes of dry solids per year

Skövde (2003)
1200 tonnes of dry solids per year

Rudkøbing (1992)
250 tonnes of dry solids per year



Greve (1999)
1000 tonnes of dry solids per year

Environmentally friendly operation and sludge handling

Environmentally friendly operation

- Operational reliability
- Long-term sludge solution
- Flexible operation


Photo: Orbicon

- No problems with winter operation
- Very low operational costs and low energy

- Release of waste water treatment capacity
- No use of chemicals (polymers) for dewatering

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Environmentally friendly operation

- Better working environment
- Non-polluting dewatering
- Reduction of CO2 and NOx emission
- Reduction of transportation costs
- Mineralisation of Hazardous Organic Compounds
- Good reduction of the Pathogenic micro-organisms
- Recycling of the sludge residue

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