

IVL Swedish Environmental Research Institute

Hammarby Sjöstadsværk  
Water and domestic facility for domestic wastewater purification

## Situation and experiences of decentralized Wastewater Treatment in Sweden



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## Swedish regulations

### The Environmental Code (Miljöbalken) from 1999



- Permission is needed to emit household sewage including black water
- Notification is enough if there is no black water
- The local authority (community) decides if the suggested solution is OK (implies great variation)
- Permits for a certain period or without limit
- **Proper treatment unit, no general limits**

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## General guidelines 2006

**Actual performance limits: BOD, N, P in percent and infectious material like in the bathing water directive**

- Possible to check the performance (Measure at outlet, standard values for inlet)
- Difficult with soil infiltration!
- Hydrological barrier to drinking water wells

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## Different protection levels

Normal: Removal of 90% of BOD and 70% of P  
 High: Removal of 90% of BOD, 90% of P and 50% of N

High protection level in sensitive areas like  
 Close to water reservoirs  
 Dense populations  
 Close to shore

The local authority decides high or normal level  
 Long time to evaluate all existing units!

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## Kind of sources


- Local on-site wastewater treatment  
 Difficult to survey, municipal questionnaire survey concerning local on-site wastewater treatment, Information from property taxation, property and population registers
- Small municipal wastewater treatment plants  
 (200 – 2000 pe) are dominant sources of N and P emissions from the facilities that do not require permits. About 815 plants, total discharge about 2 100 tons N and 56 tons P.

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## Local on-site wastewater treatment

- Total ca 750 000 homes with about 1 250 000 people are lacking connection to municipal WWTP (2005)
- Ca 450 000 homes for permanent housing (ca 60 %)
- Ca 250 000 weekend and holiday homes (ca 40 %)
- Ca 650 000 facilities with WC
- Ca 125 000 facilities with WC and only septic tank (became illegal already in 1960s)
- Many weekend and holiday homes
- Sparse development, isolation



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### Small municipal wastewater treatment plants

< 200 pe

- Little information, calculated effluent values, but mainly biological treatment
- "always" precipitation of P, at least 90 % removal about 30 % removal of N
- Mostly not municipal

200 < 2000 pe

- ? Data från Micke O?

### Gross and net N loads to the Swedish marine environment

t/yr SEPA 2006

Sea-basin catchment	Local on-site wastewater treatment <sup>1</sup>	MWTP > 2,000 pe	MWTP ~ 2,000 pe	Industrial facilities	Total, point sources
Bothnian Bay <sup>2</sup>	100	1,200	200	800	2,300
Bothnian Sea	300	3,500	600	2,500	6,900
Baltic Proper	750	7,700	600	900	9,900
Oresund	0	1,000	0	100	1,200
Kattegat	500	4,700	400	1,000	6,700
Skagerrak	100	500	100	0	500
Whole of Sweden	1,800	18,500	1,800	5,300	27,500

### Gross and net P loads to the Swedish marine environment

t/yr SEPA 2006

Sea-basin catchment	Local on-site wastewater treatment	MWTP >2,000 pe	MWTP ~2,000 pe	Industrial facilities	Total, point sources
Bothnian Bay <sup>2</sup>	20	20	10	40	80
Bothnian Sea	40	50	20	190	300
Baltic Proper	90	120	20	60	300
Oresund	10	40	0	0	50
Kattegat	70	120	10	70	270
Skagerrak	10	10	0	0	30
Whole of Sweden	240	360	60	360	1,020

### Proposed emission factors for local on-site and small wastewater treatment

Treatment type	COD <sub>Cr</sub>	BOD <sub>5</sub>	N-tot	P-tot
A: Septic tank	30±20	20±10	10±5	15±10
B: A + infiltration	85±10	90±5	30±10	50±30
C: A + buried sand filter	85±10	90±5	25±10	40±20
D: B or C + P-chemical treatment	90±5	90±5	30±10	85±10
E: small-scale WWTP	85±5	90±10	40±20	85±10

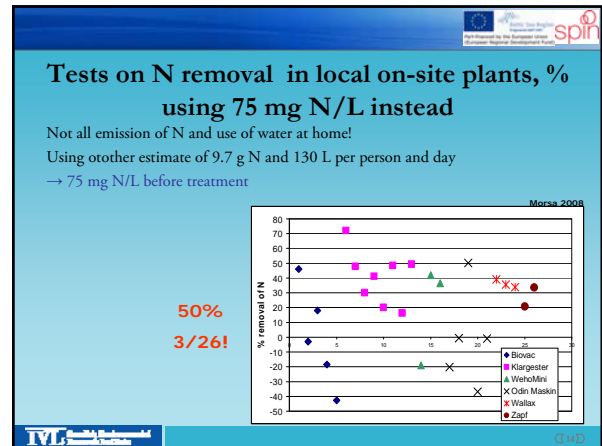
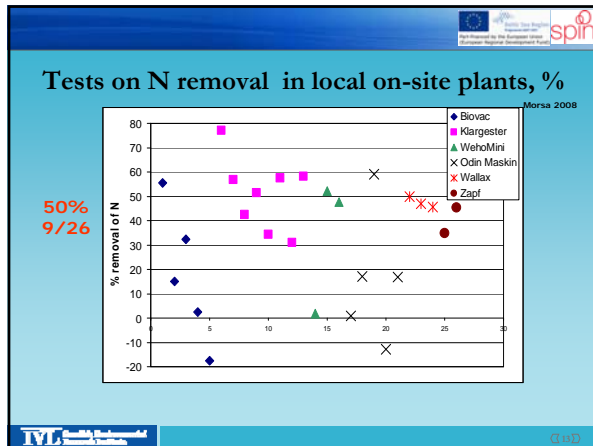
### Evaluation of on-site treatment

- Very difficult to analyze the concentration before treatment!
- Mean emission of BOD, N and P from one person per day, and mean use of water per day
- 13.7 g N and 150 L/person, day gives 91 mg N/L
- 2.1 g P and 150 L/person, day gives 14 mg P/L

Mean values over longer time and many people! So it is right to use these values?

### Tests on N removal in local on-site plants

Morså 2008



No priority on nitrogen yet

- 10% removal of N in sludge separation
- 15% removal of N in formed biosludge

Further removal with nitrification with air  

$$\text{NH}_4^+ + 2\text{O}_2 \rightarrow \text{NO}_3^- + \text{H}_2\text{O} + 2\text{H}^+$$
 and denitrification without air  

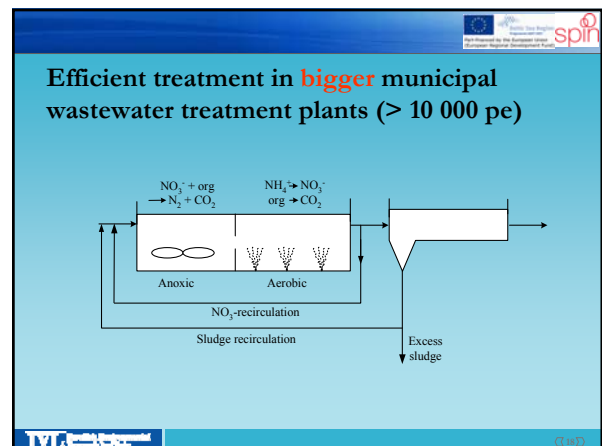
$$2\text{NO}_3^- + \text{BOD} \rightarrow \text{N}_2 + x\text{CO}_2 + y\text{H}_2\text{O} + 2\text{OH}^-$$

Several investigations

- Various filter based on-site plants in Enköping
- 15 different on-site technologies in Stockholm county
- A number of on-site facilities in Västerås
- Test of 3 different technologies in Luleå
- Test of 2 techniques by Gothenburg University
- SMED (Swedish Environmental Emissions Data) Investigation in Morsa (Norway)
- Bioforsk (Norway)

Results

- Good BOD removal in on-site plants
- Phosphorus removal not enough in on-site plants
- High variability in operation performance of advanced on-site plants, requires proper operation
- Problems with varying loads
- Difficulties with evaluation due to lack of sampling points (especially soil infiltration)



## Conclusions

- Connection to small WWTP best option to guarantee safe and good treatment
- For onsite treatment:
  - Septic tank and infiltration/sand filter good alternative for weekend homes The smaller the plant the more unreliable and variable the function. It is also difficult to measure and therefore to evaluate the appropriateness of the system
  - Regular monitoring and professional support for service, maintenance and technical support are critical
  - Service agreements necessary for the whole system lifetime

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