

## Risk assessment of Landfills and their Impact of Surface Waters

**Skov Nielsen, Sanne; Tuxen, Nina; Roost, Sandra; Pedersen, John; Bjerg, Poul Løgstrup; Sonne, Anne Thobo; Korsgaard, Trine; Pedersen, Jørn K.; Broch, Helle; Ulstrup, Alice; Larson, Helle; Rud Larsen, Henrik; Olsen, Claes ; Bondgård, Morten; Aabling, Jens**

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# Risk assessment of Landfills and their Impact of Surface Waters

Sanne Skov Nielsen, Nina Tuxen, Sandra Roost, John Pedersen, Orbicon

Poul L. Bjerg, Anne T. Sonne, DTU Environment, Technical University of Denmark

Trine Korsgaard, Jørn K. Pedersen, Helle Broch, Alice Ulstrup, Region of Southern Denmark

Helle Larson, Henrik Rud Larsen, Claes Olsen, Morten Bondgaard, Central Denmark Region

Jens Aabling, Danish Environmental Protection Agency

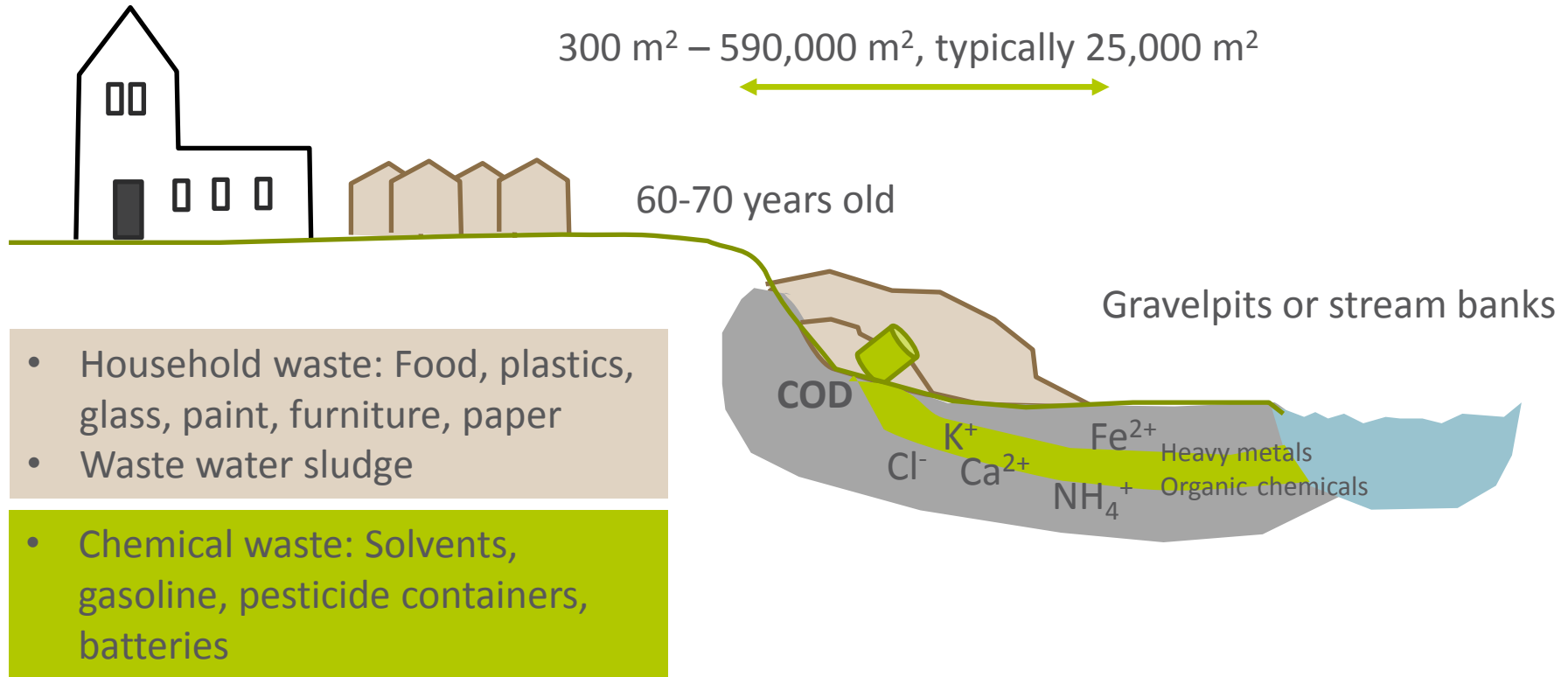
The Information Centre on Contaminated Sites



Danish Ministry of the Environment  
Environmental Protection Agency



# Background: Municipal Landfills



## Assumption:

Old landfills are more likely than other contaminated sites to impact surface waters, particularly streams

# Concept for Risk Assessment

# Concept for Risk Assessment



## Input Data

**Tier 4**  
Total impact

Data from other impacts

**Tier 3**  
Field investigations

Flux measurements  
Discharge zones

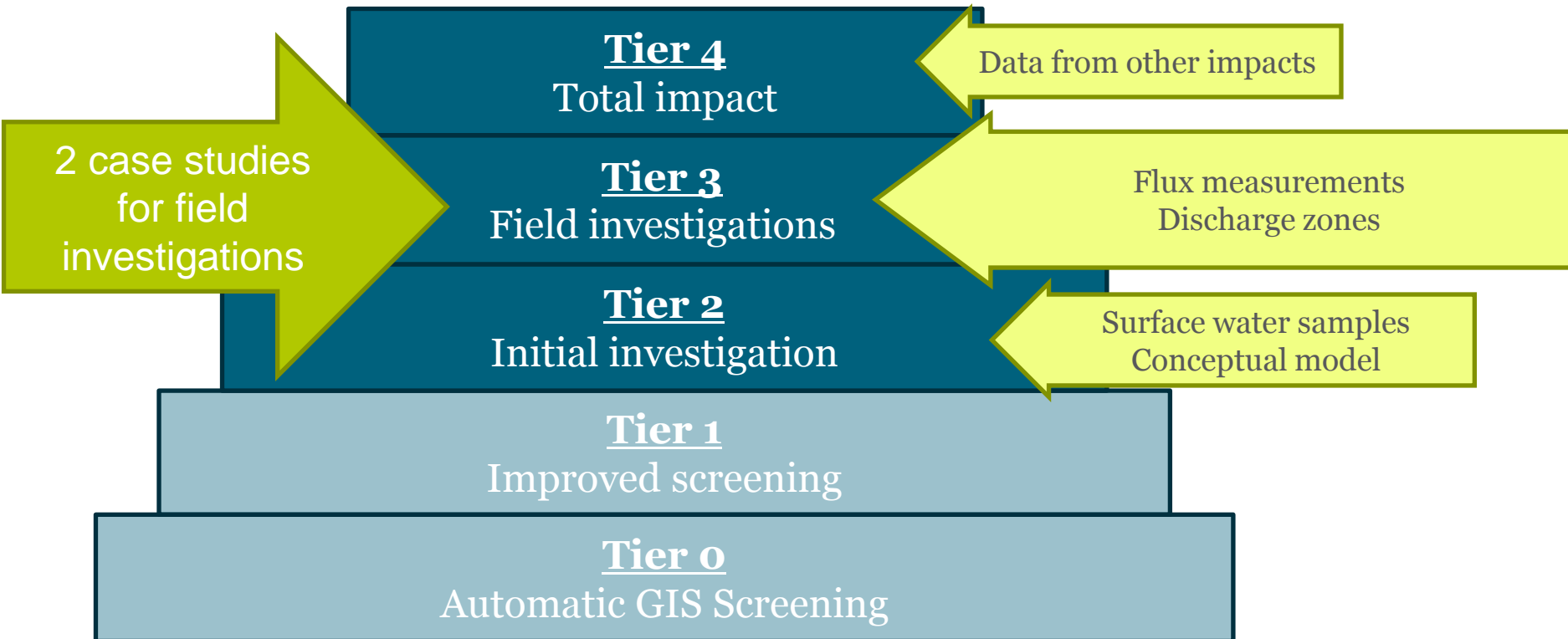
**Tier 2**  
Initial investigation

Surface water samples  
Conceptual model

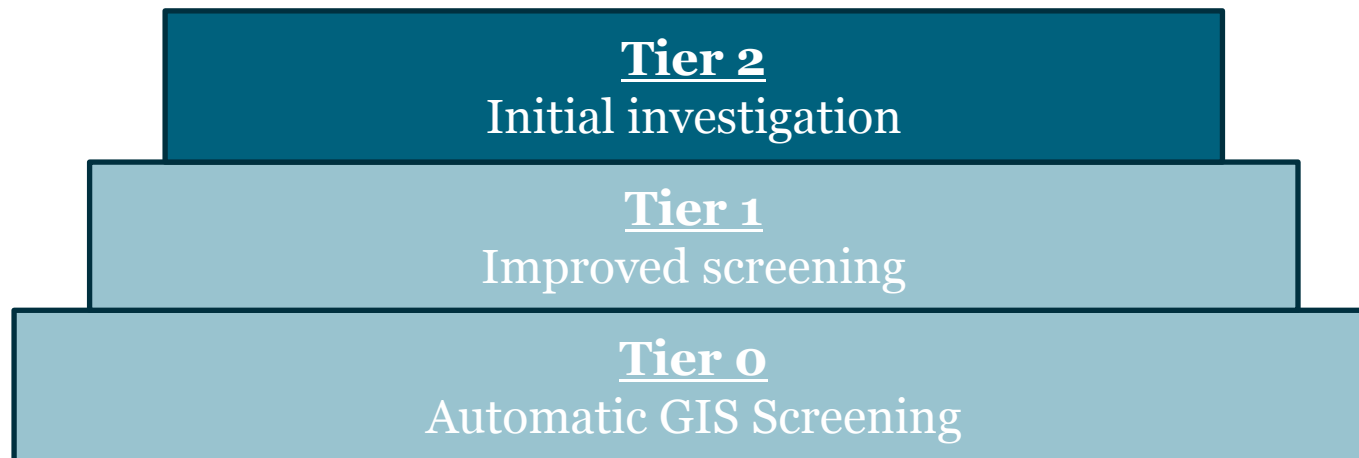
**Tier 1**  
Improved screening

**Tier 0**  
Automatic GIS Screening

2 case studies  
for field  
investigations



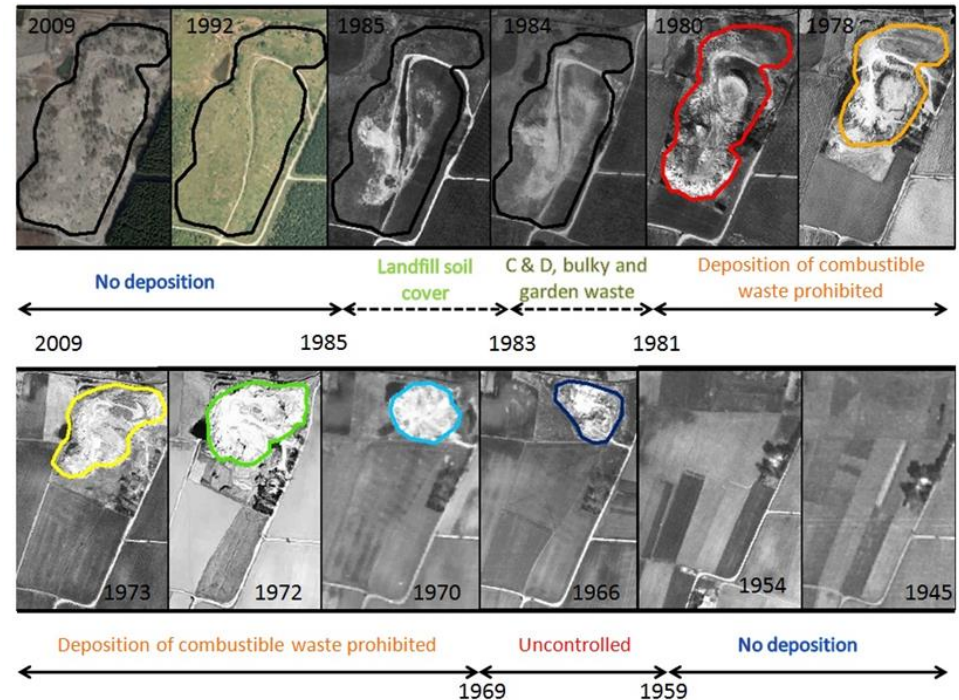
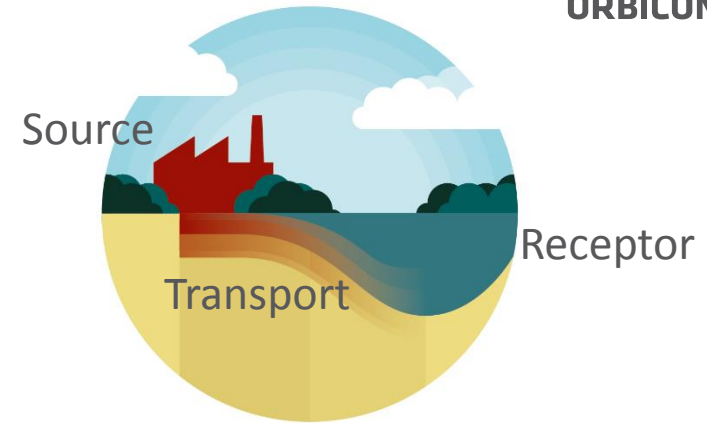
# Tier 2: Conceptual Model + Initial Sampling



# Tier 2: Existing data for conceptual model

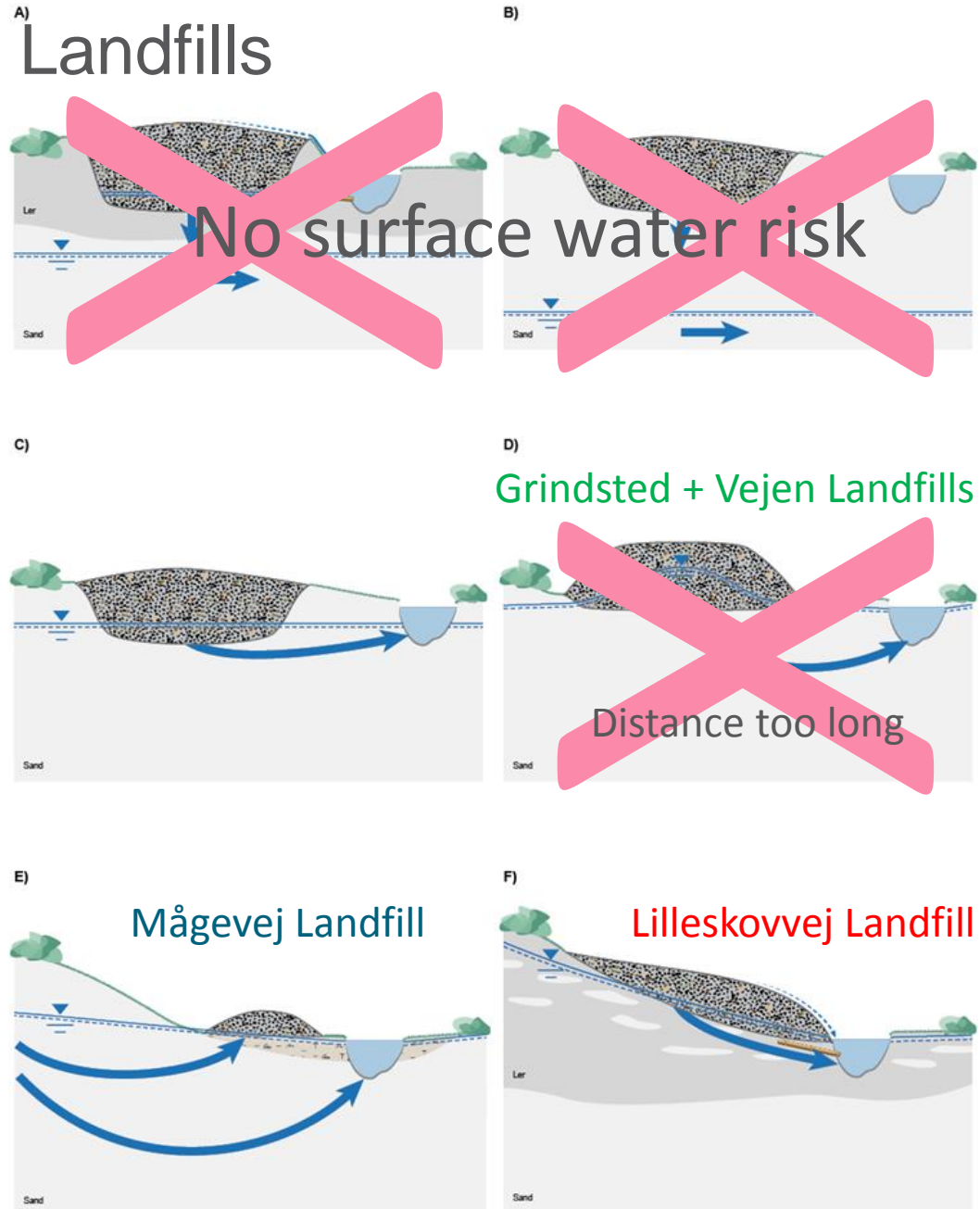


- Source
  - Historical records, aerial photos, old maps ect.
  - Previous investigations: Wells, contaminants, concentrations
  - Geometry and site
- Transport
  - Groundwater and geology
  - Drain pipes
  - Surface run off
  - All part of conceptual model
- Receptor
  - Size of stream
  - Flow: discharge, temporal pattern



# Conceptual Models for Landfills

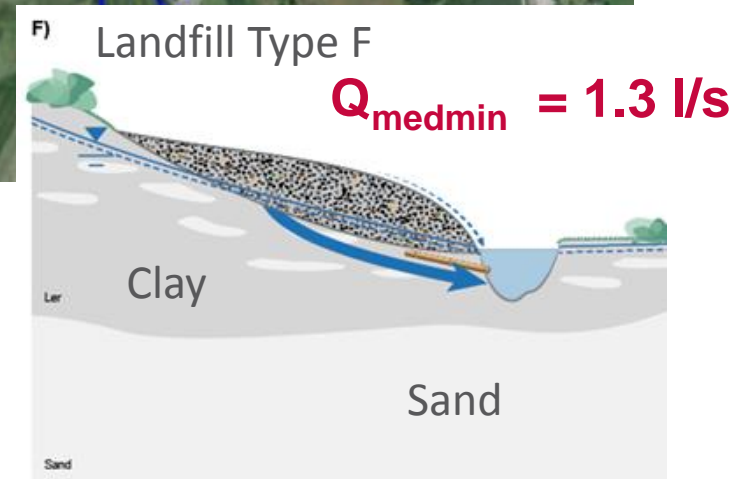
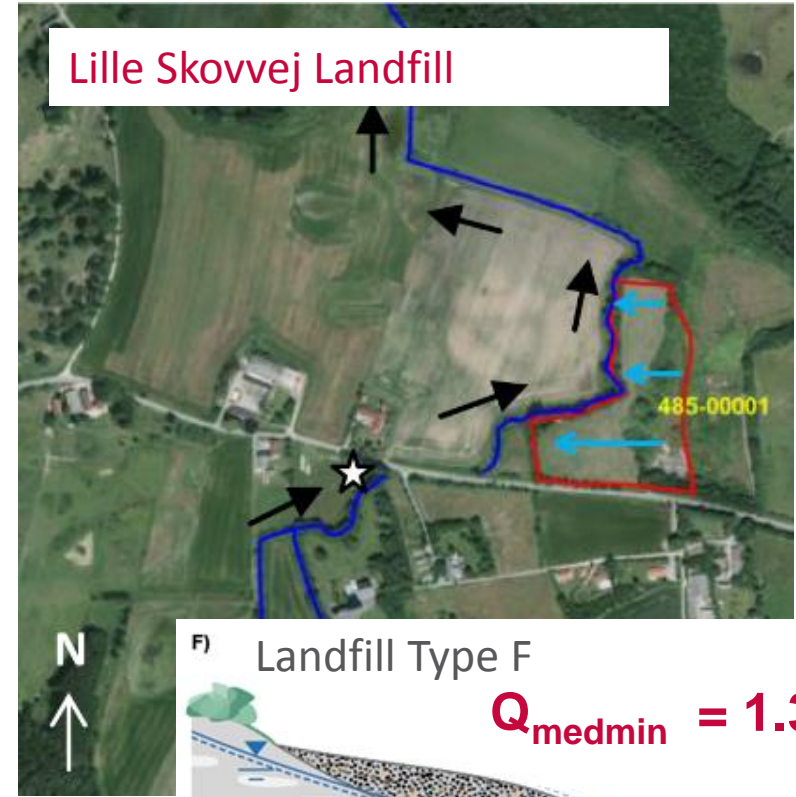
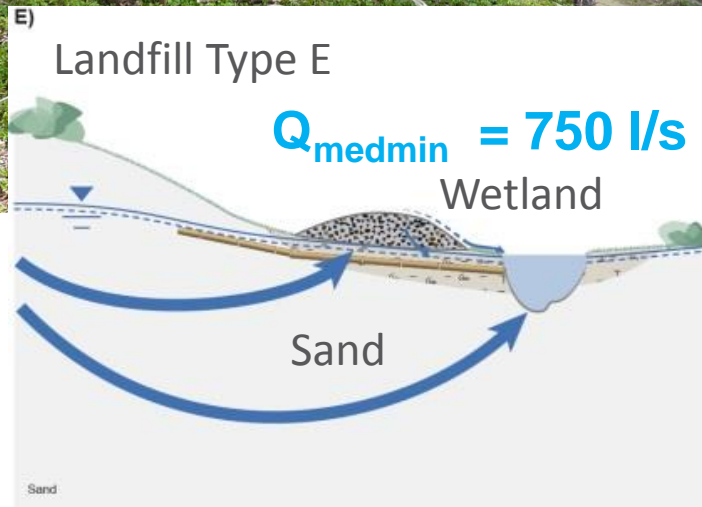
- Models describe leachate transfer pathway(s)
- Contaminant transport depends on
  - Shallow hydrogeology
  - Distance to surface water
  - Water table in waste?
  - Configuration of waste
  - Drain pipes



Inspired by:  
*Guide for contaminant investigations on landfills (AVI)*  
*GOI-typologies from Danish EPA*



# Tier 2: Conceptual models - Typologies



## Tier 2: Initial sampling

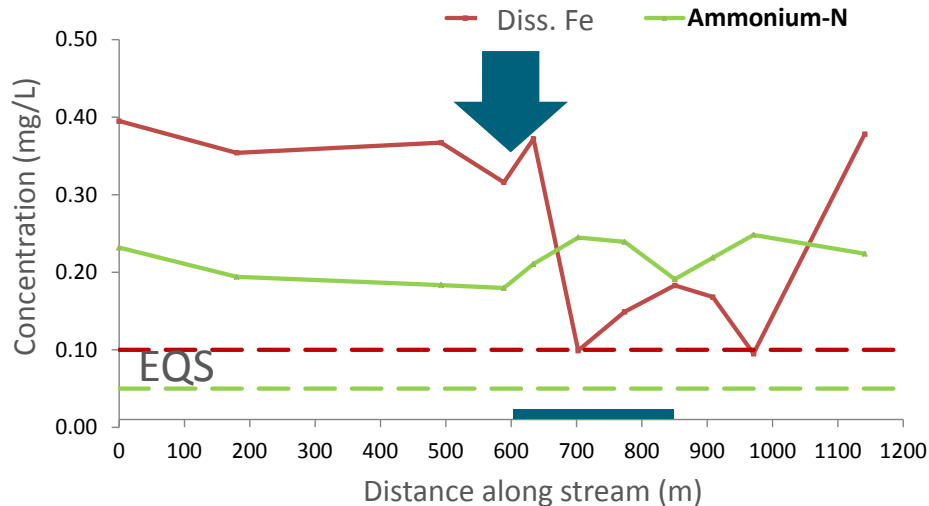
- Why sample groundwater, when you can sample surface water?
  - Ground water sampling: Wells, pumps, risk of wrong placement, dry well ...
  - Surface water sampling equipment: Rubber boots
- Critical points:
  - Mixing in stream water
  - Several plumes or discharge points
  - Good conceptual model helps finding sampling point



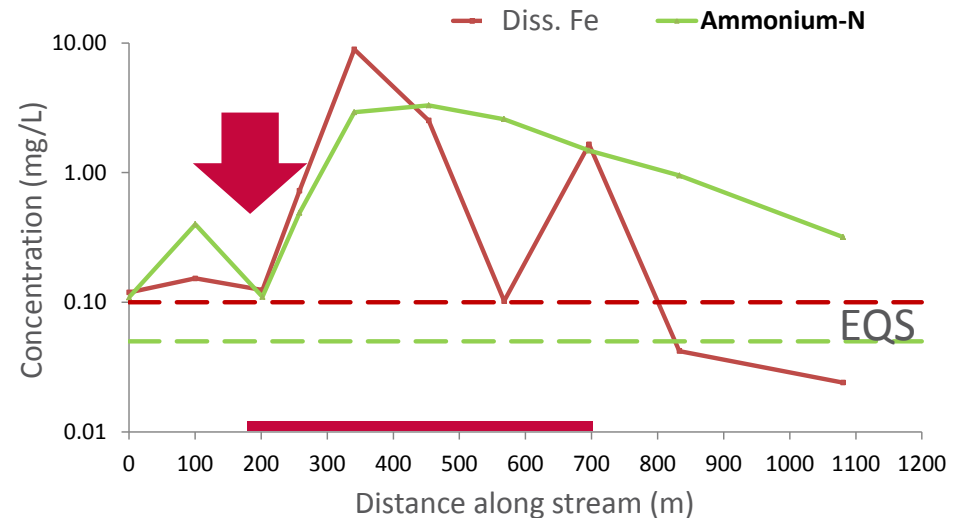
# Ammonium and Dissolved Iron in Streams



## Mågevej Landfill



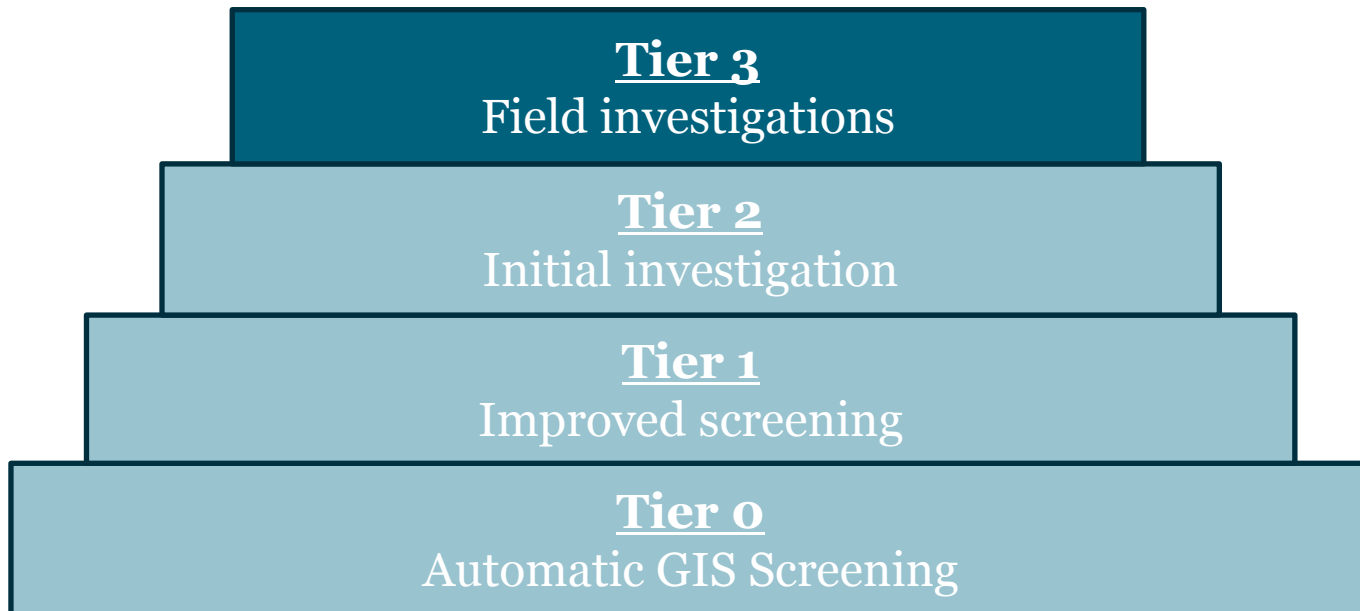
## Lille Skovvej Landfill



Ammonium level in stream exceeds EQS before landfill  
Iron is possibly complexed

Ammonium level in stream  $\approx$  EQS before landfill  
Ammonium and Iron increases at landfill

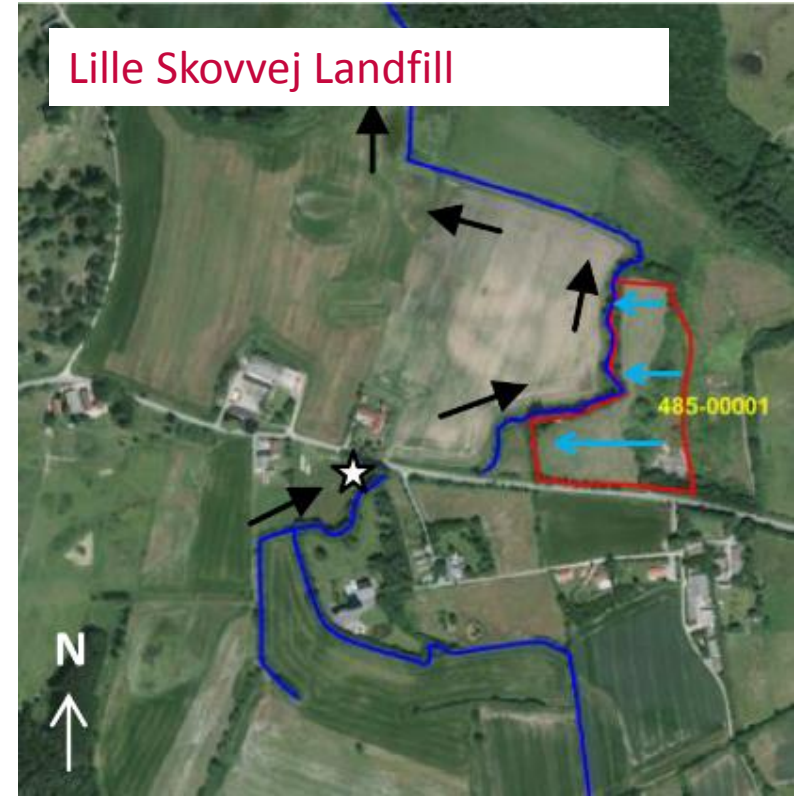
# Tier 3: Further investigations



# Tier 3: Field Investigations



$$Q_{\text{medmin}} = 750 \text{ l/s}$$

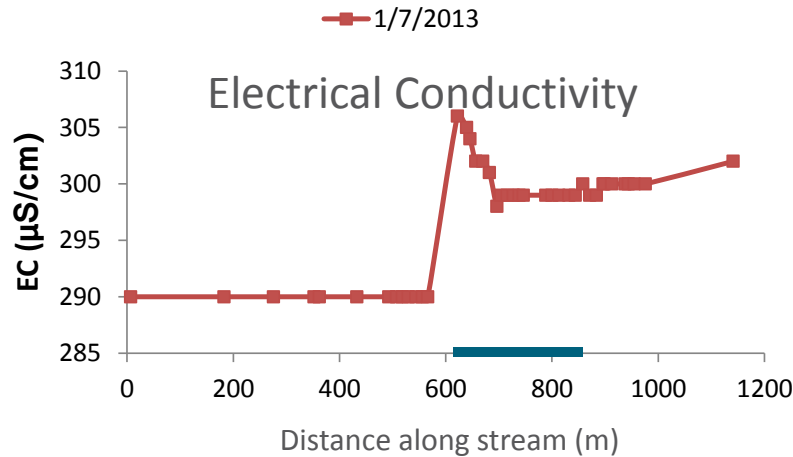


$$Q_{\text{medmin}} = 1.3 \text{ l/s}$$

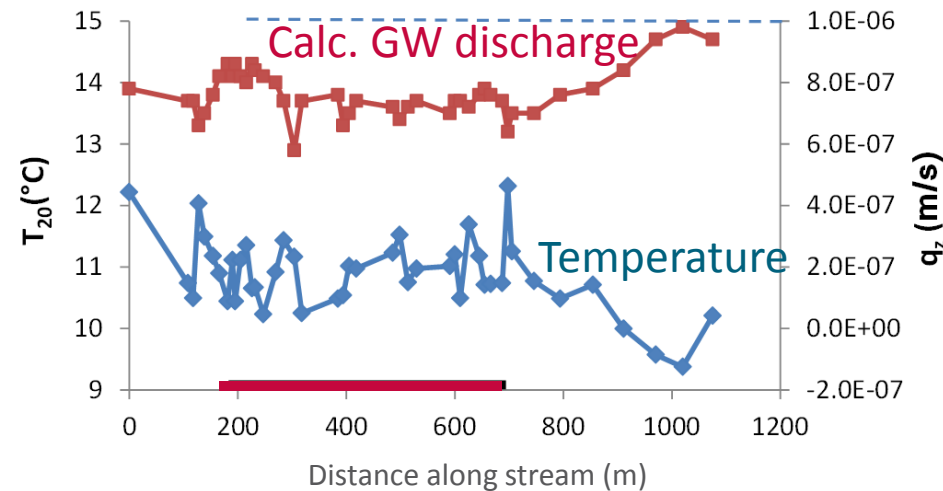
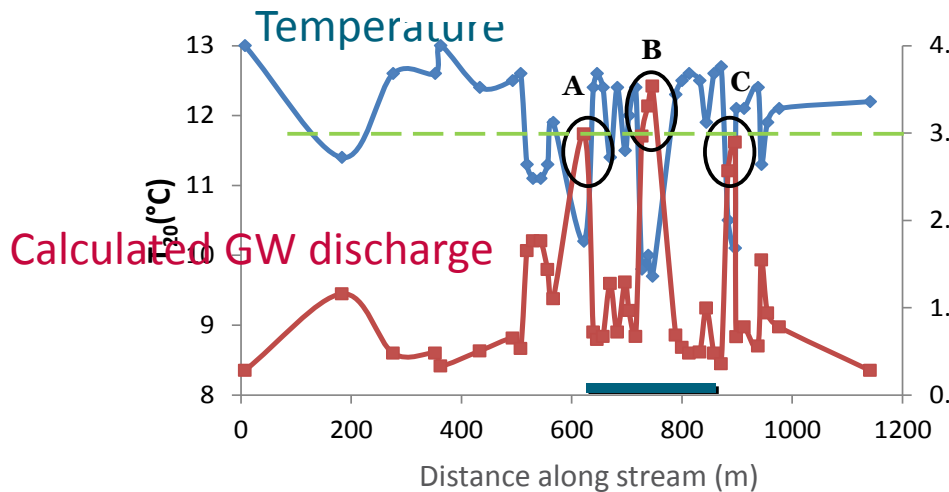
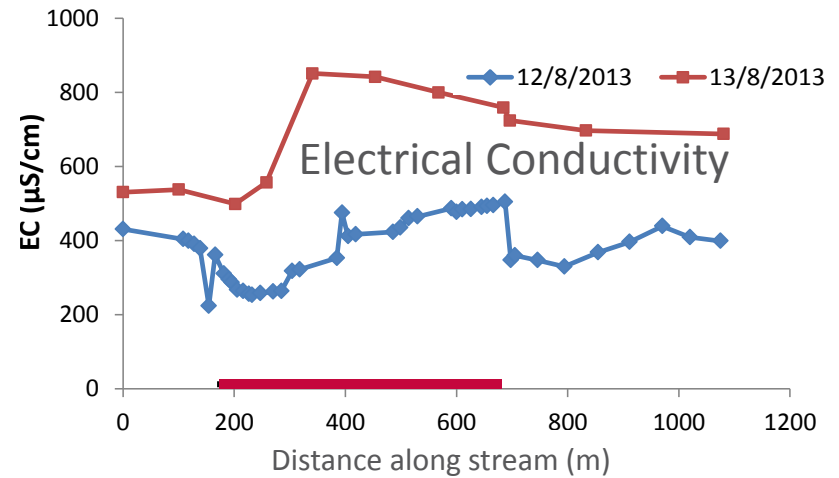
# Tier 3: Discharge of Groundwater?



## Mågevej Landfill



## Lille Skovvej Landfill



# Tier 3: Results from investigations



## Mågevej Landfill



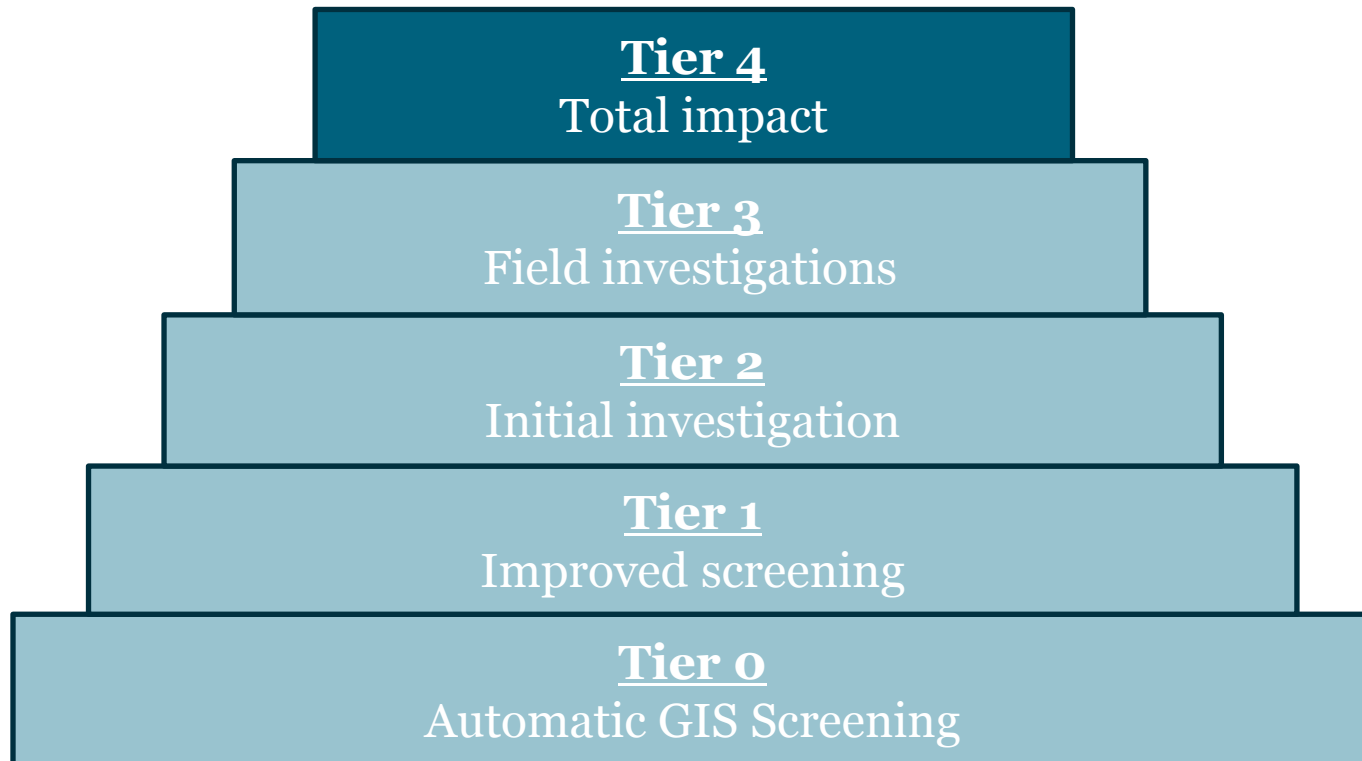
- Temperature and EC measurements: 3 discharge zones
- Discharge from sides of stream, not stream bottom
- Heavy metals and xenobiotics below detection limits in surface water and stream bottom
- Leachate (Fe, Ammonium, NVOC), above surface water criteria

## Lille Skovvej Landfill

- Temperature measurements: No direct hydrogeologic contact
- Electrical conductivity shows clear leachate impact but with temporal variability
- Leachate (Fe, Ammonium, NVOC), heavy metals (Cd, As, Ba) and xenobiotics above surface water criteria way downstream landfill
- Most important pathway was drainage pipes, not groundwater



# Tier 4: Total impact on water body





## Tier 4: Total Impact on Water Bodies

- Chemical status: EQS
- Ecological status not considered so far. No direct measurements on ecology
- Consider the impact from other sources

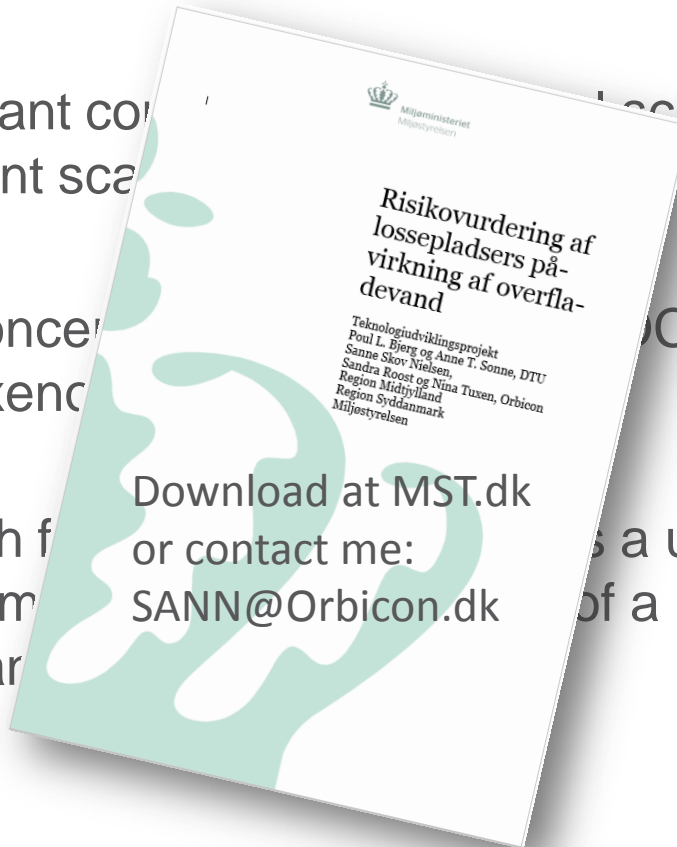
| Compounds                    | Other sources   |
|------------------------------|---|
| Salts and chloride           | Fertilizers<br>Roads (de-icing)<br>"Clean" municipal waste water              |
| Nitrate, NVOC, ammonium      | Agriculture<br>Aquaculture  |
| Dissolved iron               | Anaerobic groundwater<br>Ochre formed by drainage                             |
| Xenobiotics and heavy metals | Waste water (municipal and industrial)<br>Road run-off<br>Contaminated sites? |
| Pesticides                   | Other point sources<br>Washing stations<br>Agriculture                        |

Mågevej Landfill: Insignificant impact  
Unknown sources of ammonium and iron upstream of landfill

Lille Skovvej Landfill: Significant impact  
Not only lechate, but also xenobiotics, Ba, Cd and As

# Conclusions

- Old landfills are important contamination sources which may deteriorate the chemical status of surface water bodies, mainly small streams
- Landfills are important contamination sources on local scale but not on catchment scale
- Contaminants of concern are heavy metals and xenobiotics
- The tiered approach for assessment is a useful tool developed for implementation of a complex contamination



Danish Ministry of the Environment  
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