

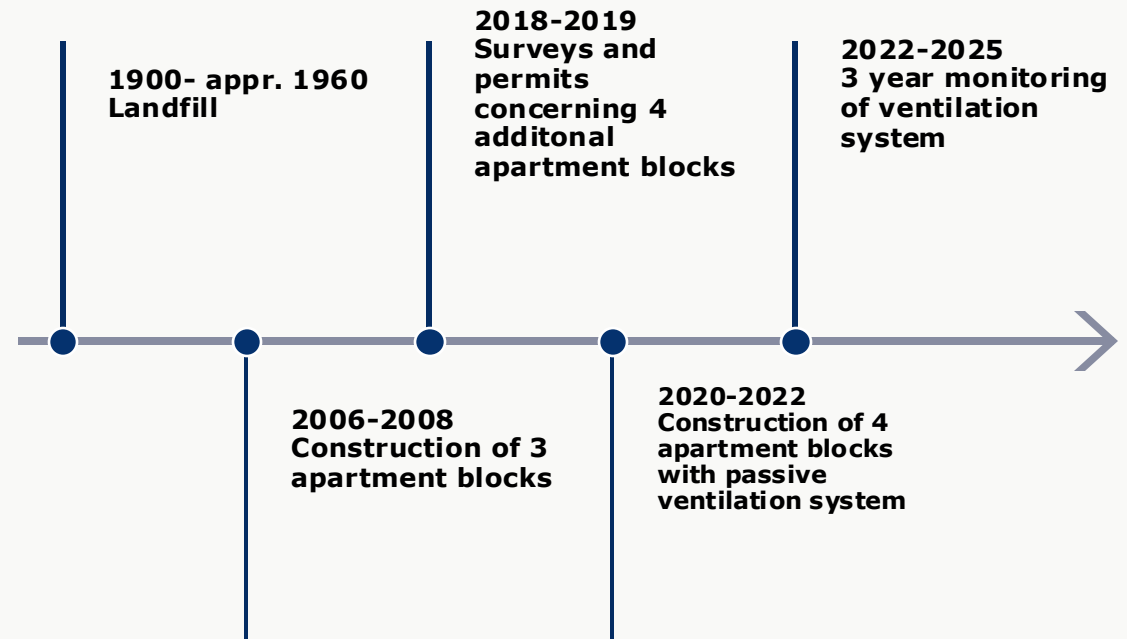
Protection against methane vapour from previous landfill in newly built housing blocks

- From site investigation to a 3-year monitoring of a passive ventilation system



Case relevance

- The project covers residential development on a former landfill site
- Soil gas was detected before construction and had to be managed to protect future residents
- The key issue was not classical VOC vapor intrusion, but landfill gas with methane as the main concern.
- The case is relevant because it follows the full chain from investigation and permitting to construction, documentation and long-term monitoring

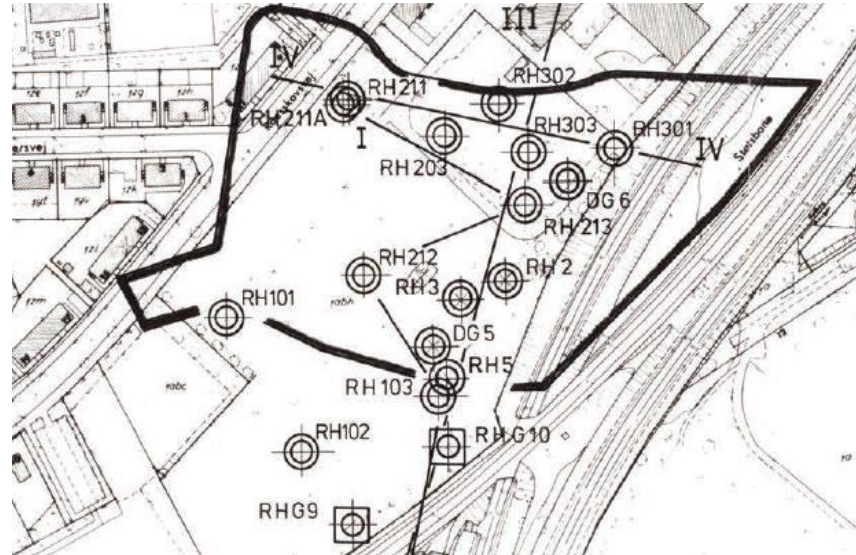
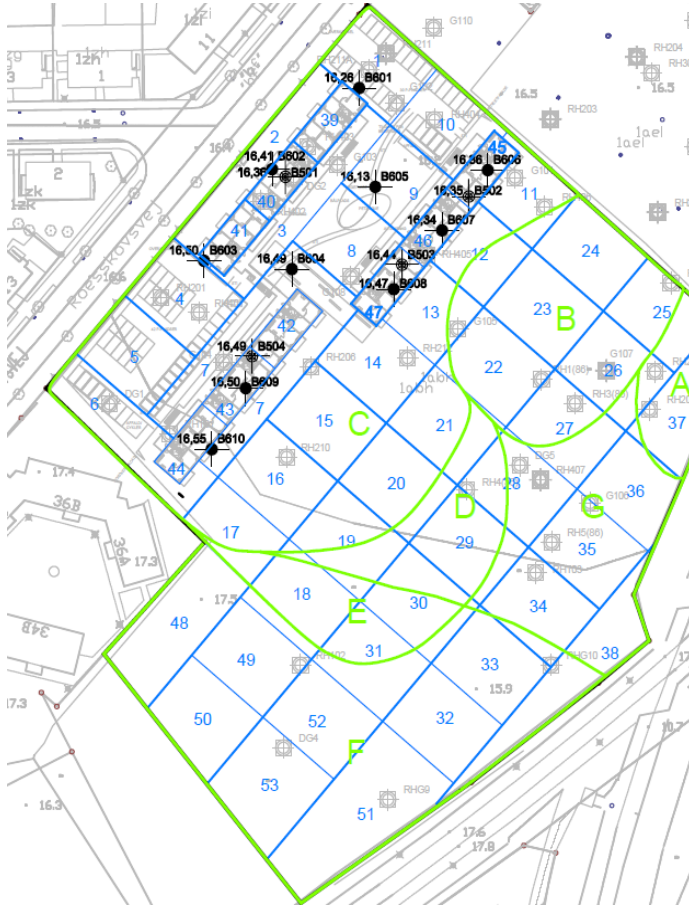


Objectives of the presentation

- Present survey methods used at former landfill site
- Show how criteria for vapor and gas management have changed over from 2006-today
- Share experience from following a project from the first surveys to construction of the blocks and the ventilation system
- Inconsistencies between the planned and the built system were identified and handled.



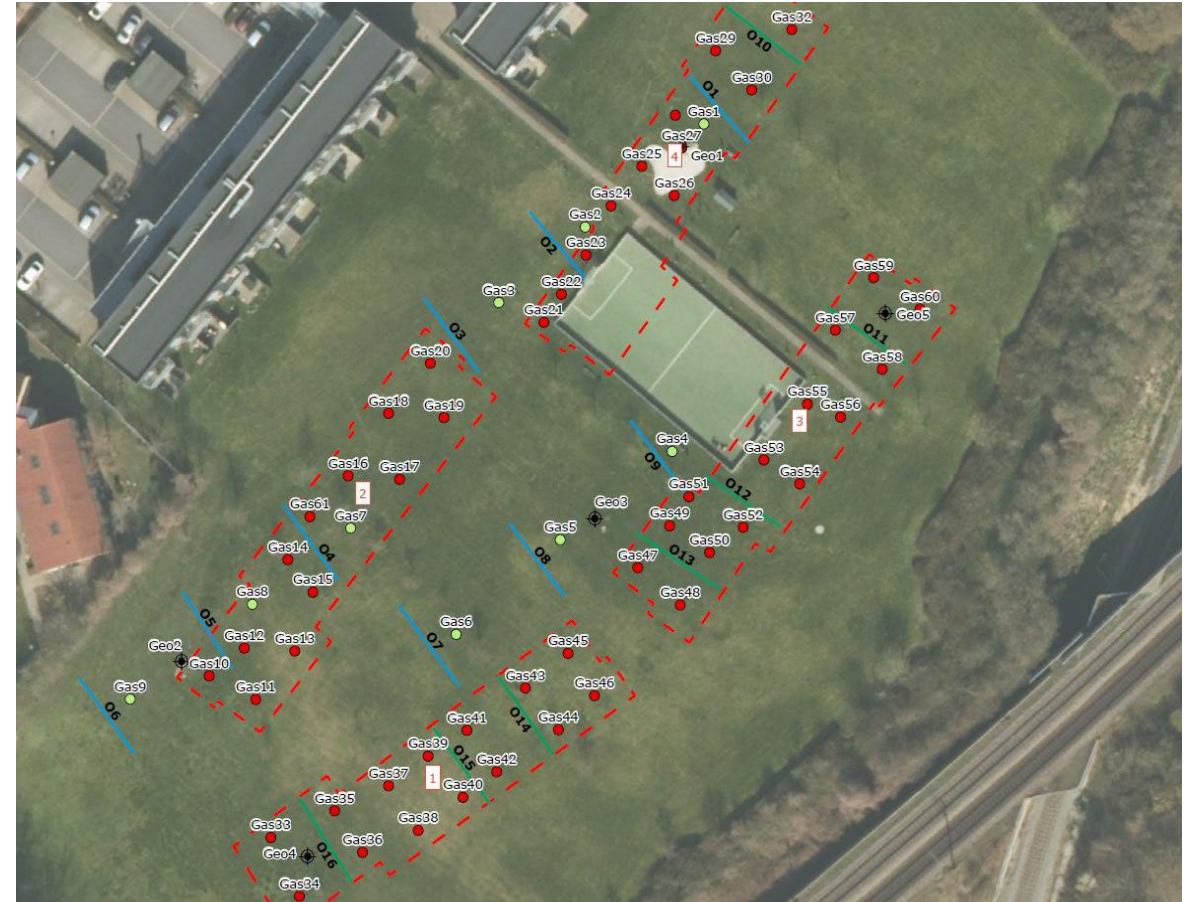
Site history and construction of first apartment blocks



- The former landfill were filled with waste and gasworks slag before the area was developed for housing 2006.
- Previous surveys including field work from 1988-2006 confirmed waste and fill materials in parts of the site.
- Immobile substances in surface soil (Heavy metals and PAH's)
- Moderate contamination of groundwater
- Gas emissions of methane up to 8 vol% from 10 gas boreholes
- Risk assessment stated that methane gas in the former landfill fill could migrate upward and potentially enter buildings and indoor air through the concrete slab
- 2006-2008 construction of 3 apartment blocks with gas membrane above concrete slab and passive ventilation system.
- Substitution of top surface soil to 0,5-1 m ind the surrounding areas
- 2-year monitoring of ventilation system.

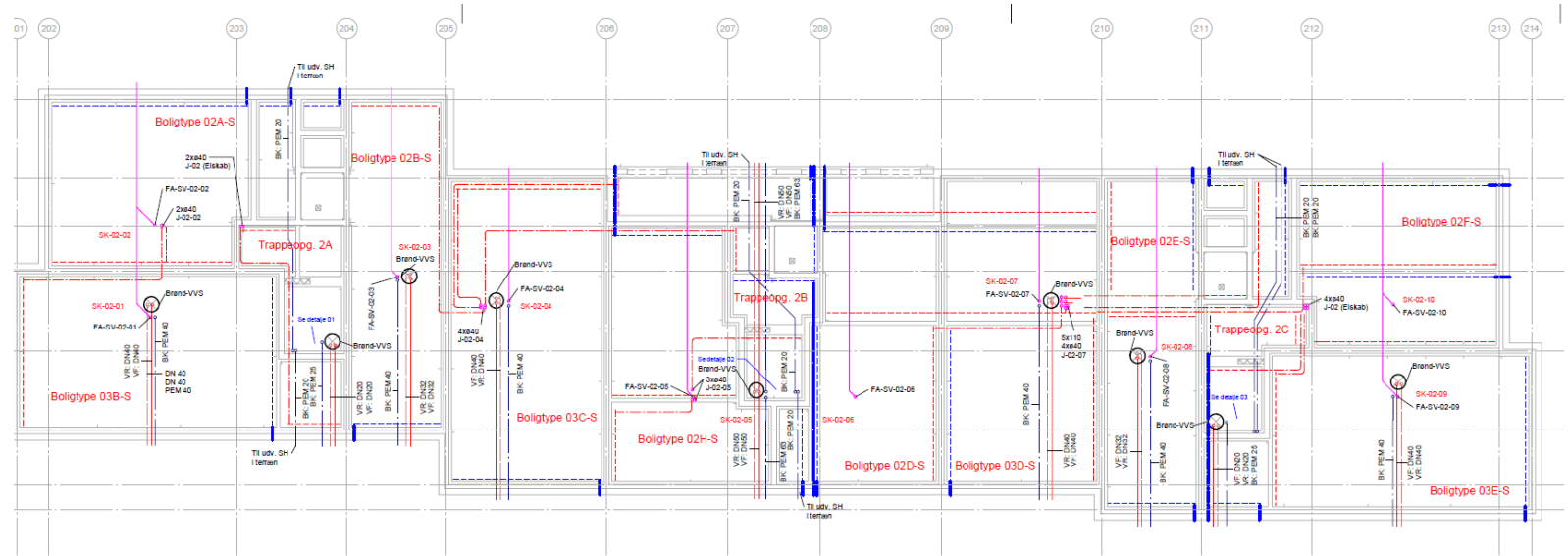
2018-2022 Surveys and permits before construction of 4 new apartment blocks

- Construction of apartment blocks requires a Danish § 8 permit from the municipality and Danish Regions
 - The site investigations included trenching, soil sampling, fill-soil investigation and landfill-gas measurements in several campaigns.
 - Higher sample density with 60 soil gas boreholes and 16 trenches in footprints of new blocks
- Landfill waste was visible in trenches, confirming the risk for landfill gas intrusion in future buildings
- Methane reached 1,7-21,5 vol.% the most northern and eastern building footprints
 - Low or no methane content in the other boreholes
- CO₂ content between 3,8 and 14 vol.%.
 - Methane levels showed that remediation measures were needed to eliminate gas intrusion of the affected buildings was necessary.
 - Passive ventilations system in 2 of 4 buildings



2018-2022 Surveys and permits before construction of 4 new apartment blocks

- The permit required
- A passive ventilation system under the concrete slab in a ventilation layer in 2 of 4 the buildings.
 - Ventilation layer is divided in flow cells
 - Swan neck inlets at ground level
 - Outlets on roof
 - Wind and temperature drives the air circulation
 - Monitoring points in each flow cell
- Prepared for active ventilation
- Airtight membrane under the floor
- Monitoring plan for 3 years after completion of the buildings
- A drain between the eastern and western buildings to prevent horizontal gas migration



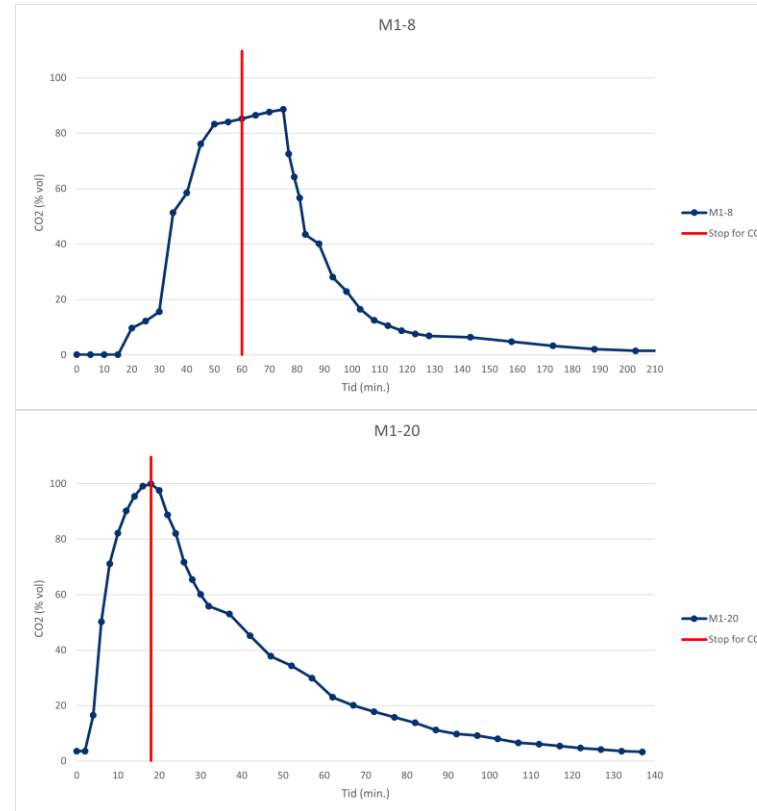
Construction reality: planned vs built

- The drain planned between eastern buildings and western buildings 3–4 was not built (contractor "forgot")
- Instead, gas migration between the buildings was assessed using soil gas measurements between the building
- Missing swan-necks in lets were repaired
- Some monitoring points could not be located or was clogged
- The case demonstrates that construction supervision is critical when gas protection measures are implemented in real projects
 - The client and their consultant did not want supervision



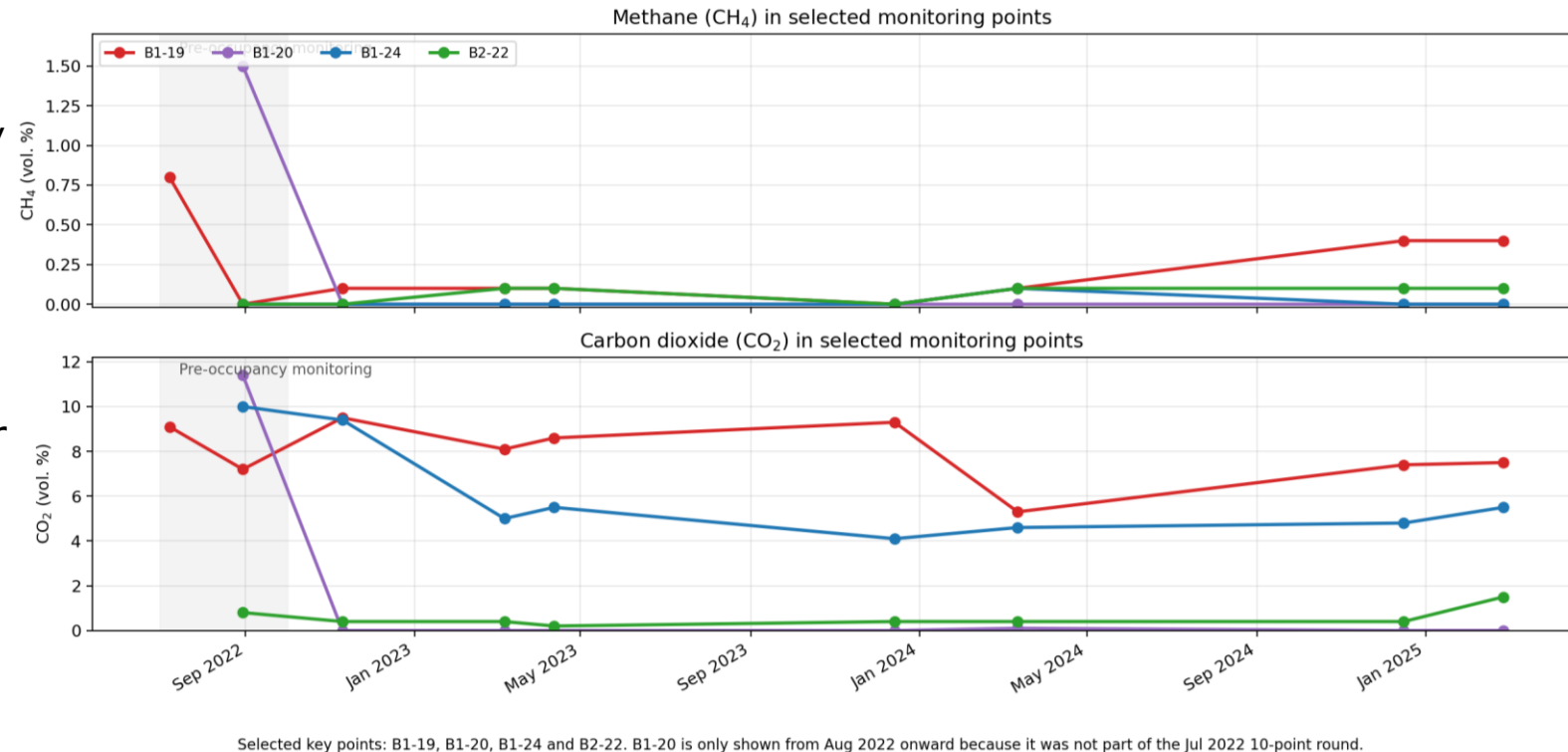
Verification and monitoring strategy

- The monitoring plan included verification before occupancy and 3-year monitoring after occupancy.
- Before occupancy, the plan included gas measurements and flow checks in the ventilation system
- After occupancy, the system was monitored
 - 3 times in year 1
 - 2 times in year 2 and year 3



Monitoring results after 3 years

- Methane concentrations in the ventilation layer were generally very low during the monitoring period
 - Higher concentration in the pre-occupancy phase
- Methane was mostly 0–0.1 vol.% and reached 0.4 vol.% in B1-19 in year 3.
- CO₂ was elevated in specific flow cells, especially B1-19 and B1-24, with values up to 9,5 vol.% in year 1 and 7,5 vol.% in year 3
- The monitoring conclude that the measured gas content did not pose an unacceptable risk for residential use.
- The overall picture is stable long-term performance of the ventilation system, with methane effectively controlled and CO₂ remaining a relevant secondary assessment parameter



Key lessons



Former landfill sites can be developed for housing when the gas risk is investigated, risk assessed, documented and mitigated



Passive ventilation can be an effective system for controlling methane intrusion to buildings.



CO₂ should not be overlooked, because it can remain elevated even when methane is low.



Construction supervision is essential, because small deviations from the design can affect system performance and monitoring strategy.



Long-term performance also depends on general maintenance of the system, including keeping air inlets and roof outlets free from blockage.

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