

Passive Soil Gas Sampling:

An Alternative to Active Sampling for Chlorinated Compounds

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Soil Gas Investigations

Pumped/active sampling



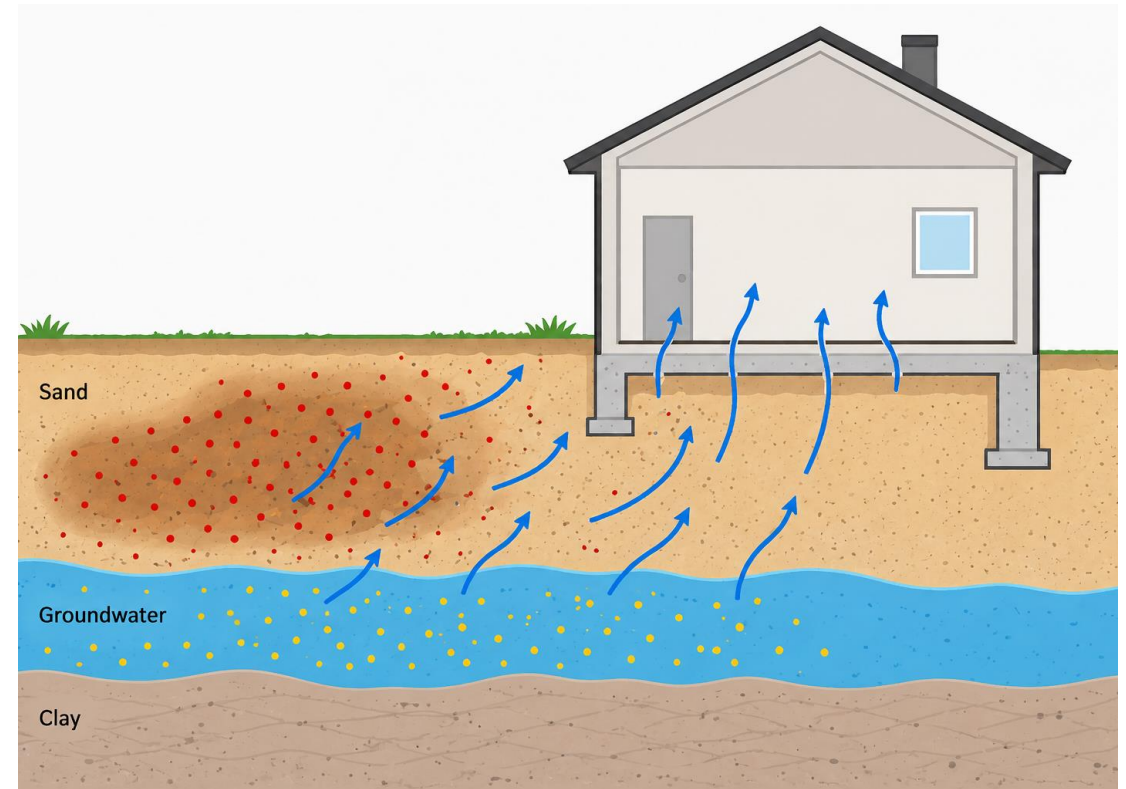
Source identification



Delineation

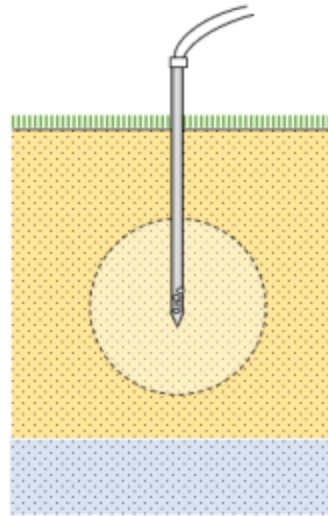


Risk assessment



Soil Gas Investigations

Pumped/active sampling

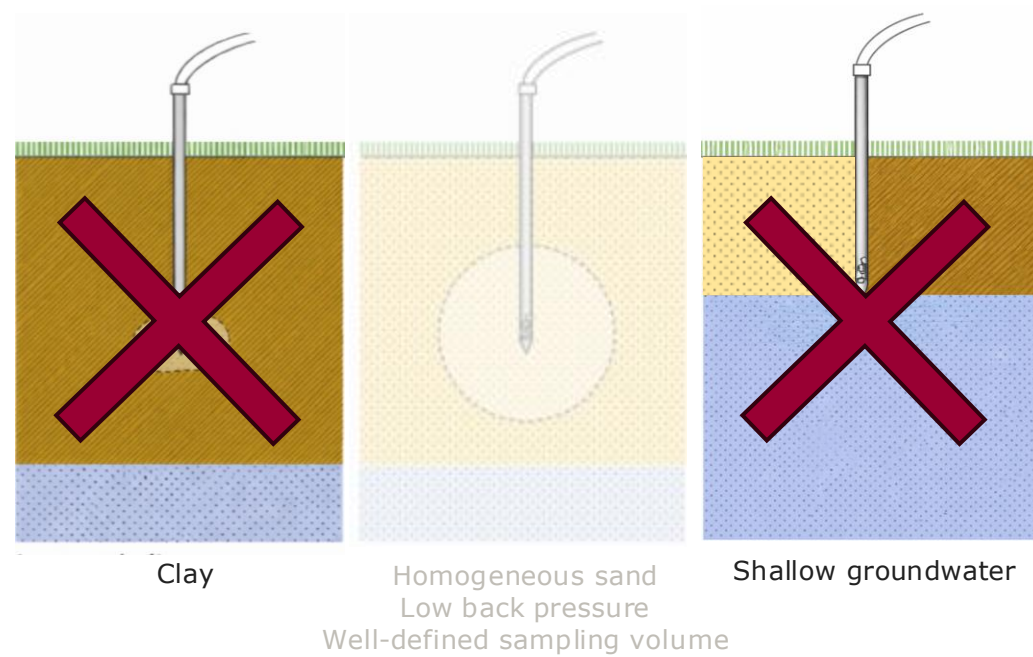


Homogeneous sand
Low back pressure
Well-defined sampling volume

*Modified from:
Retningslinjer for udtagning
af luftprøver ved
forureningsundersøgelser (VMR)*

Soil Gas Investigations

Pumped/active sampling



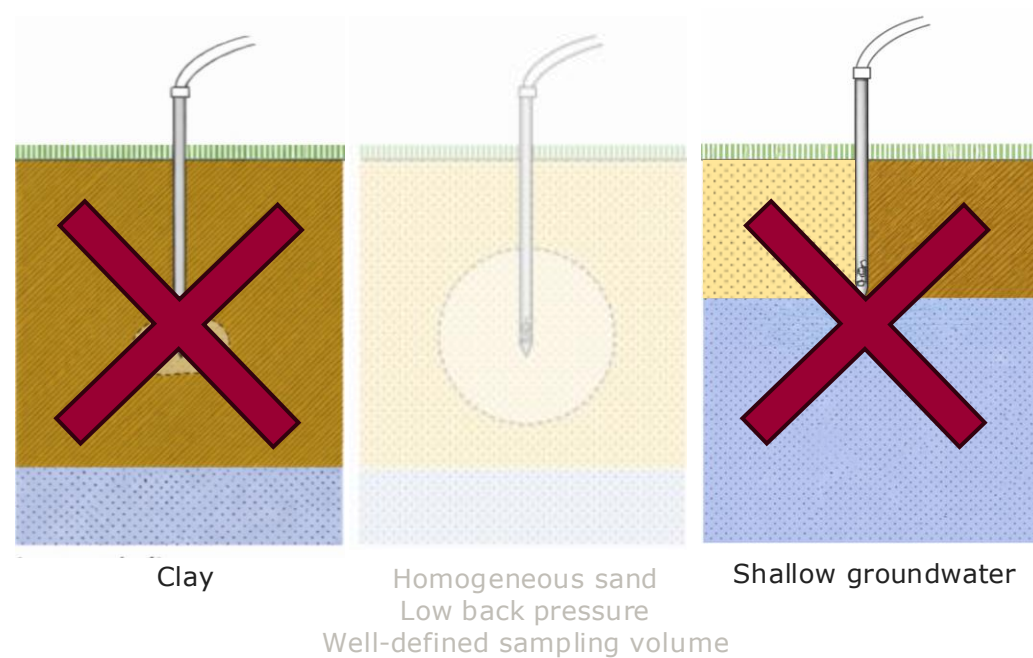
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Vinyl chloride in shallow groundwater, but not in soil gas?

Soil Gas Investigations

~~Pumped/active sampling~~

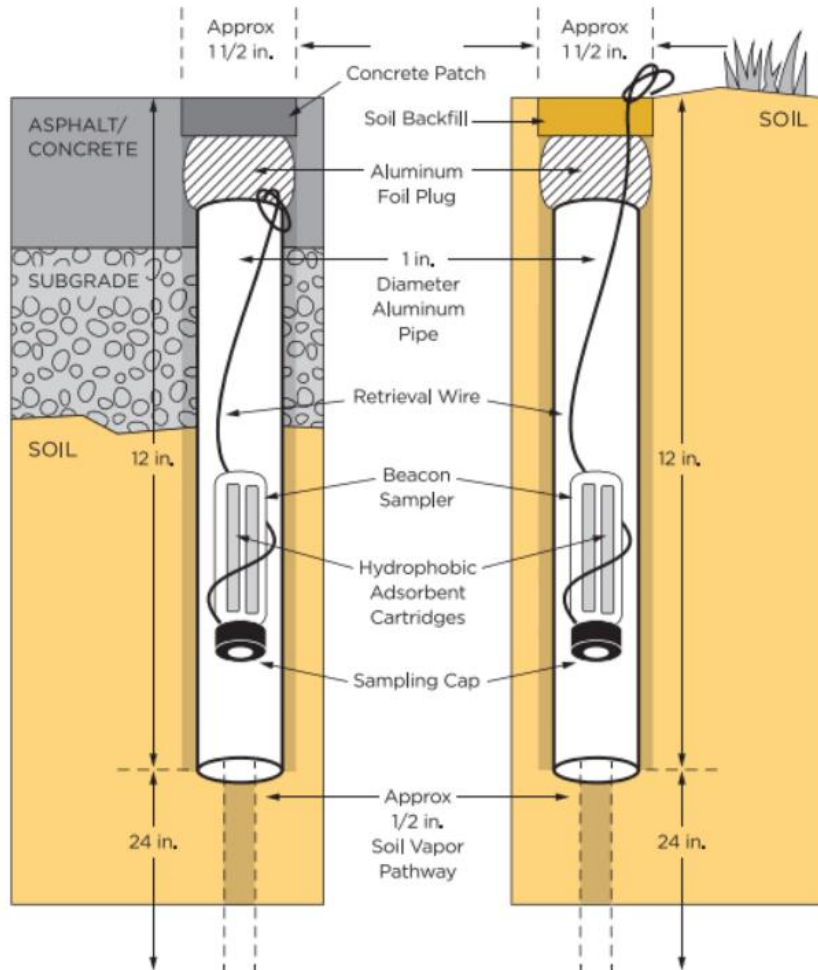
Passive soil gas sampling as an alternative?



Modified from:
Retningslinjer for udtagning
af luftprøver ved
forureningsundersøgelser (VMR)

Vinyl chloride in shallow groundwater, but not in soil gas?

Passive soil gas (PSG) samplers



Absorb volatile and semi-volatile organic compounds
 Sampling period: 3 - 14 days
 ng/sampler or $\mu\text{g}/\text{m}^3$ using sampler uptake-rates (ml/min)

Passive Soil Gas Survey Representative List of Target Compounds	
TPH C5-C8	Ethylbenzene
TPH C9-C15	p & m-Xylene
Vinyl Chloride	o-Xylene
1,1-Dichloroethene	1,2,3-Trichloropropane
Methylene Chloride	Isopropylbenzene
1,1,2-Trichlorotrifluoroethane (Freon 113)	1,3,5-Trimethylbenzene
trans-1,2-Dichloroethene	1,2,4-Trimethylbenzene
Methyl-t-butyl ether (MTBE)	1,3-Dichlorobenzene
1,1-Dichloroethane	1,4-Dichlorobenzene
cis-1,2-Dichloroethene	1,2-Dichlorobenzene
Chloroform	1,2,4-Trichlorobenzene
1,2-Dichloroethane	Naphthalene
1,1,1-Trichloroethane	Hexachlorobutadiene
Carbon Tetrachloride	Trichlorobenzenes
Benzene	2-Methylnaphthalene
Trichloroethene	Biphenyl
1,4-Dioxane	Acenaphthylene
1,1,2-Trichloroethane Toluene	Acenaphthene
1,2-Dibromoethane (EDB)	Dibenzofuran
Tetrachloroethene	Fluorene
1,1,1,2-Tetrachloroethane	
Chlorobenzene	



Beacon Environmental
 Passive Soil Gas Testing:
 Standard for Site Characterization



Project: Testing the applicability of Passive Soil Gas (PSG) samplers

Phase 1

ORSA og PSG sampler in indoor air (dry cleaner)

Phase 2a

Charcoal tubes, ORSA and PSG samplers in soil gas (landfill)

Phase 2b

Charcoal tubes, ORSA and PSG samplers in soil gas
(residual contamination after remediation)

Phase 1: Comparison of ORSA and PSG samplers in indoor air (dry cleaner)



*Sampling principle
PSG and ORSA*

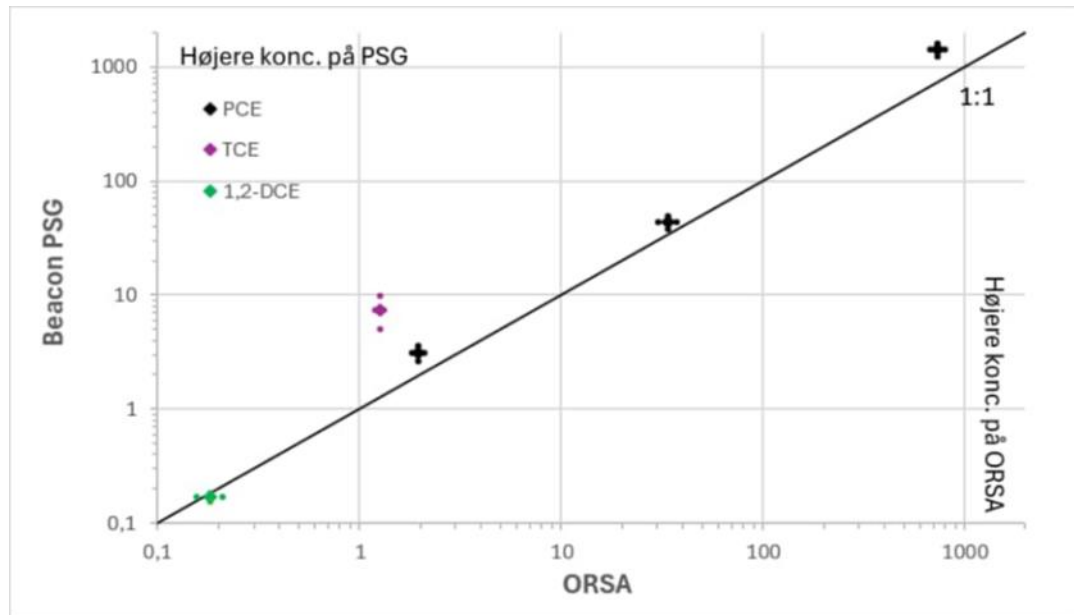
Aim

Investigate whether the PSG sampler can reproduce known indoor-air contamination (compounds, concentrations) detected using ORSA.

Sampling

5 PSG and 5 ORSA samplers at each of three measurement points, with a 14-day sampling period.

Phase 1: Comparison of ORSA and PSG samplers in indoor air (dry cleaner)



Mean PSG concentrations plotted against mean ORSA concentrations.

Aim

Investigate whether the PSG sampler can reproduce known indoor-air contamination (compounds, concentrations) detected using ORSA.

Sampling

5 PSG and 5 ORSA samplers at each of three measurement points, with a 14-day sampling period.

Conclusion

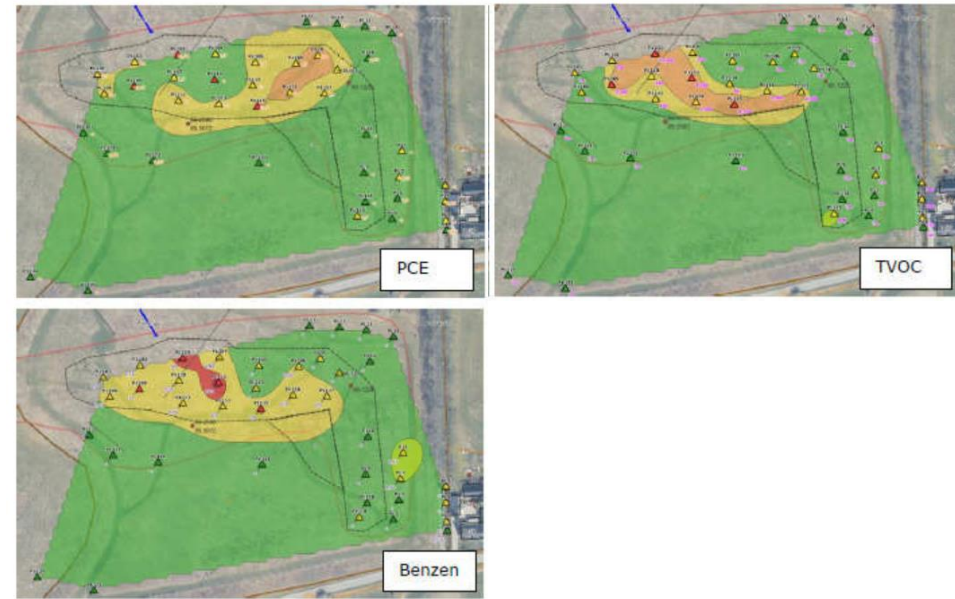
PSG sampler reproduced the detected compounds. Slightly higher concentrations, indicating higher sensitivity.

Phase 2a: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (landfill)

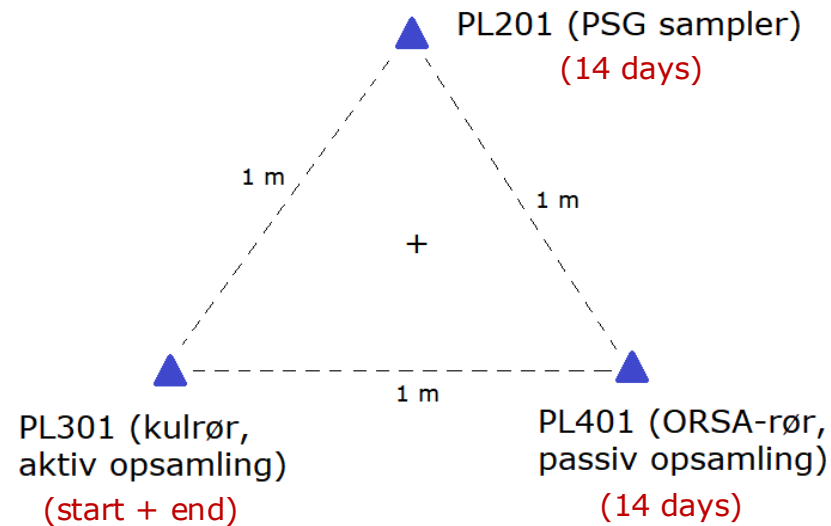


Aim

Assessing the ability of ORSA and PSG samplers to reproduce known soil gas contamination (compounds and concentrations) measured using active charcoal tube sampling.



Phase 2a: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (landfill)



Sampling principle

Aim

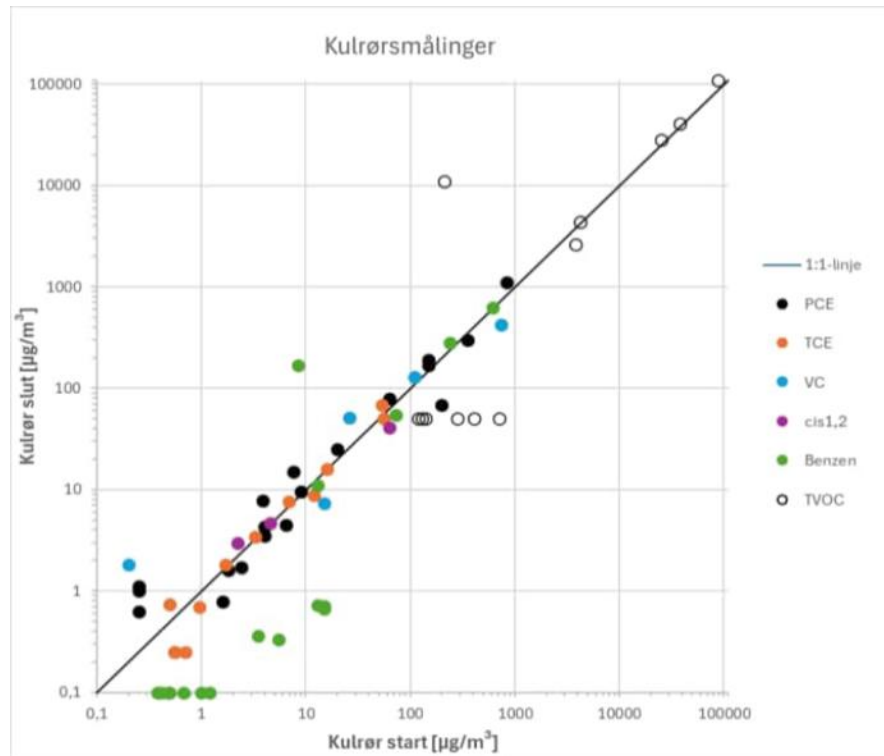
Assessing the ability of ORSA and PSG samplers to reproduce known soil gas contamination (compounds and concentrations) measured using active charcoal tube sampling.

Sampling

17 sampling clusters: charcoal tubes, ORSA and PSG
Duration: start + slut (active), 14 days (passive)

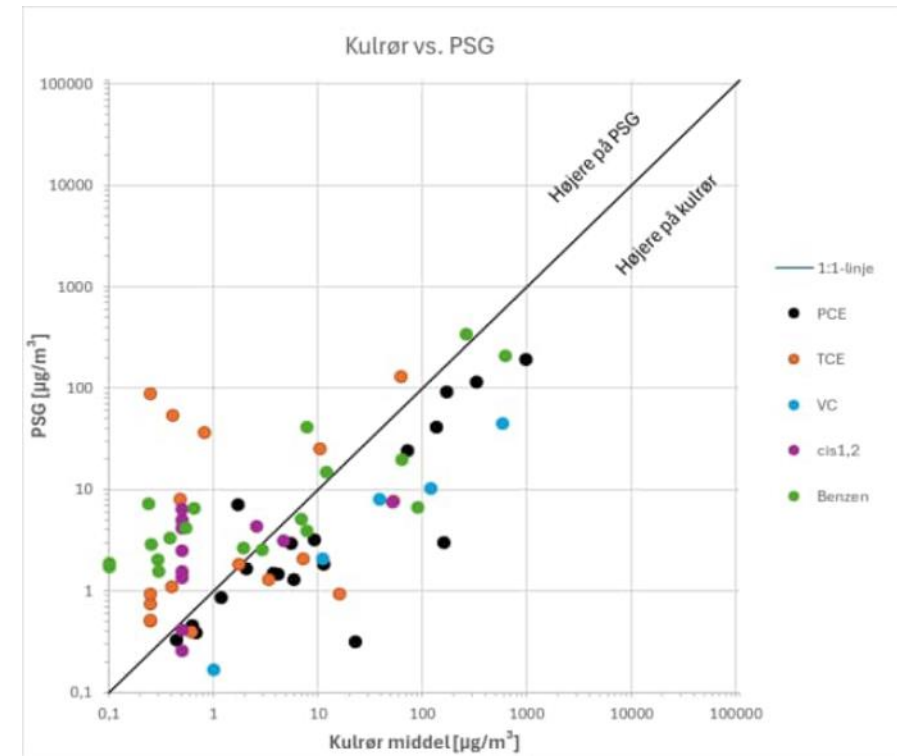
Phase 2a: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (landfill)

Small temporal variations for the two charcoal tube measurements.
Assessed as suitable for comparison.



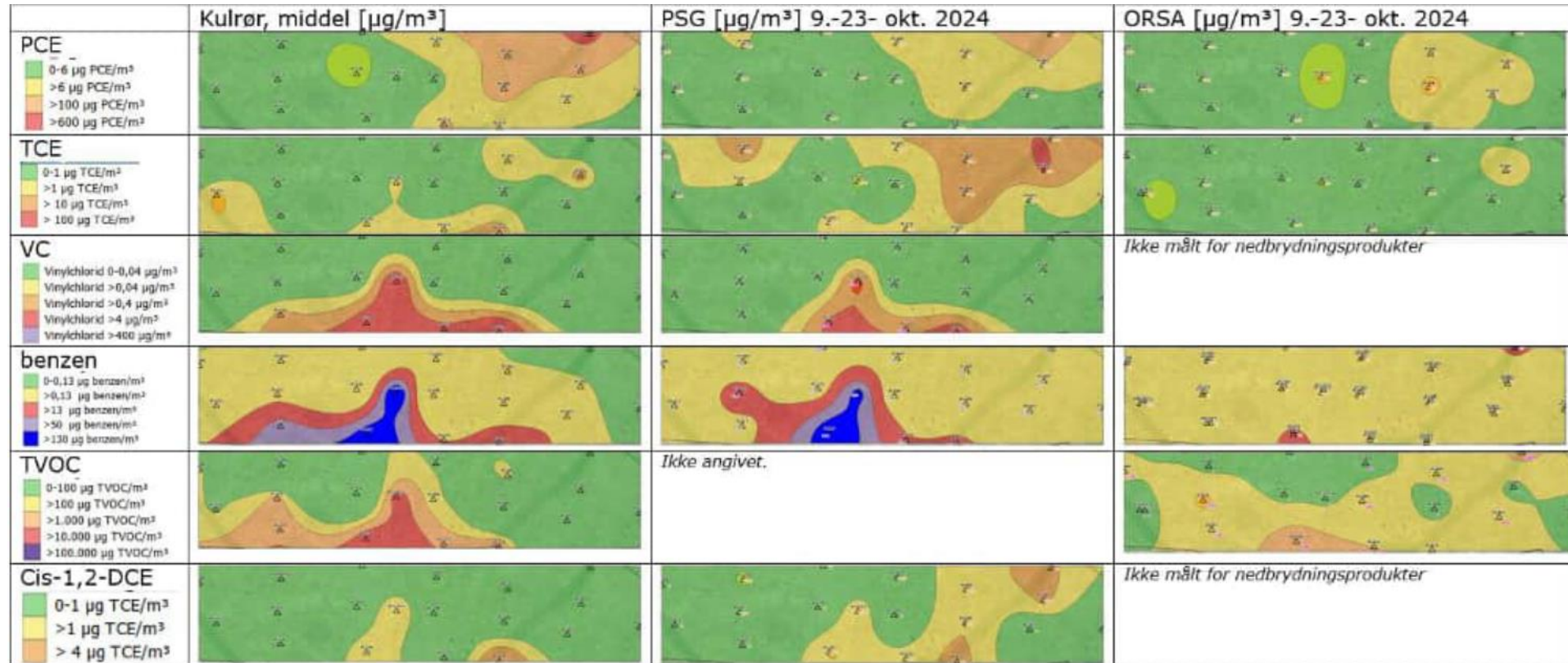
Charcoal start + end plotted

Variation in concentration levels for different compounds (affinity, passive/active).



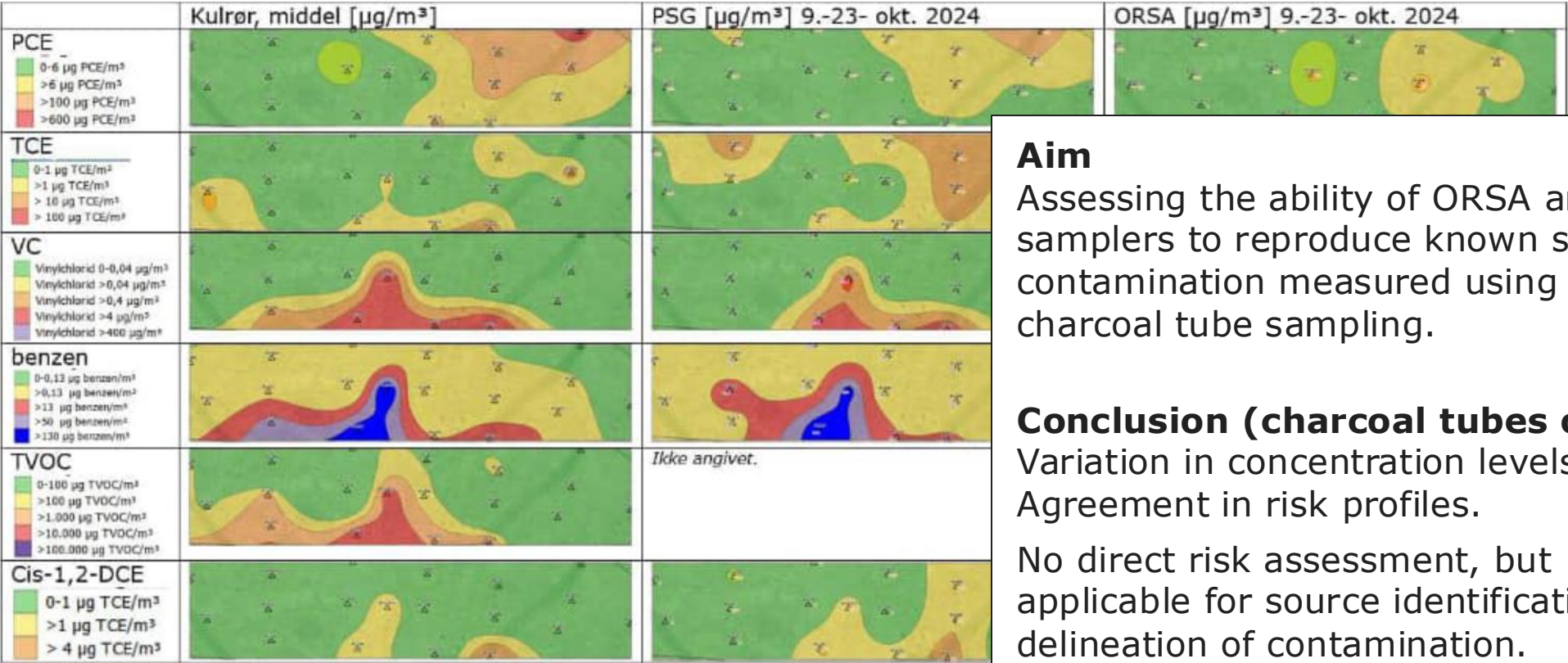
PSG plotted against charcoal (avg.)

Phase 2a: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (landfill)



Risk plots for selected compounds plotted for the three sampling methods; average values for charcoal tubes.

Phase 2a: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (landfill)

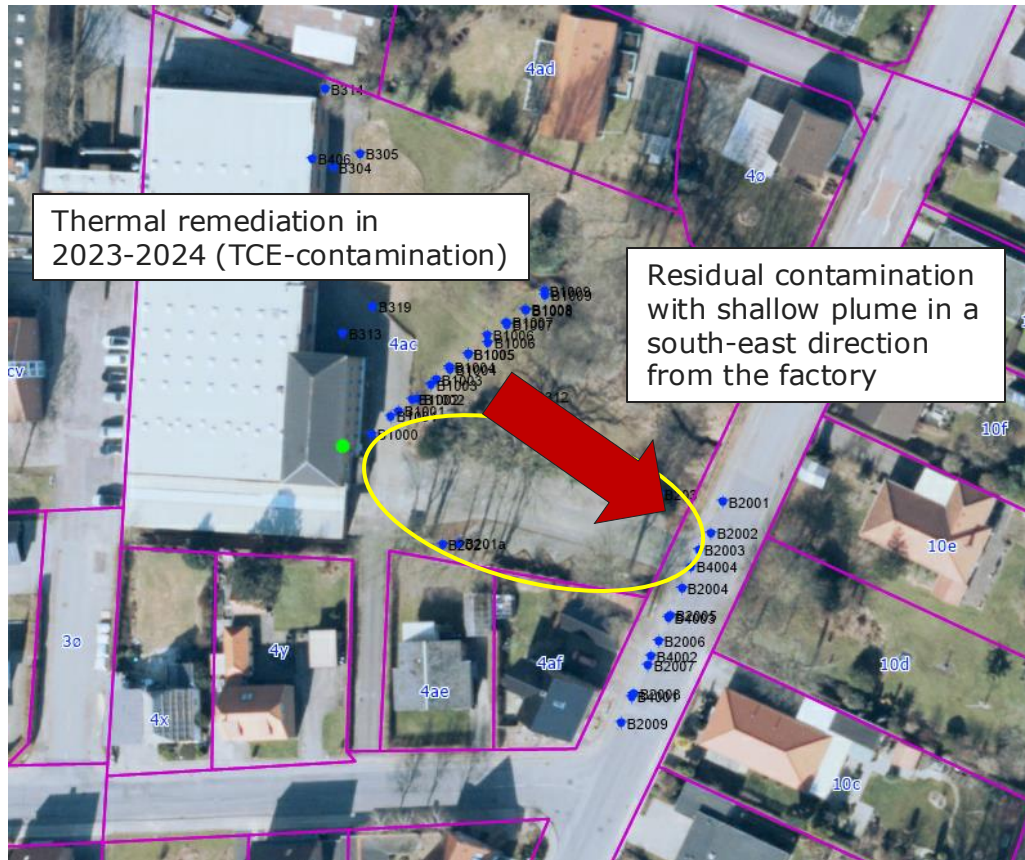


Aim
Assessing the ability of ORSA and PSG samplers to reproduce known soil gas contamination measured using active charcoal tube sampling.

Conclusion (charcoal tubes og PSG)
Variation in concentration levels.
Agreement in risk profiles.
No direct risk assessment, but applicable for source identification and delineation of contamination.

Risk plots for selected compounds plotted for the three sampling methods; average values for charcoal tubes.

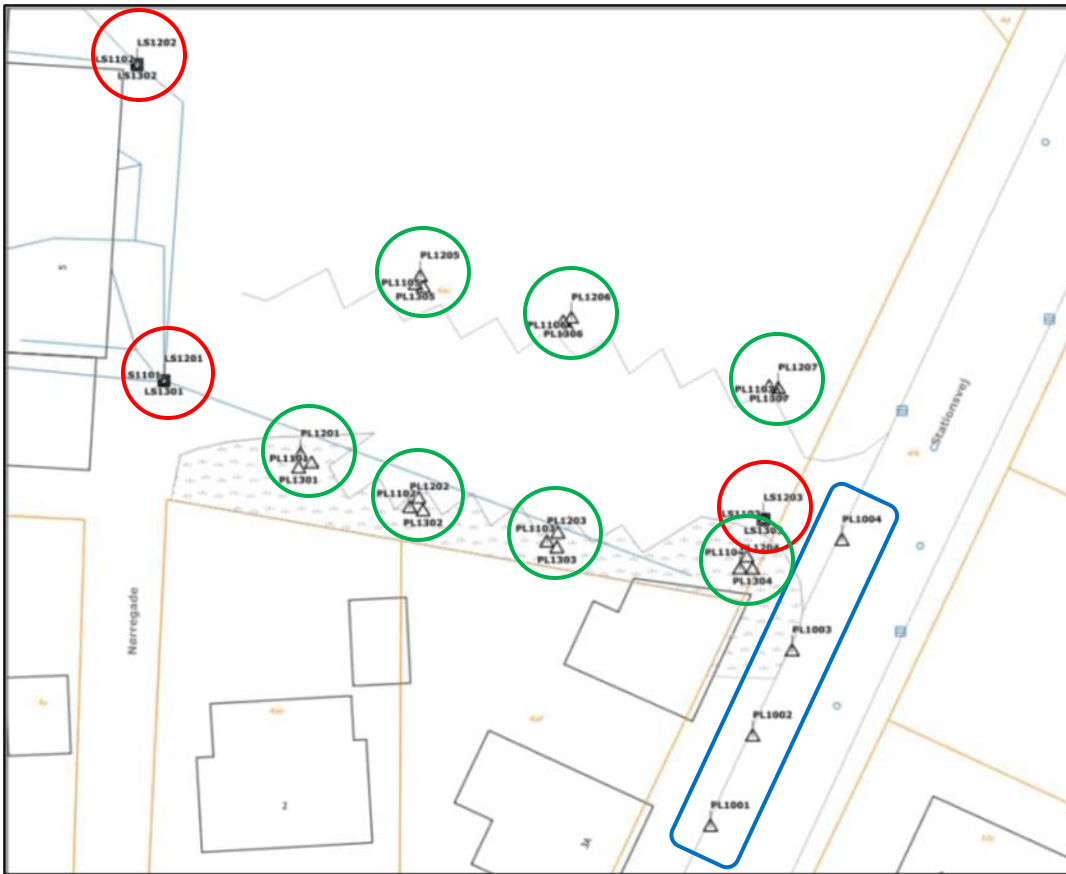
Phase 2b: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (residual contamination)



Aim

Repeat Phase 2a: TCE contamination in shallow groundwater with risk of vapor intrusion into homes.

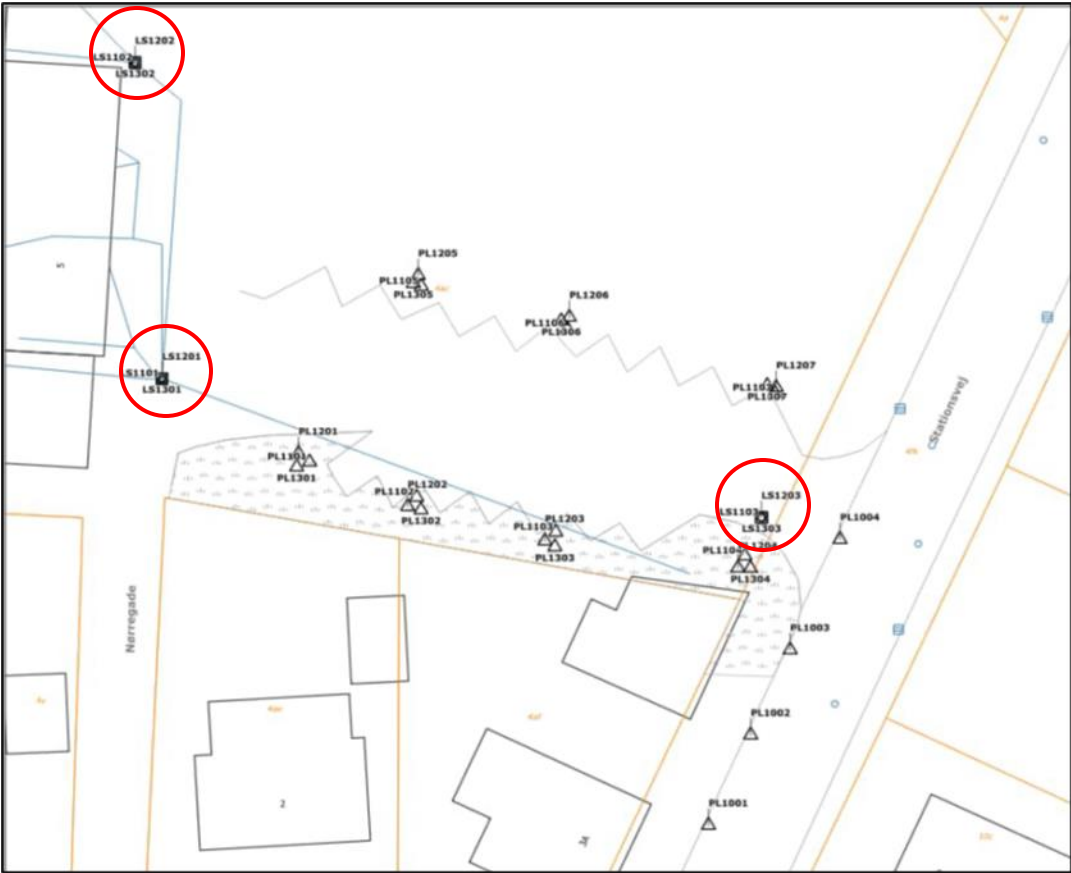
Phase 2b: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (residual contamination)



Sampling (round 1)

- 1) **Cluster principle** as in phase 2a: charcoal tubes, ORSA, and PSG in the factory driveway, north of homes
- 2) **Three sewer wells**: charcoal tubes, ORSA, and PSG
- 3) **Charcoal tube measurements** in four permanent monitoring points (boreholes)

Phase 2b: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (residual contamination)

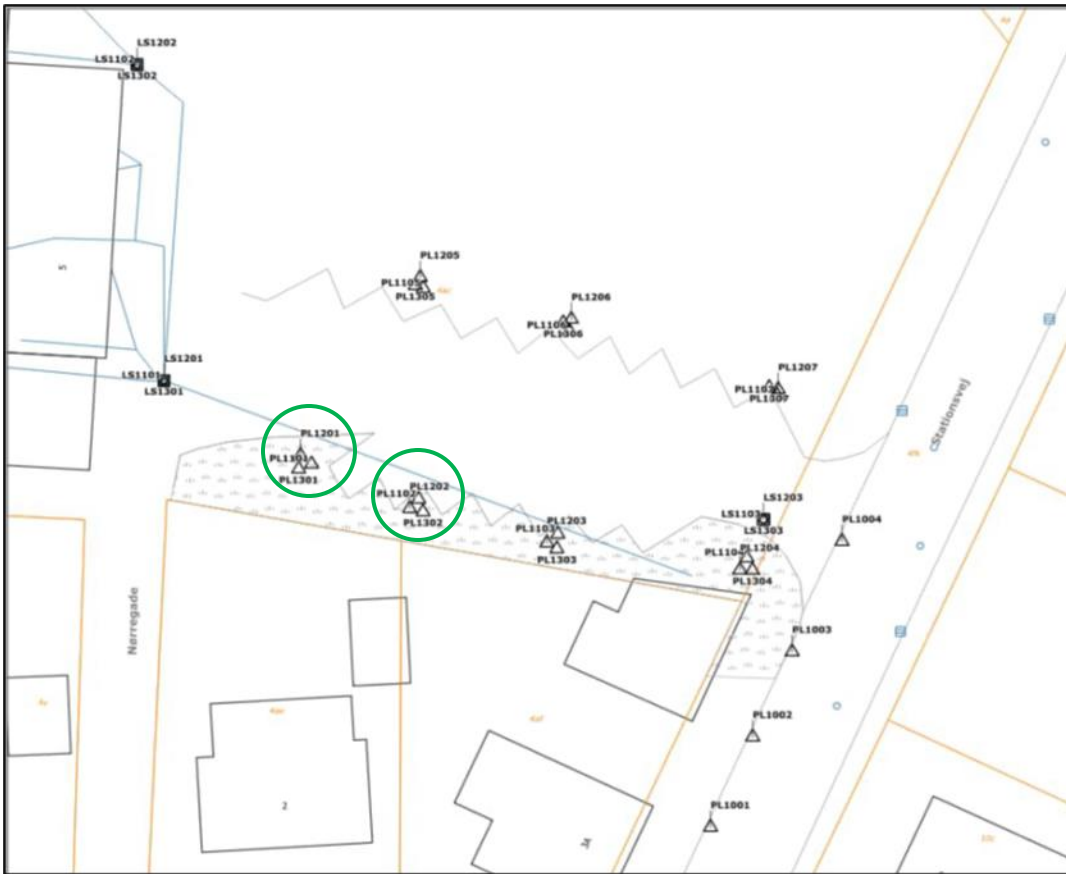


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Målepunkt	Prøvedato	Metode	TCE	PCE	Vinylchlorid
LS1101	24/4-8/5-2025	PSG	483	1.29	2.86
LS1201	24-04-2025	kul op	150	< 0.5	3.2
LS1201	08-05-2025	kul ned	2.5	< 0.5	2.8
LS1301	24/4-8/5-2025	ORSA	370	1.1	0.57
LS1102	24/4-8/5-2025	PSG	299	< 0.302	0.799
LS1202	24-04-2025	kul op	2.5	< 0.5	< 0.4
LS1202	08-05-2025	kul ned	82	< 0.5	6.6
LS1302	24/4-8/5-2025	ORSA	180	0.66	0.33
LS1103	24/4-8/5-2025	PSG	556	1.58	5.39
LS1203	08-05-2025	kul op	410	< 0.5	< 0.4
LS1203	24-04-2025	kul ned	480	< 0.5	14
LS1303	24/4-8/5-2025	ORSA	430	1.3	0.89

TCE / PCE (µg/l)	< 1	1-10	10-100	> 100
Vinyl chloride (µg/l)	< 0.04	0.04-0.4	0.4-4	> 4

Phase 2b: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (residual contamination)



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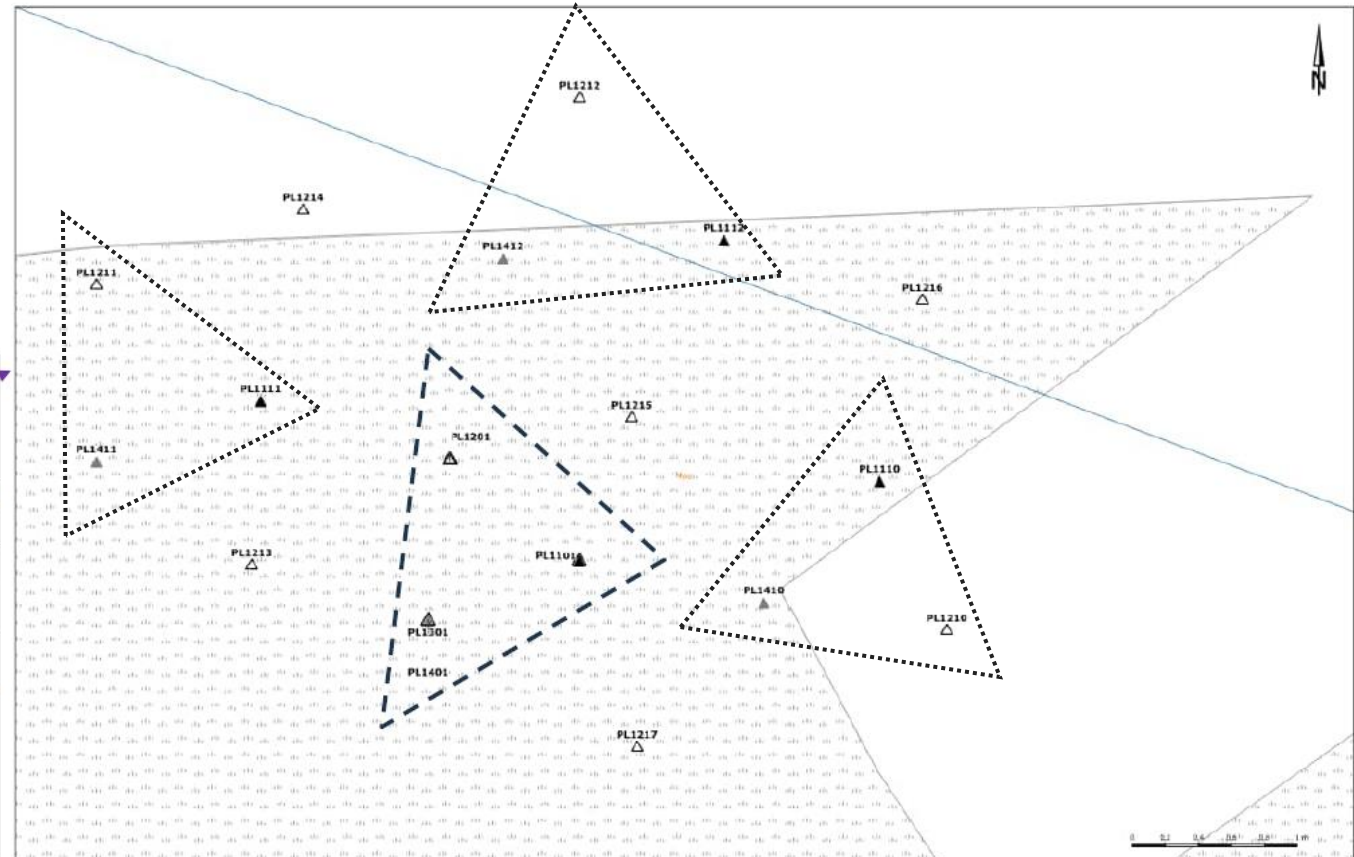
Måle-punkt	Prøvedato:	Metode	TCE	PCE	Vinylchlorid
PL1101	24-04-2025	PSG	20.5	1.61	< 0.155
PL1201	10-04-2025	Kulrør op	15,000	1.1	180
PL1201	24-04-2025	Kulrør ned	16,000	1.1	59
PL1301	24-04-2025	ORSA	2.5	< 0.1	< 0.04
PL1102	24-04-2025	PSG	388	< 0.307	< 0.155
PL1202	10-04-2025	Kulrør op	1,600	0.51	< 0.4
PL1202	24-04-2025	Kulrør ned	1,500	< 0.5	< 0.4
PL1302	24-04-2025	ORSA	110	< 0.1	< 0.04

TCE / PCE (µg/l)	< 1	1-10	10-100	> 100
Vinyl chloride (µg/l)	< 0.04	0.04-0.4	0.4-4	> 4

Sampling clusters: High variation in concentration, same "hotspot"

Sampling (round 2)

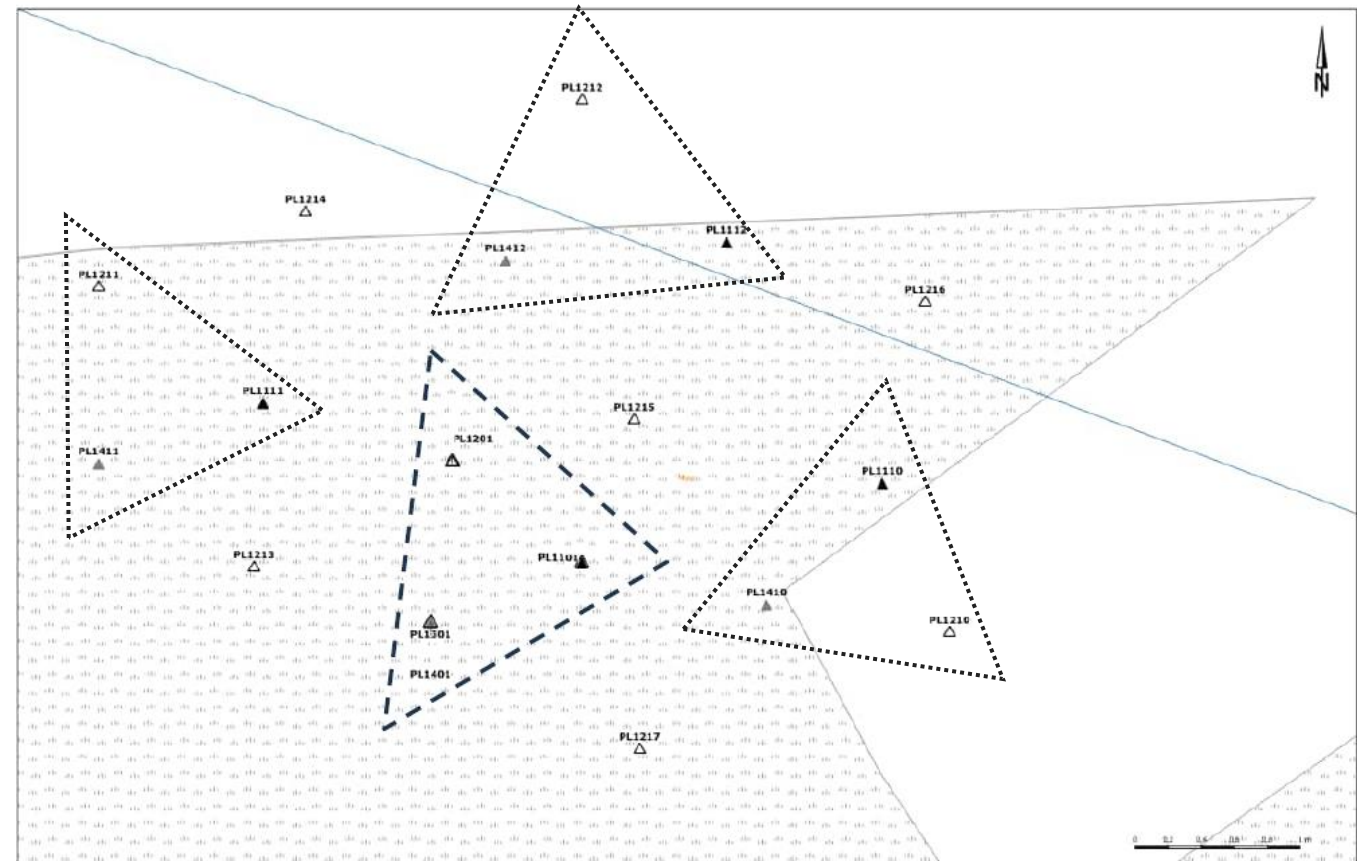
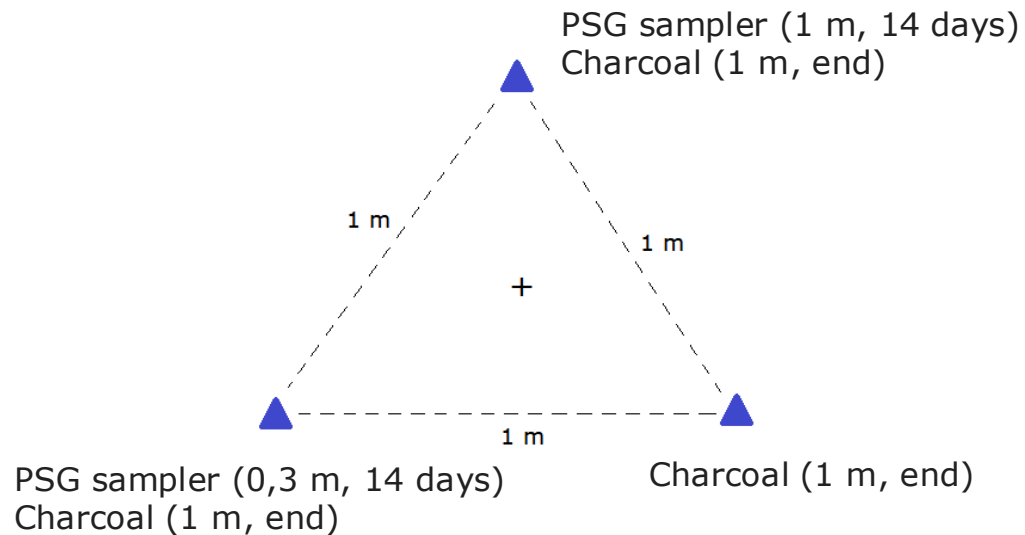
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Phase 2b: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (residual contamination)

Sampling (round 2)

- 1) Cluster principle: one replication, three new Charcoal tubes and PSG – different depths
- 2) Five charcoal tube measurements in between the clusters



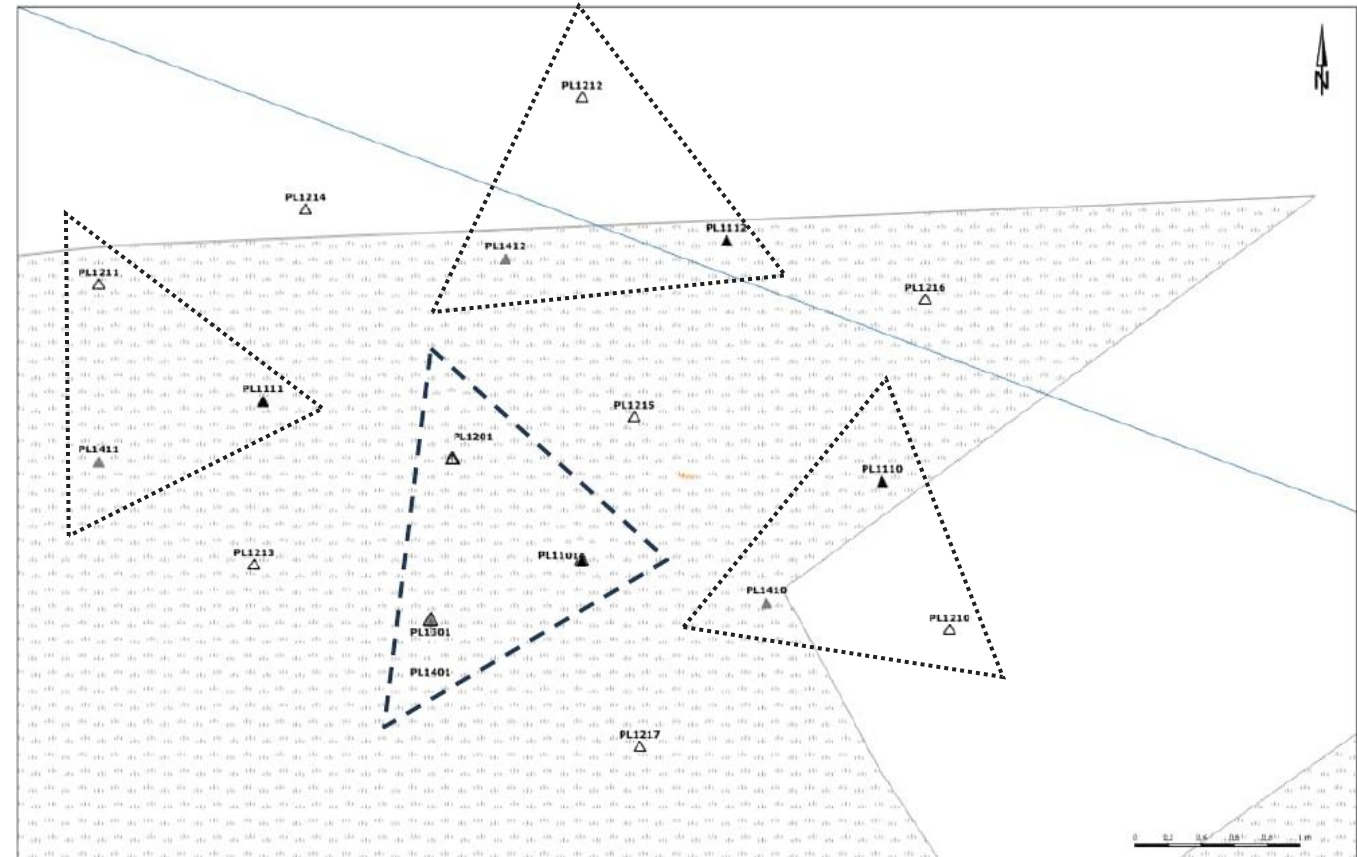
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Conclusion

High variation in soil gas concentrations within short distances, less suitable test site



Phase 2b: Comparison of charcoal tubes, ORSA and PSG samplers in soil gas (residual contamination)

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Conclusion

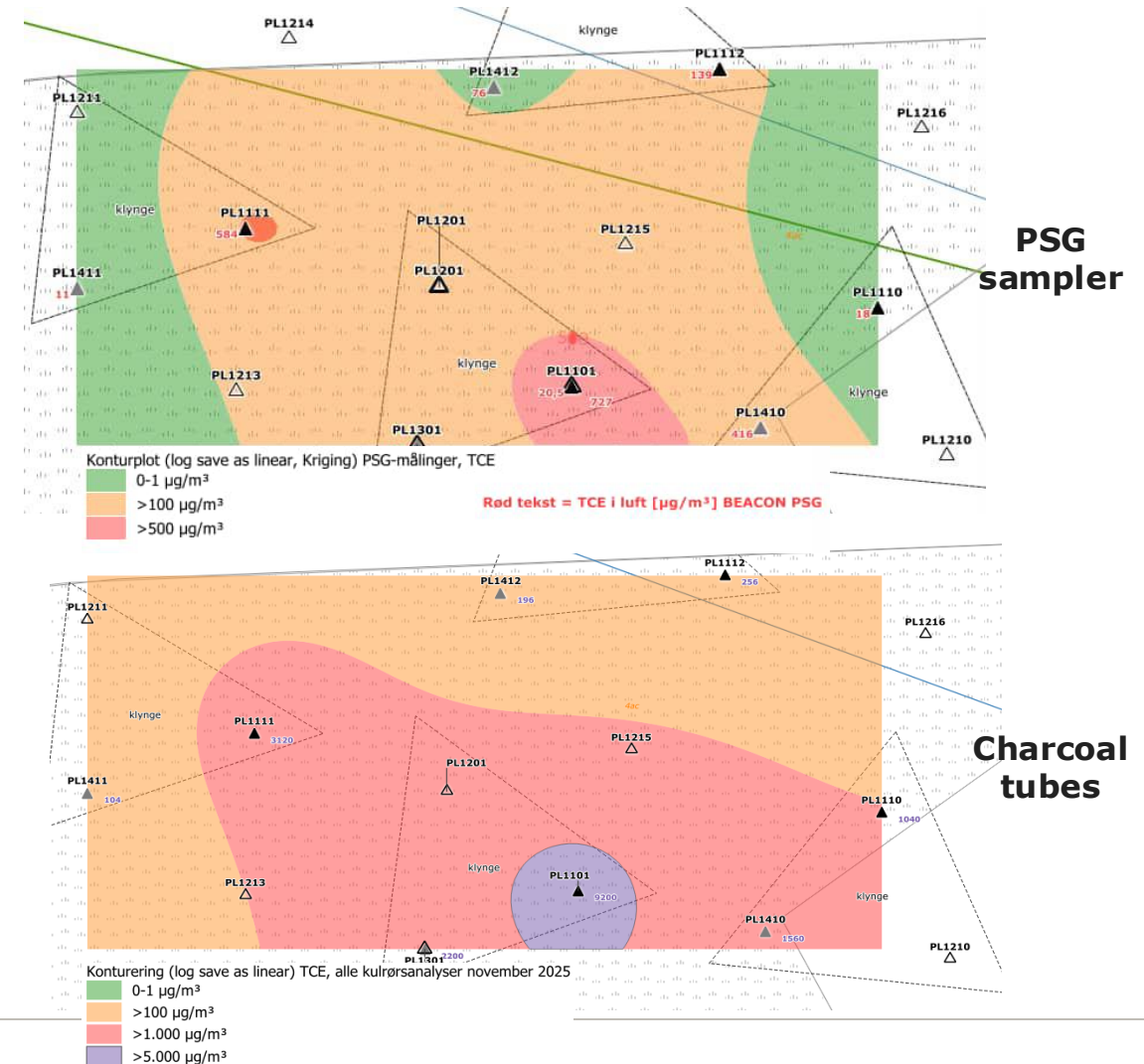
High variation in soil gas concentrations within short distances, less suitable test site.

Agreement in the contamination pattern between charcoal tubes and PSG samplers.

Overall

Good alternative when sampling with charcoal tubes is not possible

- Source identification
- Relative extent of contamination



Experiences using PSG samplers from Beacon

An additional, useful tool in the toolbox when standard methods cannot be applied.

CAN IDENTIFY



Source identification

Useful at sites with low-permeability formations or shallow groundwater

Identifies source areas and hotspots

Supports decisions on where to place boreholes

CAN INDICATE



Delineation

Indicates contamination patterns and distribution

Useful for initial screening of larger areas

Not suitable for final quantitative delineation

CANNOT (YET?)
QUANTIFY



Risk assessment

Indications of lower concentrations than active charcoal-tube sampling, potential risk of underestimation.

Not (yet) suitable for indoor-air risk assessment or direct comparison with Danish guideline values (afdampningskriterium)

Thank you for listening