

## The “Gandalf” soil sampling project at a former industrial site in Copenhagen, Denmark: evaluating soil classification reliability

Bo Svensmark<sup>a</sup>, Peter Mortensen<sup>b</sup>, Nemanja Milosevic<sup>c</sup> and Jan H. Christensen<sup>d</sup>

<sup>a</sup>Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, 1871, Frederiksberg C, Denmark, E-mail: [svensmark@plen.ku.dk](mailto:svensmark@plen.ku.dk)

<sup>b</sup>Research and Development at Eurofins Environment Denmark, Ladelundvej 85, DK-6600 Denmark, E-mail: [pm@eurofins.dk](mailto:pm@eurofins.dk)

<sup>c</sup>MOE A/S engineering consultancy, Buddingevej 272, 2680, Søborg, Denmark, E-mail: [nmi@dmr.dk](mailto:nmi@dmr.dk)

<sup>d</sup>Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, 1871, Frederiksberg C, Denmark, E-mail: [ich@plen.ku.dk](mailto:ich@plen.ku.dk)

Handling and transport of contaminated soil from industrial sites in Denmark requires classification based on concentrations of selected metals and organic contaminants. Reliable soil classification is needed for defensible remedial decision-making. Today's sampling process in Denmark is based on grab sampling of prescribed standard volumes of soil; 30 tons is typically used as the basic sampling Decision Unit. Soil classification follows a number of varying systems, but classification into five classes (class 0 to class 4) based on analytical results from sub-samples of 50 g is the most common. In this study we investigate the sampling uncertainty obtained by sampling of > 1800 samples at a former industrial site in Copenhagen, Denmark. The aim of the study was to conduct a critical assessment of the current sampling strategy by determination of soil classification errors obtained for duplicate primary samples collected from the same truck-load of soil, but with different distances from the original primary sample. It is also discussed which contaminants are the major parameters responsible for final soil classification designations. The original primary samples for the soil classification were taken at the centre of a 7 x 7 m grid for every 33 cm to a depth of 1 m or 3 m. In addition - for approximately half of the positions - samples were taken at a distance of 1, 2 or 3 m from the original sample. The classifications for the original samples were compared to the classifications for the additional samples in the same Decision Unit (7 x 7 x 0.33 m box) and from duplicate original samples. The results show that at least 50 % of all samples were misclassified, 20 % were misclassified by two or more classes. This study demonstrates that the risk of misclassification is highest for less mobile parameters, metals and PAHs compared to the volatile organic solvents.

### ORCID iDs

Bo Svensmark: <https://orcid.org/0000-0003-0430-6181>

Peter Mortensen: <https://orcid.org/0000-0002-7290-8080>

Nemanja Milosevic: <https://orcid.org/0000-0001-7226-1910>

Jan. H. Christensen: <https://orcid.org/0000-0003-1414-1886>

### References

1. B. Svensmark, P. Mortensen, Nemanja Milosevic and Jan H. Christensen, *The “Gandalf” soil sampling project at a former industrial site in Copenhagen, Denmark: evaluating soil classification reliability*, SpectroscopyEurope. 33, 37-47 (2021). <https://doi.org/10.1255/sew.2021.a29>