Interreg North-West Europe RAWFILL

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I1.2.1 Deliverable – Survey Design Report (Meerhout)

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SUBJECT:	…						
☒	report	☐	information	☐	consideration	☐	decision
To:	…			From:	ULiege and BGS		

D I2.2.1 Pilot site 1 – Meerhout landfill

Introduction

This report describes the geophysical survey design of the 2 investigations carried out in the Meerhout landfill, Belgium. It is based upon the outcome of the SWOT analysis of geophysical methods for LF characterization (T1.3.1: Swot analysis of LF characterization methods), the prior information gathered and conclusions from desk studies about the site (see DI1.1.2 Remote imaging report). The survey was prepared in close cooperation with the members of OVAM. As an outcome, a safety and environmental plan will also be provided (report I1.1.4).

The first geophysical survey in Meerhout was planned to take place from January 15-18, 2018. After data processing and the sampling survey, a second geophysical investigation was planned from January 29-31, 2019. Adjustments of the survey design presented here might occur during the site investigations according to unexpected site conditions.

1. First geophysical survey

1.1 Survey coverage

Within the first geophysical survey, we plan to focus the investigation on the North-eastern corner of the site. This will include parts of zone 1, 2, and 3 and cover an area of approximately 10881 m^2 (Fig. 1, yellow area). We decided to start the investigations on this part of the LF firstly, because no high vegetation is present what makes the area easily accessible for detailed mapping with magnetics and EM. Secondly, zone 1 has no covering membrane what allows us to test ERT and IP measurements. In addition, it is expected that zone 2 and 3 contain more industrial waste than zone 1. It is therefore interesting to investigate how good we can characterize these differences.

In the second area in the southern part of the LF, less dense surveying is planned (Fig. 1, blue area 2). This area covers zones 4 and 5, where the thickness of the LF is expected to be double (20m) in comparison to the North-eastern corner (4m and 10m). Also a HDPE covering membrane and possibly intermediate layering is present in this part. Comparing the performance of seismic methods as well as EM and magnetics on this and the North-eastern area might therefore be interesting.

In the following, the survey design of each geophysical method is described. Since it is difficult to estimate the required survey time, possibilities to extend or densify the survey are considered and the number of profiles are not yet fixed.

1.2 Geophysical methods

The following geophysical methods will be tested (for method suitability description see T1.3.1 SWOT analysis, for description of the geophysical method see I1.2.1 Attachment):

- Magnetometry
- Electromagnetic survey (EM)
- Ground Penetrating Radar (GPR)
- Electrical methods (ERT, IP)
- Seismic methods (MASW, SRT, H/V)

Figure 1: Planned extent of the first geophysical survey at Meerhout. Denser geophysical investigations are planned in area 1 (yellow) than in area 2 (blue).

Magnetometry

We plan to cover the two investigation areas with a grid of 4 m spaced and at least five perpendicular lines (Figs. 2 & 3, grey lines).

For the positioning, a GPS will be attached to the MagMapper device. In order to ensure consistent coverage and positioning with respect to the other surveying methods, tape measures will be used and start-, centre- and endpoints will be marked.

System planned to be used: MagMapper with GPS positioning (no RTK).

Possible extension: Increase amount of perpendicular lines.

EM surveying

The EM survey will be conducted on the same grids as the magnetic survey. The measurements will be done with two antennas. This allows us to reach investigation depths of 1.2 m and 3.0 m (2 m antenna) and 2.5 m and 6 m (4 m antenna). Both, quadrature (apparent conductivity) and in-phase (related to apparent magnetic susceptibility) are recorded simultaneously.

System planned to be used: DUALEM-2/-4 with GPS positioning (no RTK) and mounted onto a cart (the 2m and 4m antennas can't be used simultaneously)

Possible extension: Increase amount of perpendicular lines.

GPR surveying

GPR surveying should help to detect if zone 2 has a covering membrane. To do this, zone 1, 2, and 3 will be traversed with three profiles.

System planned to be used: Mala/PulsEkko 250MHz or 100MHz mounted onto a cart

ERT/IP surveying

At least two ERT/IP profile lines will be measured on zone 1 where no covering membrane is present. The profiles are planned to be parallel at a distance of 10m and have lengths of 63m and 95m (Fig. 2, blue lines). The position of these profiles might be adjusted if large anomalies are seen on the EM and MAG measurements. On zone 1, the maximum waste thickness is about 4m. Therefore, a small electrode spacing of 1m is required to reach enough resolution within the waste layer.
If the GPR survey indicates that no covering membrane is present on zones 2 and 3, at least two more ERT profiles will be measured in line with the seismic profiles. The spacing of 1m will be maintained for these profiles.
All measurements will be done with a predefined dipole-dipole array. This allows us to achieve a good lateral resolution. Reciprocal measurements are added for quality control.

System planned to be used: SuperSting R8/IP with switch box allowing attaching max. 128 electrodes

Possible extension: Measure additional interjacent and perpendicular ERT lines.

Seismic surveying

We plan to measure at least three seismic profile lines on the North-Eastern area and one profile on the Southern area (Figs. 2 & 3, yellow dashed lines). For the profiles on zones 2-5, where the waste has a thickness of 10m and 20m, a geophone spacing of 2m is sufficient to obtain enough resolution. This results in a one-spread profile length of 94m. Due to the reduced waste thickness of 4m in zone 1, only a spacing of 1m will be used, resulting in a profile length of 47m. All data will be recorded with vertical geophones. By recording data at densely spaced shot locations the S-Wave velocities can be derived from the MASW data.
In addition, we plan to test a passive source seismic method, the horizontal to vertical noise spectral ratio (H/V or HVNSR). We aim to test its ability to estimate the thickness of the waste and we plan to deploy a seismic station along the same line than the MASW profiles but every 10 m. This allows us to correlate the waste thickness with the MASW, SRT and ERT/IP.

System planned to be used: ABEM with 48 geophones (hiring of a land streamer is in discussion to increase coverage) and a 3D Lennartz seismic station LE-3Dlite MkIII with an eigenperiod of 1 s.

Possible extension: Further extend the measured profile lines.

Positioning

Differential GPS with real time kinetic (RTK) corrections will be used to ensure precise positioning to provide coordinates for later ground-truthing and sampling.
All electrodes and geophones will be surveyed. Additionally, also edges and intermediate points of the EM/MAG-grid will be surveyed in order to correct for the lower precision of the uncorrected GPS devices.

System planned to be used: differential GPS with RTK corrections

- Timing and staff

The survey will involve six people.

Planned time schedule:
Day 1:

- grid layout (area 1 and 2): 6 persons
- EM/MAG mapping and GPR surveying (area 1, northern part): 3 persons
- measuring one seismic profile (area 2): 3 persons

Day 2:

- EM and MAG mapping (southern part area 1 and area 2): 2 persons
- measuring two ERT profiles (area 1, zone 1) and two seismic profiles (area 1, zones 1 and 2): 4 persons

Day 3:

- measuring one seismic profile (area 1, zone 3): 4 persons
- measuring the seismic hvsnr positions (areas 1 and 2): 2 persons
- possible extensions (4 persons):
  - If no covering membrane is present in zones 2 and 3: two additional ERT profiles at the position of the seismic profile and one profile perpendicular could be measured.
  - If enough time: seismic profiles will be extended with a second spread

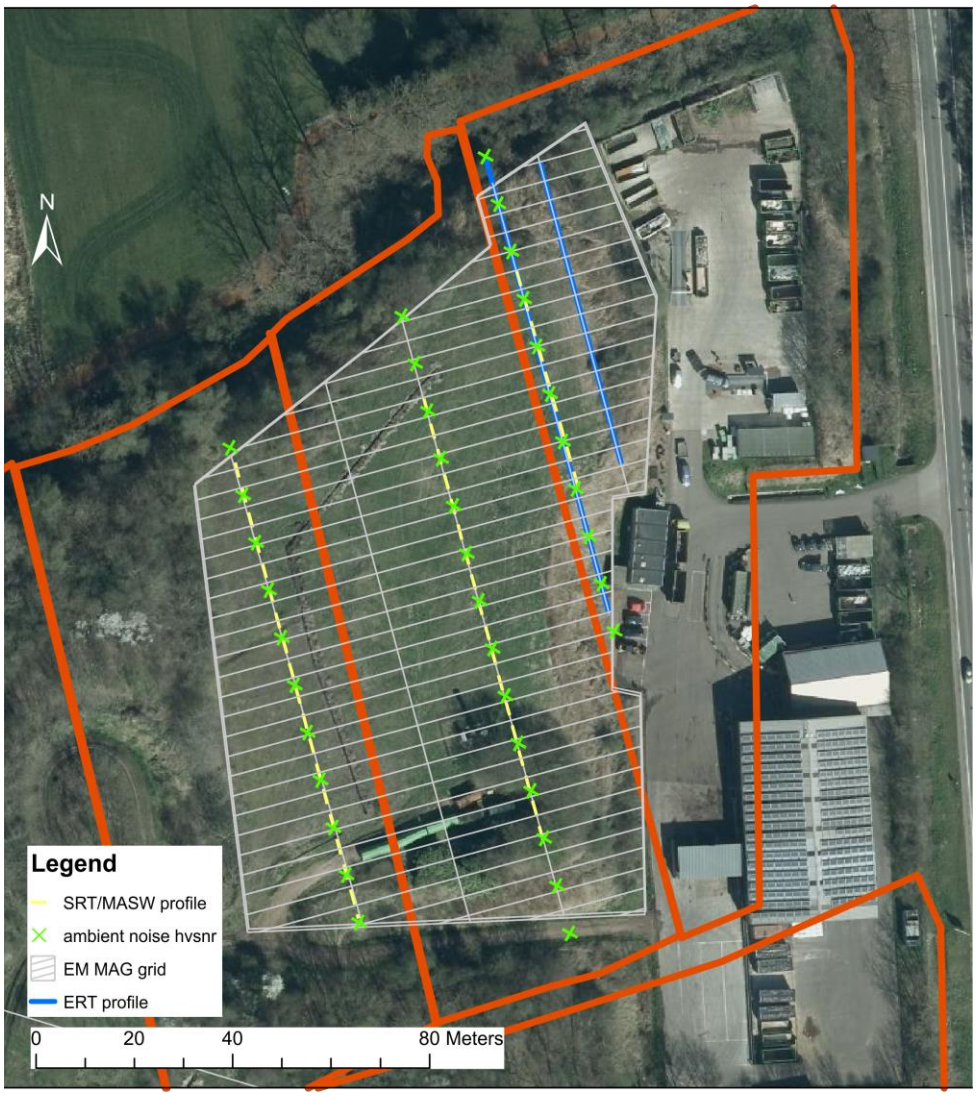

Figure 2: Planned measurement layout on investigation area 1

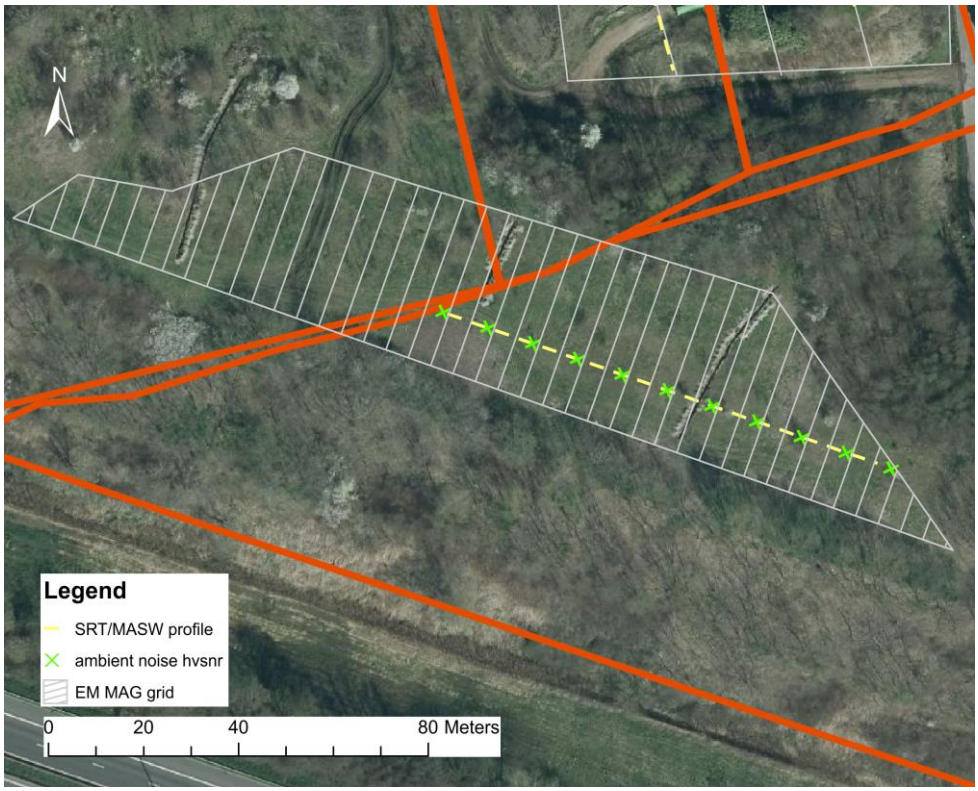

Figure 3: Planned measurement layout on investigation area 2.

2. Second geophysical survey

2.1 Survey coverage

After the analysis of the sampling results, we planned the second geophysical survey in the lower zone of the landfill, mainly because of the large amount of boreholes in the area and the excavated trench as well as the large variabilities in the ERT and IP data. This second survey will be done previously to the excavation of the trench.

2.2 Geophysical methods

The following geophysical methods will be applied (for method suitability description see T1.3.1 SWOT analysis):

- Electromagnetic survey (EM)
- Ground Penetrating Radar (GPR)
- Electrical methods (ERT, IP)

EM surveying

The EM survey will be conducted first on a coarse grid using the 2 m antenna and it will cover nearly all the lower zone of the landfill. Secondly, a fine grid will be acquired using the 2 and 4 m antennas and will be set in an area where a large contrast in conductivity was found previously. Furthermore, this fine grid overlaps with two boreholes and a large length of the excavated trench (see Fig. 4).
The investigation depths for the 2 m antenna are 1.2 m and 3.0 m and 2.5 m and 6 m for the 4 m antenna. Both, quadrature (apparent conductivity) and in-phase (related to apparent magnetic susceptibility) are recorded simultaneously.

System planned to be used: DUALEM-2/-4 with GPS positioning (no RTK) and mounted onto a cart.

GPR acquisition

To further investigate the thickness and integrity of the cover layer we plan to use the GPS on several lines northwest- southeast oriented forming a fine grid (see Fig. 5). This grid will be overlapping with all the boreholes and will cross the entire length of the excavated trench.

System planned to be used: Mala/PulsEkko 250MHz or 100MHz mounted onto a cart

ERT/IP surveying

First, we plan to deploy a high-resolution ERT/IP profile along the trench (prior excavation). For this purpose, we shall use 111 electrodes with a spacing of 0.75 m using a dipole-dipole array. Afterwards, we plan to acquire a 3D ERT grid co-located with the fine EM grid, by deploying 8 parallel lines with 32 electrodes and a spacing of 0.75 m for each line (see Fig. 4).

System planned to be used: Resistivity Meter ABEM Terrameter LS.

Figure 4: Planned geophysical survey. The EM acquisition is formed by a fine and coarse grid displayed in pink and blue respectively. The green grid represents the location of the 3D ERT acquisition. Yellow dots represent the boreholes and the blue line the planned trench (and the high-resolution ERT/IP profile).

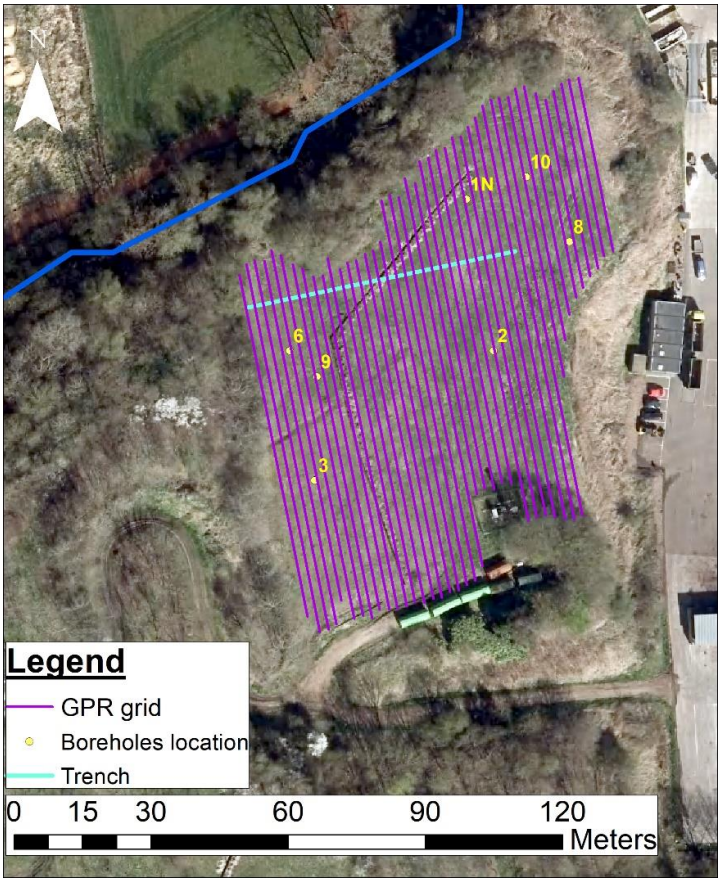

Figure 5: GPR acquisition grid.

Contact

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