Site-investigation and landfill characterisation by airborne geophysics

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Why landfills?

**Potential sources of pollution**
- migration pathways in the subsurface
- source-pathway-receptor model

**Methane emissions and climate change**
- Landfills are main contributor (40%) to UK methane release
- Methane is 21 times more powerful than CO₂ as a greenhouse gas
- They are a significant factor in UK reduced emission targets
Outline

Principally considering subsurface electrical conductivity
- It’s a ‘new information’ data set
- Ignoring main geological discoveries (regional scale)
- Concentrating on environmental information at scale of ~1 to 3 km
- Simple mapping information and subsurface volumetric information

From geophysical perspective (without technical site-information)
- 1 active quarry
- 1 sewage works
- 5 landfills
subsurface electrical conductivity depends on:

**Geology (solid component)**
- porosity (i.e. void space)
- mineralogical associations (e.g. clays)

**Pore water geochemistry**
- ionic concentration & mobility
  - (e.g. Na⁺, SO₄²⁻, Cl⁻, K⁺, and NO₃⁻ groups)
- No geochemical discrimination…
- it measures only Total Dissolved Solids
Flight direction:

**Bulk conductivity sampled every ~15m along line**

Subsurface volume that contributes to measurement of bulk conductivity
- conductivity > 25 mS/m in black
- conductivity > 50 mS/m in red
- cut at coast
Conductivities > 5 mS/m

Yellow = deepest

Study area 2x2 km
Target sewage works (north of Killeter)
Demonstrating low amplitude conductivity mapping (1 to 5)

Study area
3x3 km

Apparent conductivity (mS/m) 1 to 5 mS/m 3x3 km
Sewage works (symbol) in centre

Apparent conductivity (mS/m) 1 to 5 mS/m 3x3 km
Sewage works (symbol) in centre

deeper

shallowер

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Study area
2x2 km

Demonstrating landfill anomaly confined to ~1 flight line

Conductivity > 2 mS/m

Magnetic field
Strabane : Refuse tip adjacent to river Finn/border

Strabane : concrete works
Demonstrating landfill anomaly with extensive plume

Study area
3x3 km
Study area
4x4 km

Demonstrating more extensive landfill anomaly with high conductivity

conductivity

Power-line monitor

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Demonstrating volumetric subsurface (to 40 m) information

LF44 1 x 1 x 0.04 km
Conductivity isovolumes
Demonstrating the 3D conductivity distribution beneath the site

Study area
1x1 km

> 80 mS/m
Demonstrating subsurface conductivities > 55 mS/m (to 30 m)
Study area
3x2 km

Craigahullier landfill, operating since 1998, occupying a former quarry
Demonstrating an engineered landfill in a complex setting

Study area

3x2 km

Largest landfill conductivities encountered (young reactive site)

3D perspective view of conductivity
Detail. Largest amplitude response (pink contours) and line of cross-section

2 km conductivity cross-section across landfill
Demonstrating regional scale of saline intrusion and likely geological control.

Study area
7x7 km
Hightown/Belfast Hills Landfill

Study area
1.5x1.5 km

Conceptual hydrogeological flow model
(Site Conditioning Plan Report/Site Permit,
White Young Green for Macwill Services Ltd)
Demonstrating conductivity mapping at shallowest frequency

Belfast Hills Landfill
1.5 x 1.5 km looking north-east

AEM shallow apparent conductivity (25kHz)
200m flight line sampling (dots)

Conductivities > 20 mS/m
5 cell construction in red
Demonstrating conductivity iso-surface > 55 mS/m, slices to 80 m depth
To a degree I’ve have been showing you the data with a view to addressing the environmental question:

- What’s in my back-yard? Or more correctly….
- What’s under my back-yard?
- …..that can be a sensitive question

- From a safe perspective, it may be best to treat the airborne data (at the site-scale) as ‘pathfinder’ information
- It is ‘new’ information and takes time/effort to digest
- The data, inevitably, tend to pose questions that require further understanding and follow-up studies