Locating and Defining the Extents of Landfill

Southern Geophysical

New Zealand has a complex history of waste disposal to landfill, with many landfills located near eroding riverbanks or within urban developments and of unknown sizes and extents. With this in mind, Southern Geophysical Limited (SGL) provides a multi-faceted approach to landfill surveying to satisfy the needs of councils, environmental scientists and the local Iwi.

Which survey method suits your needs? We have some suggestions below, or follow our flow chart on page 3.

If an area of interest has historical information indicating landfill activity but the exact area is unknown, we recommend locating the landfill by utilising broad survey techniques which can be completed quickly and in a cost-effective manner, typically within a single day. We utilise Ground Penetrating Radar (GPR) and Conductivity Surveying (EM31) as they can detect buried objects in the subsurface and identify the extents of landfill material for additional surveying, if required.

If the location of a landfill is known, but the extents of the landfill remain unknown or poorly defined, we recommend capturing a grid of survey lines over the landfill area, allowing the extents to be accurately mapped. The survey would include a grid of Ground Penetrating Radar (GPR) and Hypersensitive Metal Detection (EM61) lines over the landfill site, identifying landfill material and ferrous metal objects in the subsurface. A small township's landfill can typically be surveyed in a single day**. If the vertical extents of the landfill deposits also need to be understood**, we recommend adding Electrical Resistivity Tomography (ERT) or Seismic Refraction to the survey. These methods collect 2D transects through the survey area, enabling the base of the landfill to be imaged and vertical extents to be determined.

We provide the following survey techniques:

- Ground Penetrating Radar (GPR)
- Ground Conductivity (EM31)
- Hypersensitive Metal Detection (EM61)
- Electrical Resistivity Tomography (ERT)
- Seismic Reflection or Refraction
- Multi-channel Analysis of Surface Waves (MASW)

Questions we may ask prior to surveying:

What material were placed in the landfill? Knowing the type of materials present in the landfill may change the survey techniques most appropriate for the site. We often encounter saw dust and offal pits, buried metal drums or vehicles, or general domestic/farm waste.

Are there any records which can narrow down the survey area, or perhaps a local farmer who remembers some key information? Having a refined starting point can reduce the time and cost of a survey.

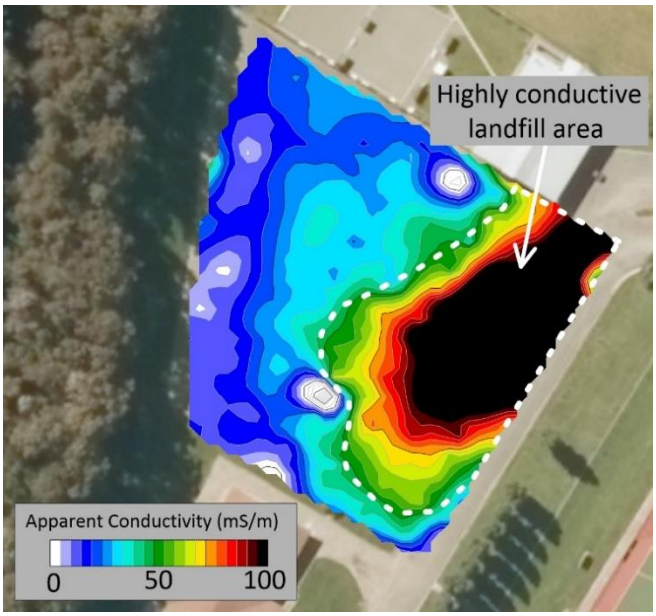
What do you plan to do with the information we gather? Knowing your end goal can help us tailor a survey to your needs, and answer key questions which may be overlooked otherwise. It also allows our maps to be seamlessly integrated into client models and GIS.

Brief overview of the survey types:

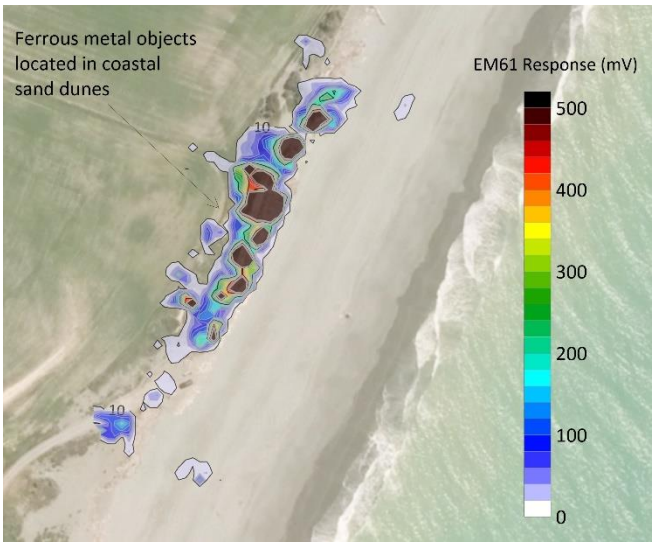
Seismic P-S wave Reflection and Refraction surveying can be used to identify the vertical extents of a landfill. The survey works by transmitting acoustic impulses into the ground, when they encounter significant changes in the subsurface, such as landfill deposits or sedimentary structures, some of the impulses are reflected/refracted back to the surface. The intensity and arrival time of the returning impulses are captured by an array of geophones, and the data is combined to produce a 2D cross section.

Left - Ground Penetrating Radar (GPR) is a staple of landfill investigations. GPR has the highest resolution of all the geophysical survey methods and kilometers of radar lines can be captured in a day. A grid of GPR lines can identify the extents of most landfills by locating objects in the subsurface, or alteration of the natural sedimentary layers.

Right - Ground Conductivity (EM31) surveying is a quick and cost-effective way of locating a landfill by identifying conductivity changes in the subsurface, down to a depth of six metres. The system also runs as a broad metal detector which is particularly useful when ferrous metals are known to have been buried. A grid of survey lines can delineate the extents of many types of landfills as the conductivity of landfill materials and leachate can differ significantly from that of the surrounding natural ground.

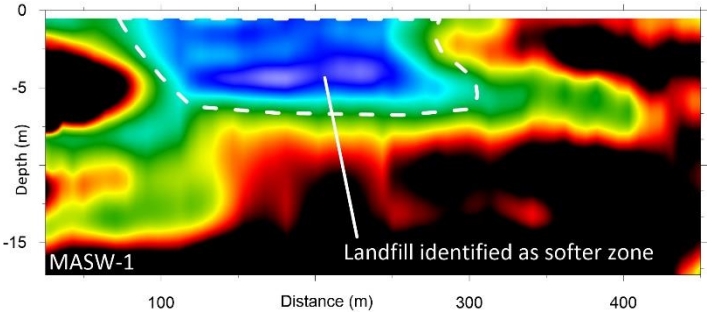


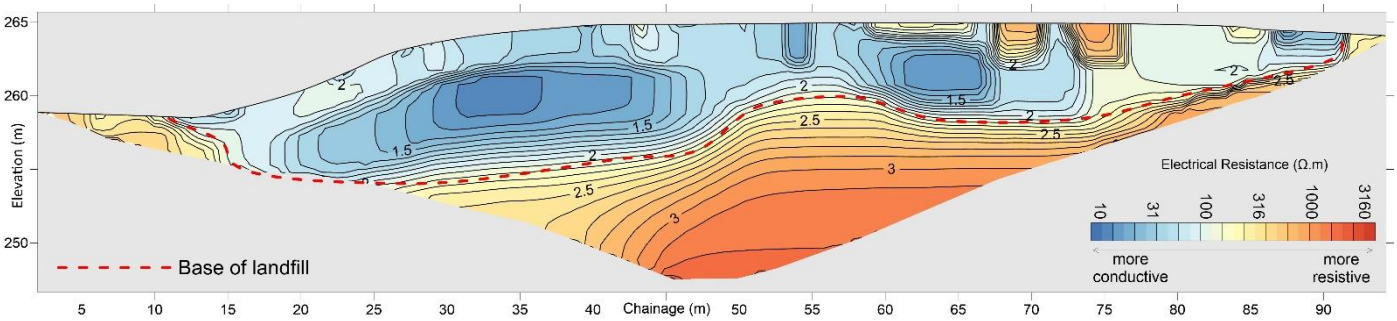
Below - A GPS synced hypersensitive metal detector (EM61) can be extremely useful in clearly defining the extents of ferrous metal landfill materials when they are within the upper two metres of the subsurface. With the position of the unit captured in real time, surveying is not only quick but extremely accurate.



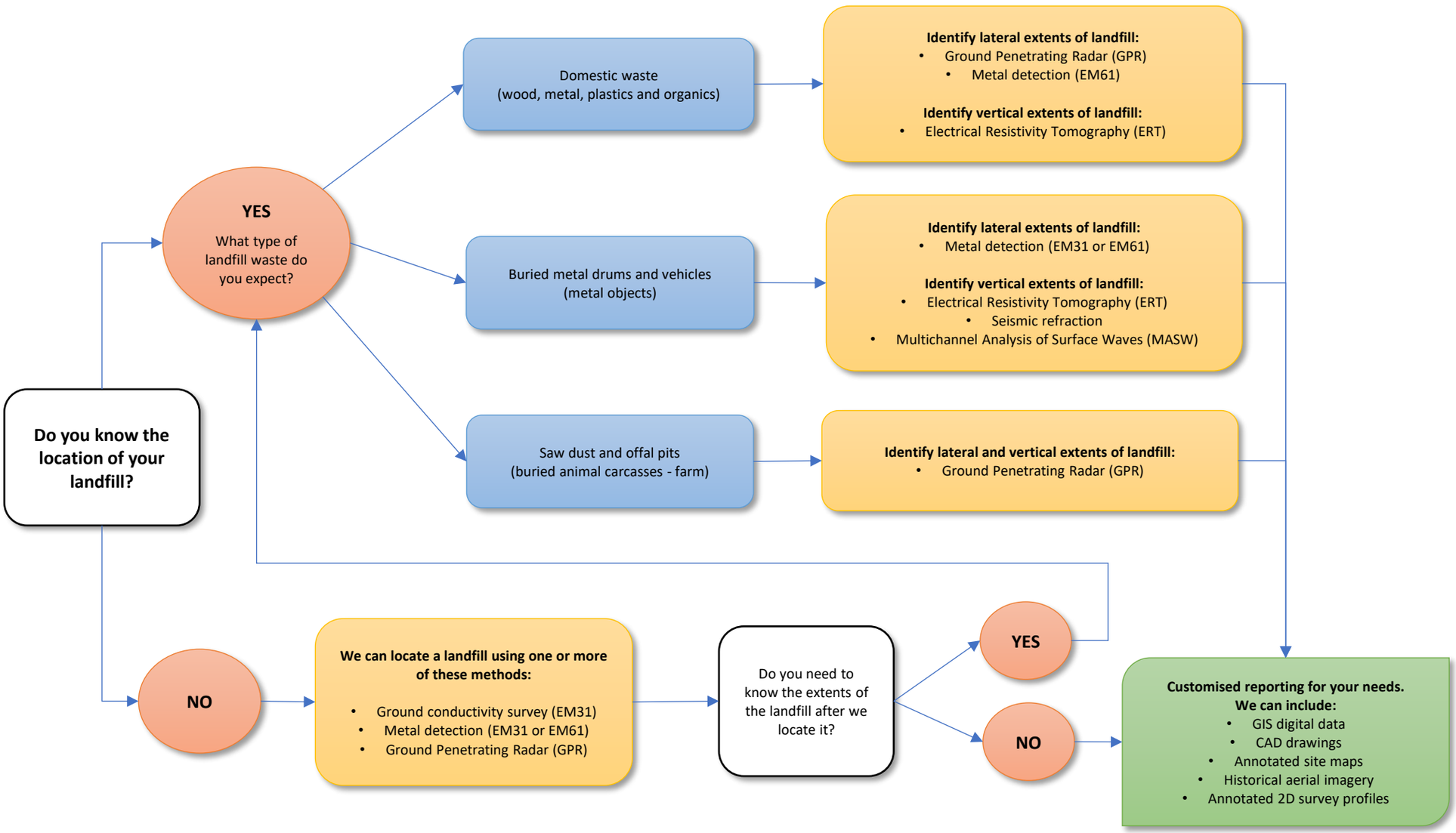
Below - Multi-channel Analysis of Surface Waves (MASW) can also be used to identify the vertical extents of a landfill. However, MASW only works in well consolidated landfill materials. MASW works by dropping or accelerating a heavy weight onto the ground surface, generating surface waves. The surface waves propagate outwards from the source, towards a string of geophones on the ground surface and the frequency and velocity of the waves can be used to develop a shear wave velocity model of the subsurface. The shear wave velocities directly correlate to stiffness of the ground and the stiffness of landfill material typically differs significantly from that of natural ground. MASW results can also be used for seismic site classification or liquefaction analysis.

Below - Electrical Resistivity Tomography (ERT) can identify the vertical extents of a landfill by identifying differences in the electrical properties of the ground. Landfill deposits typically give chaotic results, with a mix of highly resistive and highly conductive materials. We typically run an ERT survey as two to four perpendicular lines, depending on the size of the site.





Landfill Investigation Flow Chart



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