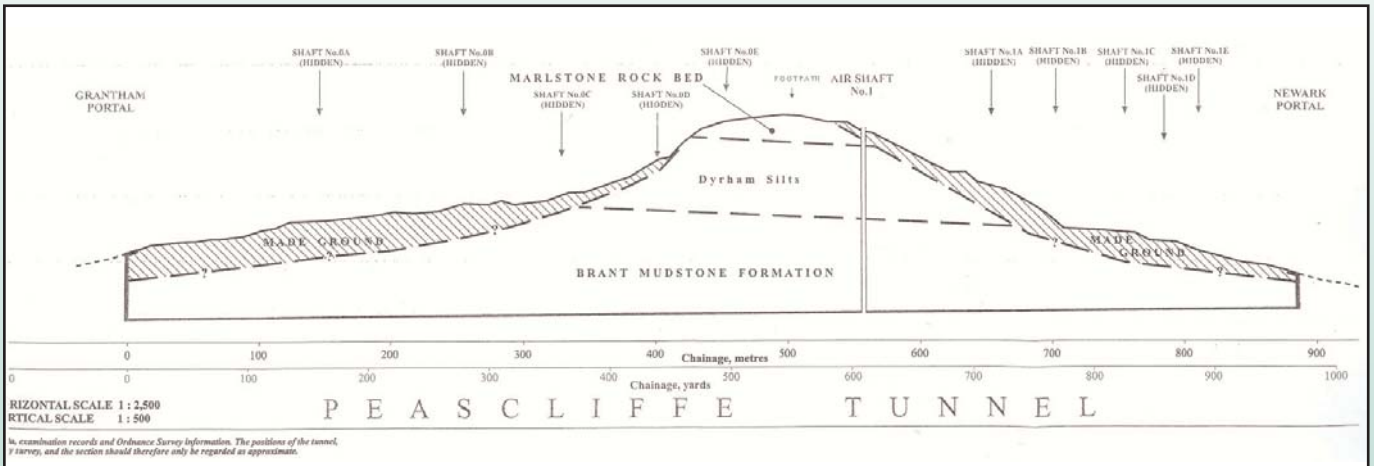


It is an unfortunate fact that historical records of 19th and early 20th century construction work are invariably inaccurate or incomplete. A prime example of this is apparent within the rail industry with regards to the presence/position of 'blind' (construction) shafts.

Presented below is a typical historical plan of a 19th century railway tunnel which infers but does not clarify the presence of several blind shafts.



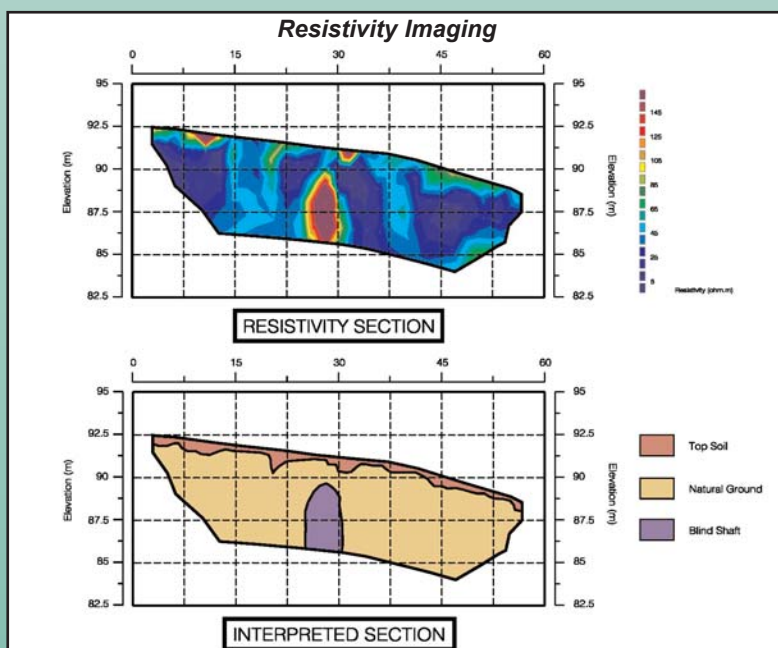
In recent years FES Ltd have conducted a number of geophysical surveys to identify, locate and investigate the presence of construction or blind shafts in Network Rail tunnels.

FES Ltd can offer a variety of investigative approaches to address this problem, working either above or within the tunnel.

ABOVE TUNNEL

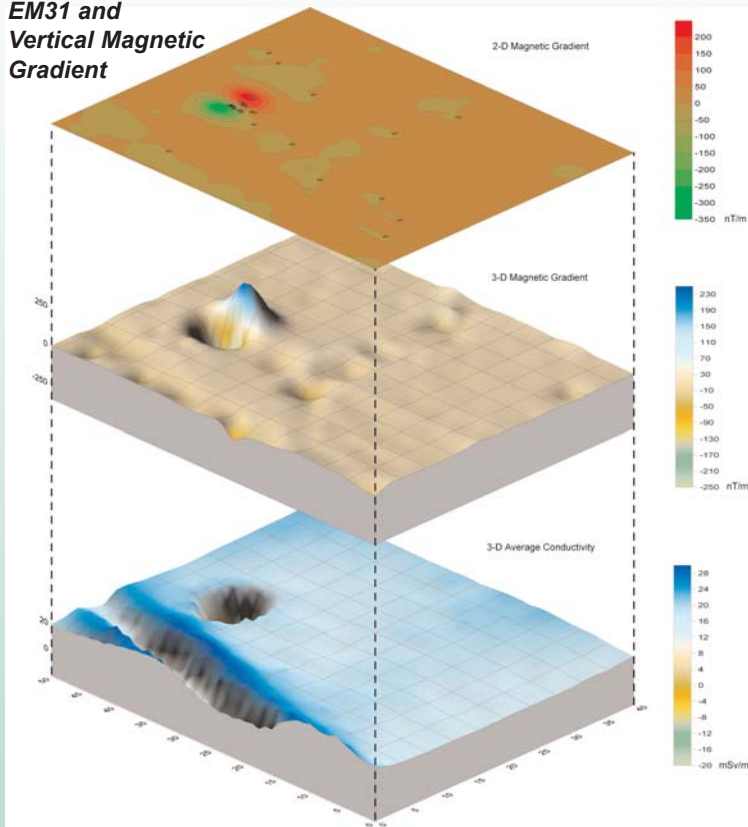
In many cases, it is advantageous to investigate for the presence of blind shafts from the ground surface directly above the tunnel.

- Access to such areas is often less problematic and therefore surveys may be completed quickly, efficiently and subsequently, cost-effectively.
- A wide range of geophysical techniques have been employed to detect blind shafts, including resistivity imaging, vertical magnetic gradient, micro-gravity, ground probing radar (GPR) and electromagnetic conductivity.

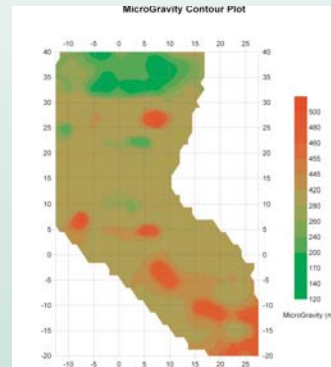


The example (left) shows a resistivity imaging survey line conducted over the location of a suspected shaft in SW Scotland. The contrast in resistivity values across the position of the shaft is clearly defined by the section.

EM31 and Vertical Magnetic Gradient



The data example (left) is taken from a combined magnetic and electromagnetic survey undertaken by FES to locate the position of a suspected shaft. Note the obvious discrete anomalous feature on the left of the survey area thought to relate to a concealed shaft. Also note the benefit of utilising complimentary geophysical techniques to increase the confidence of interpretations.



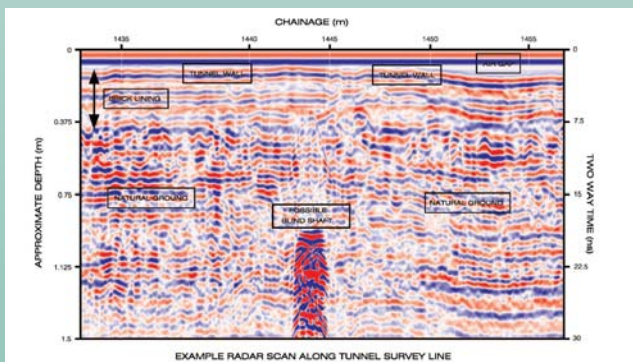
Micro gravity was used to investigate the position of a shaft in Scotland. In this case very little information about the suspected position of the shaft was available prior to site works.

The geophysical survey highlighted a number of areas that allowed for a more efficient, focused complementary intrusive investigation. FES Ltd can offer a wide range of intrusive investigative techniques.

WITHIN THE TUNNEL

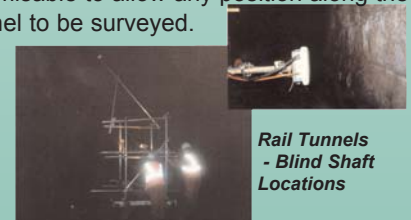
In some cases it is necessary to investigate for the presence of a shaft from within the tunnel itself. Whilst access and 'track' time is often limited, surveys from within the tunnel have the advantage of being largely unaffected by modern man-made structures (buildings, services, roads etc) and in many cases the tunnel lining has been undisturbed since construction.

The nature of such a site location limits the suitable geophysical techniques to just one - Ground Probing Radar.



Ground Probing Radar

FESL has designed and constructed its own purpose build survey frame (below) to facilitate GPR surveys of tunnels. The frame may be quickly assembled on site and is fully customisable to allow any position along the profile of the tunnel to be surveyed.



Rail Tunnels - Blind Shaft Locations

A typical radar section obtained from a tunnel survey is presented above. At the top of the plot is the tunnel wall surface. The thickness of the tunnel lining is also annotated. In the centre of the plot (approx. 1m behind the tunnel wall). We see a strong anomalous reflection relating to the presence of a blind shaft.

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