

## STRUCTURAL INVESTIGATIONS

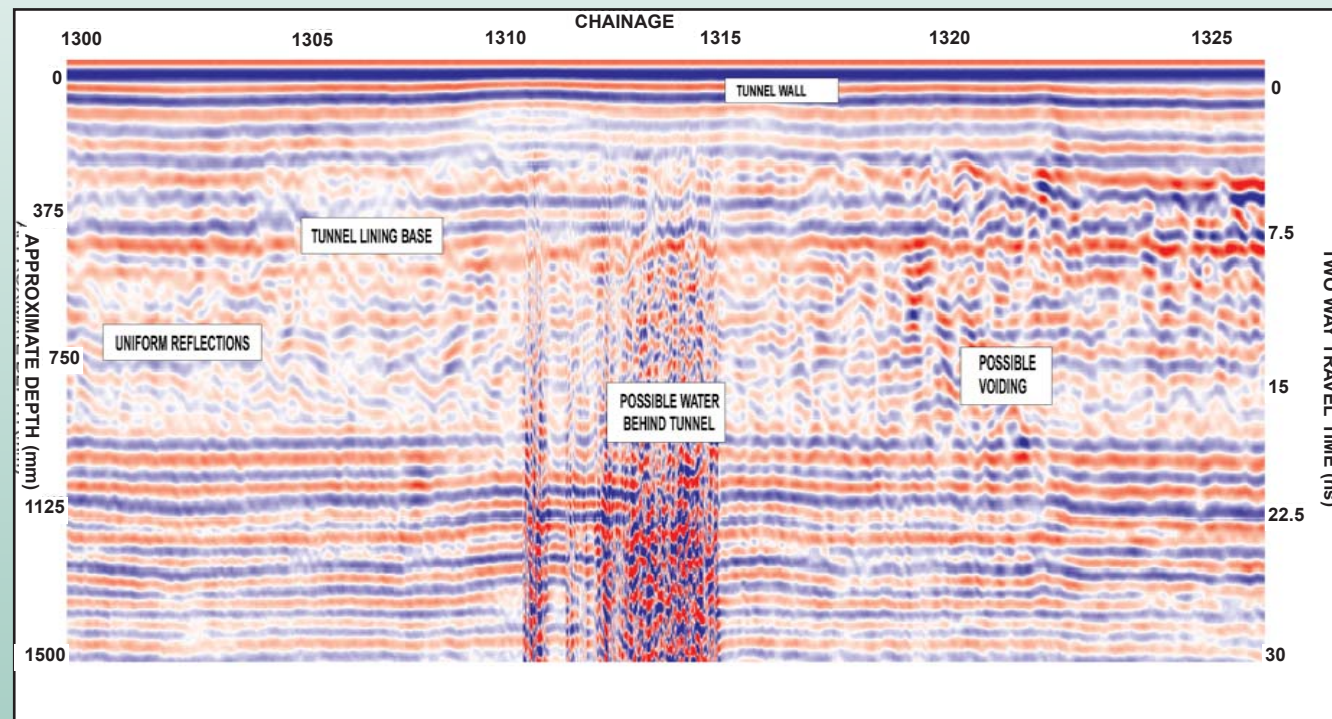
Ground Probing Radar is being used routinely as a cost effective non-destructive testing tool for structural investigations in railway environments.

This technique is ideally suited to the rail environment encompassing a diverse range of rail property and structures.

## STRUCTURAL APPLICATIONS

The scope of investigations which are most relevant include:

- Retaining wall construction
- Bridge structure determination
- Concrete slab investigations
- Sub slab voiding
- Reinforcement Distribution
- Location of voids and wash out within walls
- Location of underground services and obstructions.



Example (Above) shows a GPR survey undertaken to investigate voids behind a bricklined tunnel.

A purpose built mobile frame was constructed to allow survey coverage through 360°.

## OTHER FUGRO SERVICES APPLICABLE TO RAIL INDUSTRY

NON-INTRUSIVE	INTRUSIVE
MICROGRAVITY	CONE PENETRATION TESTING
SEISMIC REFRACTION	BALLAST SAMPLING
RADIODETECTION	BOREHOLES

## INTRODUCTION

The majority of ground investigations for railway projects have to be carried out during track possessions at night or over the weekend. The duration of these possessions is often limited, which dictates that the maximum amount of information needs to be obtained within a fixed period of time.

Fugro offer a range of geophysical services which due to their rapid speed of operation are ideally suited to the railway environment. Very often these geophysical techniques compliment our geotechnical services and can be combined into a comprehensive track/ground investigation.

All Fugro's personnel are fully PTS trained with extensive experience of working in the railway environment.

## GEOPHYSICAL METHODS AND APPLICATIONS

- GROUND PROBING RADAR
  - Base Ballast Profiling
  - Ballast/Sub Ballast Assessment
  - Subsidence
  - Mine Workings
  - Structural Assessments
- RESISTIVITY IMAGING
  - Deep Mine Workings, Faults
  - Subsidence
  - Sub Ballast Geology
- MICROGRAVITY
  - Mine Workings,
  - Voids

## GROUND PROBING RADAR

## BALLAST ASSESSMENT

Mounted on a flatbed trolley our Ground Probing Radar equipment can be easily propelled along the tracks and provide a platform for rapid and continuous surveying at speeds up to 3km/hr. This platform allows us to survey Cess, 4Ft and 6Ft areas.

Incorporating GPS allows accurate positioning. The ground probing radar can be used to prove ballast thickness and detect changes in ballast conditions such as areas of clay pumping or ponded water and identify areas which require intrusive investigations.



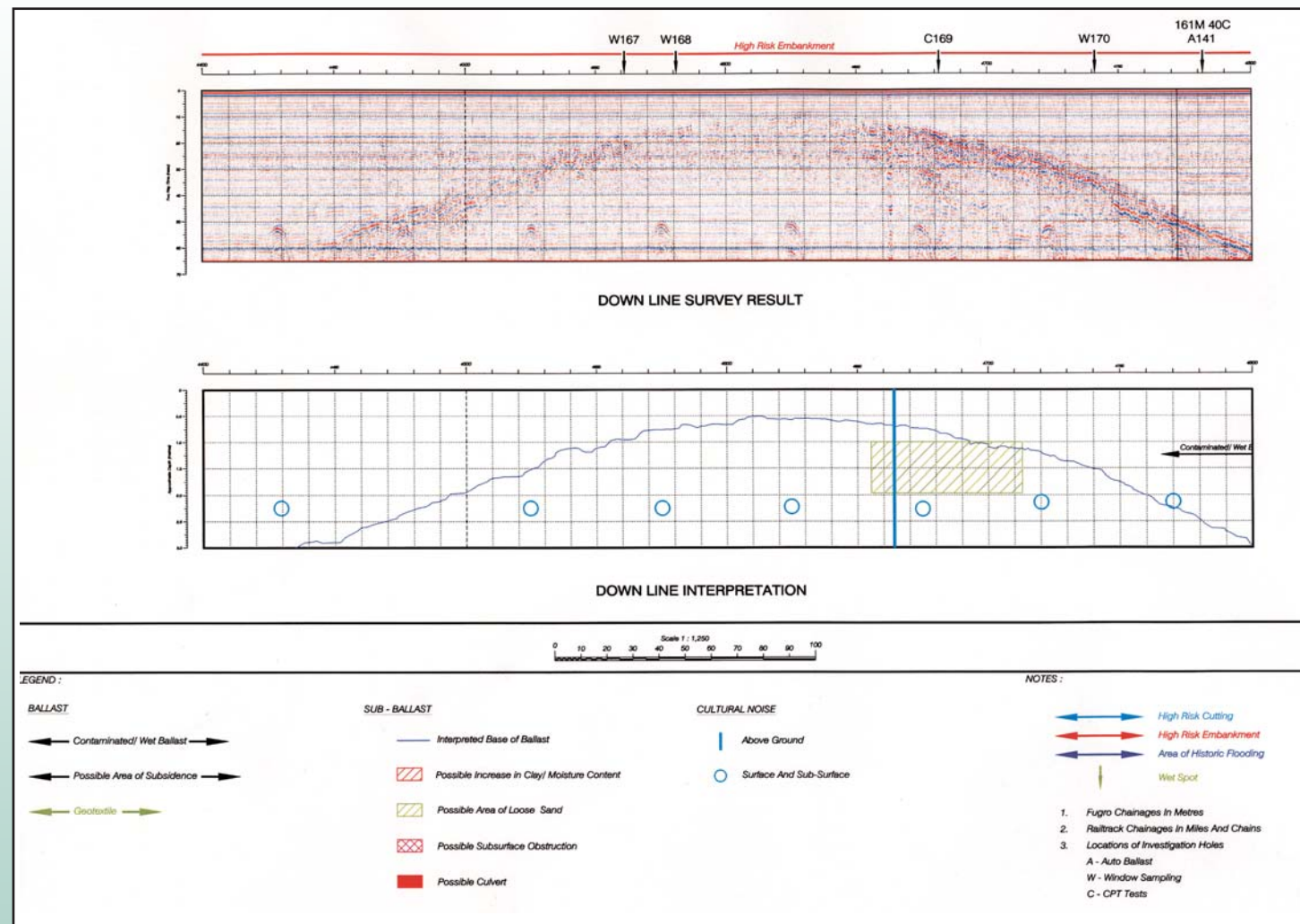
### Fugro Engineering Services Limited

Fugro House  
Hithercroft Road  
Wallingford  
Oxfordshire OX10 9RB  
Tel: +44 870 4021 400  
Fax: +44 870 4021 499  
Email: wallingford@fes.co.uk

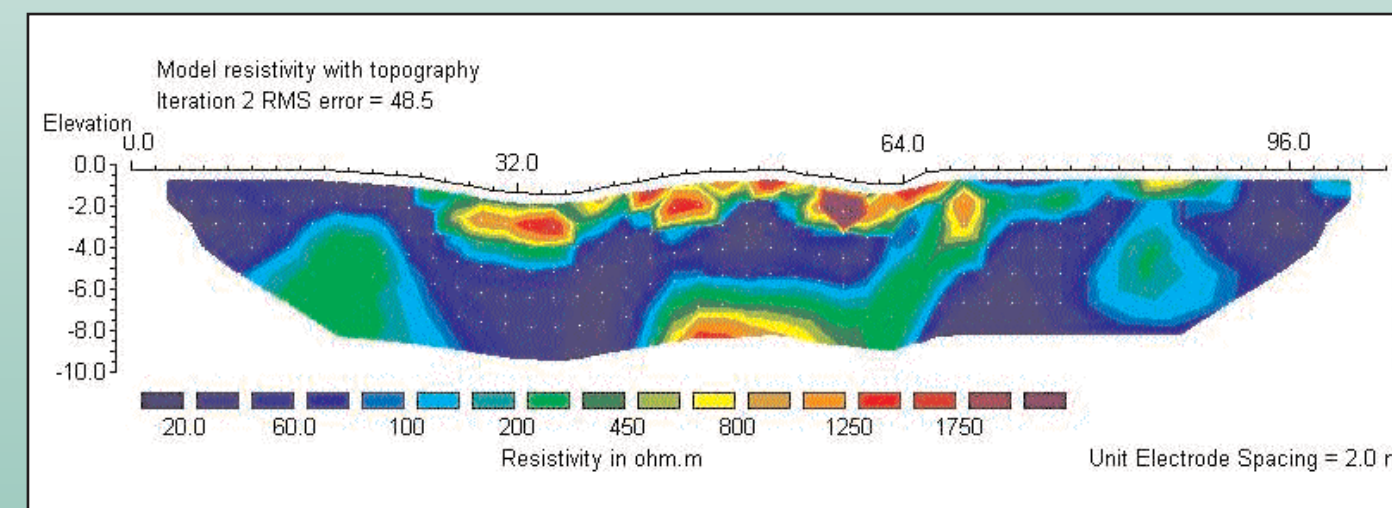
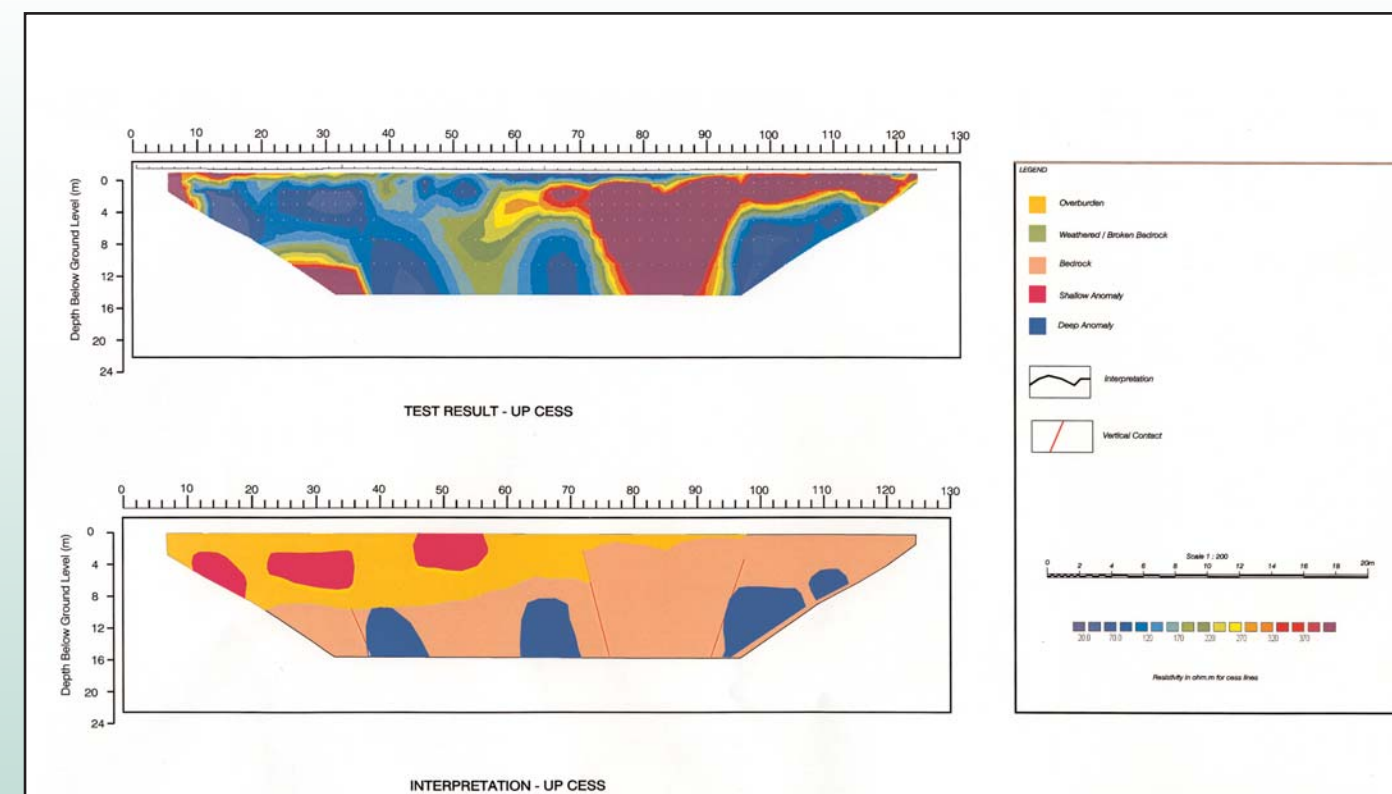
Armstrong House, Unit 43  
Number One Industrial Estate  
Medomsley Road, Consett  
Co. Durham DH8 6TW  
Tel: +44 1207 581120  
Fax: +44 1207 581609  
Email: consett@fes.co.uk



# Typical Ground Probing Radar Investigation on Network Rail Site



# Typical Resistivity Imaging Survey on Network Rail Site



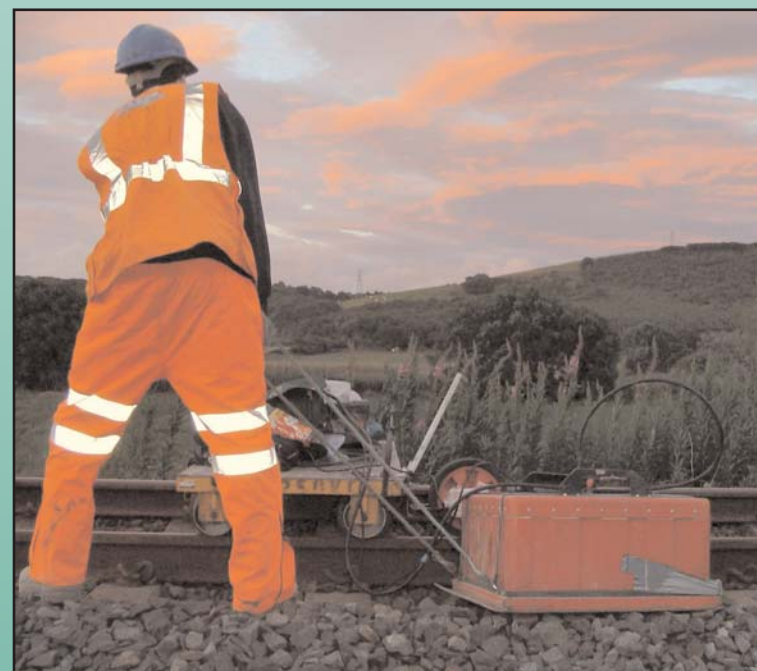
## RAILTRACK INVESTIGATION

In 2002 Fugro was commissioned to undertake a ground investigation along a stretch of railtrack in NW England.

A suite of geophysical and intrusive techniques were utilised in order to provide the client with an accurate understanding of the ballast and sub-track formations.

The example plate (Above) shows a typical GPR interpretation.

The survey shows a large increase in ballast thickness along the survey line, indicative of long term track subsidence.



## RESISTIVITY SURVEYING

Resistivity surveying involves measurement of variations in the apparent electrical resistivity of the subsurface.

Combinations of electrodes are selected in turn from a linear array of a large number of electrodes, allowing a vertical apparent resistivity cross-section of the subsurface to be constructed.

This cross section can be used to establish the subsurface profile and locate areas of subsidence.

Resistivity soundings can be used to measure apparent resistivity of the subsurface to assess the likelihood of underground corrosion to assist with proposed earthing systems.

## CASE STUDY

In 2001, Fugro was commissioned to carry out a ground investigation in SW Scotland.

Track subsidence had been recently reported.

The example (Top of page) shows the resistivity image and interpretation.

Resistivity may also be used to map out small-scale features. The example (Above) shows a resistivity imaging result over a length of railtrack thought to contain extensive animal burrowings.