
# 3D GPR - PIPES, CABLES, AND BURIED OBJECTS

**The underground infrastructure has become increasingly complex. In a small country like Denmark, there are approximately 750,000 kilometres of pipe and cable. In urban areas, it is often difficult to find space for new cables or dig sites without impacting existing cables.**

**Often pipes and cables are not laid entirely straight, and the local documentation is either inaccurate or non-existent.**

### How the GPR works

A Ground Penetrating Radar (GPR) system sends electromagnetic pulses into the substrata. Parts of the signal are reflected by layer boundaries or items with a different electric polarization. When the reflected signal is returned to the antenna, the amplitude and the time delay are registered. The layer boundaries appear in the registration as reflectors, and objects appear as hyperbolas. It is not possible to determine which material the signal has encountered, and thus interpretation must be done through comparison with existing knowledge.

### The newest technology

The newest developments in the field of GPR are multifrequency and multichannel 3D GPR.

A system can, for example, be comprised of 20 evenly distributed antennae, so that data is typically collected across a cell size of 7.5 cm square. Multifrequency means that one measures an entire frequency range, as opposed to only a single frequency. By transmitting multiple frequencies, one can map both the surface and objects further down in one go, something that would otherwise require repeated collections with difference frequencies.

The resulting data combines the subsurface recordings with the coordinates of the collection, thereby allowing the data to be transferred to GIS systems or CAD maps.

### Cables and pipes

3D GPR enables the mapping of most types of installations, including sewers, plumbing, foundations, drains, and power cables. It is usually also possible to locate telephone and fibreoptic cables, provided they are installed in pipes.

One limitation is dirt dense in clay or salt that inhibits the radio signal.

A detailed scanning is carried out at a low speed, at most 10km per hour. It is always advantageous to compare the collected data with already accessible details, through which it is often possible to differentiate different types of cables. At times, it is helpful to combine scanning with another method, typically an EM Cable Locator.

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**Technical data**

Typical penetration depth of 1-2 metres

Resolution of mapping normally 7,5 x 7,5 x 0,5 cm (x-y-z), accuracy typically 10 cm

**Strengths**

Highly detailed and cost-effective mapping

Georeferenced results in GIS or CAD format

Previously known cables and pipes can be overlaid

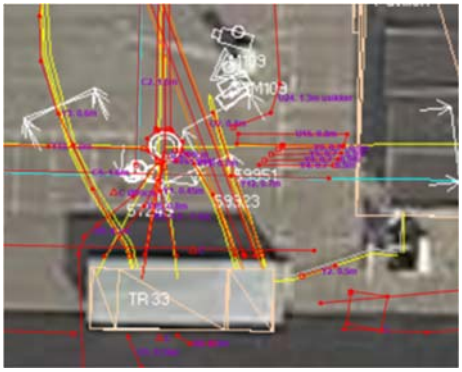
**Weaknesses**

Limited penetration through clay, and one can never assume to have found ALL cables

## EXAMPLES

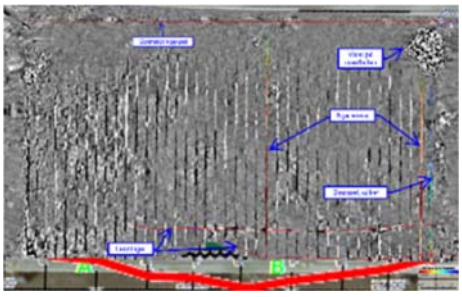
### Cables at the airport

Mapping of cables, pipes, and other installations in a 20,000m² area at Copenhagen Airport. Several hundred cables and pipes were located, down to a depth of 2.5 metres. The diagram below shows known cables coloured according to type, while cables found with GPR are shown as red lines.



### Anchors at the wharf

A GPR scan was commissioned following the collapse of a wharf. The aim was to map out possible fractures in anchorings caused by sudden faults. The picture below shows a scan of a wharf at a depth of 1.5m. Faults were found up to 80cm, and 10 possible breaks were located. Scanning is usually possible only above normal water level.



### Cavities behind tunnel walls

In order to locate an access point for a visual inspection of mountain walls, a mapping of cavities behind reinforced tunnel walls was done. An 8km double tunnel was mapped and suitable cavities were found.

### Cables in landing strip

Prior to milling the top layer of an airport runway, the depth of cables for the strip lights were mapped to avoid possible damage. The colours on the image below represent the depth below the surface of pipes with cables to landing lights.

### Foundations, etc.

Prior to excavation of a detention pool, a 5000m² area was mapped in order to locate possible buried objects. Five buried drills, seven foundations, and four previously unknown cables were found. The illustration below shows the outlines of possible foundations, wires, and drills.

### Conclusion

Rambøll uses a ground breaking radar technology to map underground cables and structures.

The use of Rambøll's 3D GPR system is a precise and cost-effective solution that helps to avoid damage to pipelines, cables, and other underground installations and structures.