

Quick Reference Guide

Service	Material	GPR (1)	Radio detection	CCTV	Sonde
Gas	metal	•	•		
	plastic	•	•		
	plastic with trace	•	•		
Water	metal	•	•		
	plastic	•	•		
	plastic with trace	•	•		
Electric	low voltage	•	•		
	high voltage	•	•2		
BT	copper cable	•	3		
	fibre optic	•	3		
Drainage	vcp	•		•	•
	concrete	•		•	•
	plastic	•		•	•
	cast iron	•	•	•	•
	pitch fibre	•		•	•
Gully Connections		•		•	•4

- 1) GPR does not identify the service
- 2) Not traceable if load is equally balanced
- 3) Illegal to lift BT covers
- 4) Only possible if access is available through the gully

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A practical guide to :

Underground Services Location

CCTV Drainage Surveys

The purpose of this guide is to explain in simple language the various methods of tracing and surveying underground services, at the same time indicating what is achievable.

Methods / equipment

CCTV

GPR

GPS

Radio detection

Total Station

Statutory Authority Services Search

These are complementary and all may be required to provide a comprehensive survey.

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Radio Detection

The purpose of electronic tracing is to locate, identify and trace buried services. Contrary to popular belief this is not like 'metal detecting'.

The site is first scanned for passive signals. These signals are called 'passive' because they already exist on buried cables and pipes and are there for us to detect. There are two types of passive signal either a power signal (50Hz or 60Hz) emitted by power cables or radio signal emitted by telephone cables.

Secondly an 'active' signal can be applied by a transmitter to a pipe or cable via a fire hydrant, stopcock, gas valve, etc. and then this unique signal is traced above ground using a receiver. The ground is then marked up with paint at about 5m centres or at changes in direction. The route is then surveyed-in.



Unique signal traced using Receiver

If only it was that simple - a number of circumstances, as listed below, can occur that will degrade the information.

- a. Fractured service
- b. Service comes into close contact with other services or rebar
- c. Electrical field from other services degrades signal

We hope to achieve an accuracy of $\pm 10\%$ of depth.

eg. Service 2m deep = positional accuracy $\pm 200\text{mm}$ / depth accuracy $\pm 200\text{mm}$



GPR (Ground Penetrating Radar)

GPR does NOT trace services, but indicates the presence of voids, disturbed ground, trenches, pipes and cables under the surface.

GPR is an echo sounding method where a transmitter/receiver is passed over the ground under investigation. It is effective at mapping metallic and non-metallic services. It is of limited use in conductive ground (e.g. wet clay) or through reinforced concrete. It can give a comprehensive image of the sub surface including service depths, trench compaction and pavement construction thickness.



Underground Services Desktop Study

The depth of investigation is decided prior to the survey so that the correct antenna can be used.

0m – 2m = 500MHz antenna

1m – 5m = 250MHz antenna

NB : GPR does not identify a particular service, only the likely location of a pipe or cable, and is best used in conjunction with Radio detection where possible.



MALA GPR System

GPS (Global Positioning System)

GPS is a satellite based positioning system owned and operated by the US DoD (Department of Defence).

The Ordnance Survey Active GPS Network provides a network of GPS receivers on known points that can be used for surveying with GPS.

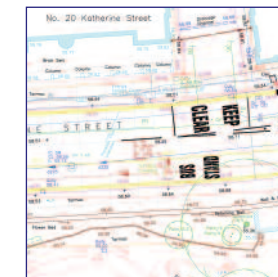
RTK (Real-Time-Kinematic) GPS enables the surveyor to survey service features instantaneously, and subsequently relate the information to OS National Grid: as sometimes required by Utility Companies.



Leica GPS Base Station



Leica Total Station



Croydon underground services survey

Total Station

A total station is an electronic angle and distance measuring device, using infra red light source, that is able, either robotically or semi-robotically, to collect and record site survey data for subsequent processing into digital mapping.



Health & Safety

The tracing and filming of underground services is a dangerous occupation. For this reason safety measures have to be established in order to protect staff and clients' interests.

Confined Spaces :

No member of our staff is allowed in confined spaces above one metre deep unless certificated to do so, and only then if all correct safety measures are in place. This often requires additional staffing in order to facilitate the correct escape procedures from confined spaces.

Gas :

Prior to, and during entry, into a confined space the air is monitored for dangerous gases using an approved gas detector. If gas is found it will be necessary to vent the chamber/pipe/sewer prior to carrying out work. If this is necessary, work will have to be suspended.

Traffic and Pedestrian Management :

For minor roads and pedestrian areas we would facilitate all safety measures after carrying out a Risk Assessment. The safety measures would be put in place by Laser Surveys staff who have City & Guilds Monitoring, Signing, Lighting & Guarding - Chapter 8. On major highways, motorways etc., where 'coning off' or 'a rolling road' is required, traffic management would be sub-contracted to a specialist company.

The Royal Institution of Chartered Surveyors. Survey of Land, Buildings and Utility Services at scales of 1:500 and larger

All work is carried out to the RICS Specification, and we would recommend this specification as a useful tool to help you specify your exact requirements.

It is important you read their preamble, which is printed below, that highlights the possible incompleteness of electronic tracing.

Electronic Tracing :

This is a more reliable method of locating buried services. On heavily built-up sites 85% completeness is probably all that can be expected. Plan accuracies of the order $\pm 150\text{mm}$ may be achieved but this figure will depend on the depth of the service below ground level. Where similar services run in close proximity, separation may be impossible. Successful tracing of non-metallic pipes may be limited (due to technology available at the time of publication of this specification).

Electronic tracing is relatively expensive. In the case of development sites it is more economical to indicate those areas where excavation will take place and concentrate there.

CCTV Drainage Surveys

The filming and reporting (to Water Industry Standards) of drainage systems using colour video camera.

This is not just shoving a camera down a drain and taking a few pictures. We first identify the drainage runs with their pipe sizes, so that the correct camera, and camera set-up is used. The drainage runs are then filmed according to pipe size. As the camera is passed down the sewer its progress is monitored and adjusted in the control van in order to investigate and highlight any faults. Cameras cost a fortune, and it is essential they are never put in danger and cannot be recovered. Therefore cameras do NOT -

- a. go under water
- b. drive into any location the operator thinks dangerous

If any of these circumstances occur the survey will be aborted.

Pre Clean - Whether the drainage system is cleaned prior to the CCTV Survey is the Client's decision, but we would recommend it for the following reasons -

- a. silt and fat deposits cleaned from the surface of the pipe exposes faults



- b. larger debris e.g. bricks, concrete etc. are removed if possible thus reducing the risk of the CCTV Survey being aborted, and necessitating a return visit resulting in additional costs

Pre-cleaning can be carried out using either a trailer-mounted jetter or a high pressure lorry-mounted vector.

A trailer-mounted jetter will clean the surface of drains up to 225mm diameter and move the arisings downstream to the nearest inspection pit - it will NOT remove the arisings or larger deposits such as bricks. A vector wagon will clean and remove the arisings for most diameter drainage runs.

Electronic Tracing Foul and Storm Water Sewers

The use of dye to trace drainage routes is not allowed in some areas, and it only proves connectivity. It is for this reason we use electro-detection. A transmitting sonde (a sausage shaped transmitter) attached to a flex-rod (a plastic glass fibre rod coiled on a rotating steel caged spool) is introduced into the sewer at an inspection pit and manually pushed down the pipe. Its progress is monitored and positioned above ground using a locator. It cannot be assumed that the sonde is lying centrally in the pipe, but a position and depth accuracy of $\pm 10\%$ of depth plus twice diameter of pipe can be expected.

What can go wrong ?

- a. It is not always possible to progress through debris and blockages
- b. For larger diameter pipes the sonde may position itself at the side of the pipe or the flexi-rod can bunch if the progress of the sonde is impeded

This method of survey will only provide the sewer route, and will NOT identify node points (remote gully connections etc.). If node points are required a CCTV camera unit with sonde enables a visual location.

Manhole Surveys

Prior to a Utility adopting a foul or storm water sewer a manhole survey will be required : see typical example below. National Grid values for inspection covers would be provided using GPS.

MANHOLE NUMBER	COVER LEVEL	JOB NUMBER	LASER SURVEYS	
LOCATION Road name and other details of location				
LOCATION Town			NATIONAL GRID REFERENCE	
Shaded Day	Other Day	Year Built	Area Code	Dist. Time
Invert Level	Depth	Upstream Manhole Number	Size Dia	Bed Level
A				
B				
C				
D				
E				
F				
Downstream Manhole Number				
X				
Y				
Z				
COVER		MANHOLE CONSTRUCTION		
Size	Quality	Shaft Size	Chamber Size	
Height	Material	Height	Material	
MANHOLE CONDITION		CALCULATIONS		
Condition	Depth	Surcharge		
REMARKS				
LOCATION SKETCH				
DIGITAL SKETCH				



Electric Cables

The tracing of underground electrical services can be split into 3 types - Low Voltage (LV), High Voltage (HV) and Domestic.

LV Electric (up to 11,000 volts)

If the cable is live we can trace the electrical field around it. If it's not live, and the cable is exposed in an inspection chamber/lighting column etc., a signal can be induced down the cable using a clamp and transmitter, this unique signal can be traced using the receiver.

HV Electric (over 11,000 volts)

This is a particularly difficult service to find as it is 'balanced' and does not normally have a field that can be traced.

It is therefore imperative that access to the cable is available in order that a signal can be induced in the cable by a non-invasive clamp.

Domestic (410 volts)

Traced in a similar manner to LV electric.

Water

Water mains are either plastic or metal and the method of tracing these two types are different.

Plastic Main

In order to trace this main it is necessary that it is 'live' and that run-off is allowed. If a trace wire is incorporated when the pipe is laid radio detection can be used.

What can go wrong ?

- a. Trace limited to 100m from transonde
- b. Sound signal corrupted by ground density (concrete etc.)
- c. Sound signal corrupted by traffic and construction plant

Metal Main

A transmitter is attached to a conductive surface of a stop valve, fire hydrant, washout, etc. or exposed pipe. The active signal is then traced above ground.

What can go wrong ?

- a. Plastic repair incorporated into pipe terminates signal.
- b. Ground density corrupts signal

Gas

There is no equipment that will trace a plastic pipe that does not have a trace wire incorporated in it. If a trace wire is present this service is traced in a similar manner to water.

What can go wrong ?

If the gas pipes are laid and the trace wire in each pipe section is not married up correctly the signal is terminated and the only method of locating is GPR.

Fibre Optic

Fibre Optic can only be traced using GPR. Access to Fibre Optic plant is prohibited by law.

Telephone Cables

Although it is possible to trace the passive signal from telephone cables it is illegal to interfere with Telecom's equipment. BT provide a 'dial before you dig' service, but the indicated route is sometimes not precise and often only derived from record drawings.

Statutory Authority Searches (stats)

Prior to carrying out a site services trace it is helpful, and sometimes essential, that 'STATS INFORMATION' is obtained.

Although the information provided by the authority comes with a 'Health Warning', explaining that it may not be correct, it does provide the services surveyor with an overview of the service layout and helps to avoid omissions.

All site-centred Statutory Authority Services information supplied by Laser Surveys is assembled into PDF Digital File and Hard Copy Report.