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# Site Engineering Guide

## UNDERGROUND SERVICES

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## UNDERGROUND SERVICES

### INTRODUCTION

All excavation operations will need to consider the presence of existing underground services as a risk. Striking underground services presents significant dangers to the operatives involved and also the company can incur the cost for repairing the damage service, loss of business to those affected and delay the projects in both the time taken to repair the damage and investigate and report the incident.

### HAZARDS OF STRIKING UNDERGROUND SERVICES

- The greatest risk of personal injury lies in striking electricity cables. Although some people are electrocuted the majority of injuries are sustained from explosive arcing of damaged cable, causing major burns.
- Damaging a gas main or a high pressure fuel line may result in a leak which potentially could lead to a major fire, explosion or persons becoming overcome by the vapours released.
- Damaging a water main may result in the flooding the excavation which could also result in the collapse of the excavation and undermining of surround structures.
- Striking a sewer carries both the risk of the release of toxic and flammable gases which maybe contained inside the sewer but also the risk of infection from diseases contained within the water.
- British Telecom, mercury communication, television services and traffic signal cables generally present no physical harm if damaged. However the cost of the repair to cable can be astronomical particularly for fibre optic cables. The cost is so high because of the cable cost and the inconvenience to business.

### PRIOR TO EXCAVATION

#### OBTAIN SERVICE RECORDS

The Health and Safety Executive (HSE) guidelines HSG47 and the Construction Design Management (CDM) regulations require that before works start on a project the designers must obtain the records of underground services from the asset owners. In general the mains and services are owned by regulated utilities and local authorities, however, some underground apparatus is owned by private organisations. Designers and developers should contact all appropriate organisations for information regarding the location of their apparatus. The details received from asset owners will typically be written and or diagrammatic details. They can come in the various

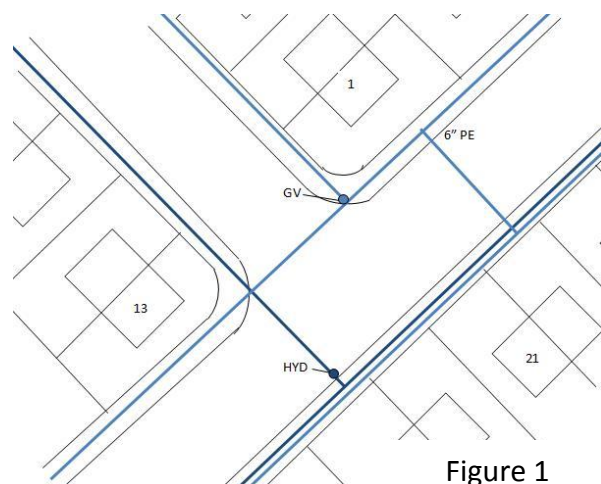


Figure 1



formats electronic or paper sometimes dependant on the age of the record, paper may be the only option. Figure 1 shows what you can typically expect a service drawing to look like, showing no coordinates or dimensions.

WALK-OVER SURVEY

Using the records from the designers/asset owners, walk over the site looking for signs of underground services e.g. manhole covers, inspection covers, draw pits, marker posts and scars in surfacing to familiarise yourself and also identify any features which are not shown on your records indicating a discrepancy in the records or services for which you have no records for.

- Figure 2: Some of the different markers you may expect to find
- Figure 3a: Scars/difference in surfacing indicating trench excavation and probably buried services
- Figure 3b: Circled a surface box, containing a stop valve for a property connection off a main, not shown on any service drawings and even after resurfacing works, some former excavation works can be visible.



Marker and aerial marker Post signifying the presence of underground services, found on boundary lines

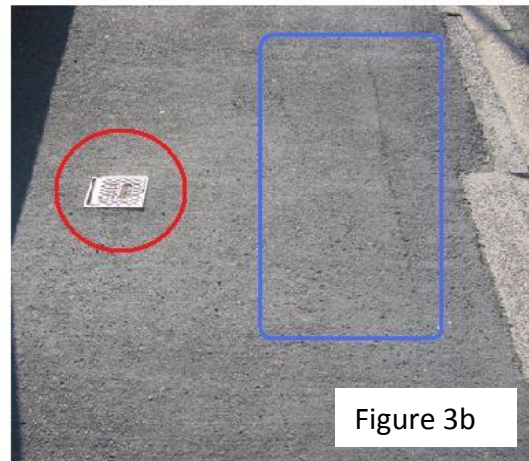
Left: Typically precast marker post as used for hydrants etc, detailing service owner and contact details



Below/Right: Aerial marker posts, typically used on agricultural land marking line of Gas main on boundary lines



Figure 2



## ONSITE LOCATION

Having familiarised yourself with the records and features of the site, start by lifting manhole covers and draw pits lids, marking the location, number and size of incoming pipes and ducts on the surrounding surface.

When attempting to locate underground services it is worth noting the following:-

- Cables may be found snaked within the width of the original excavation created for their installation, even though records show straight lines.
- Depths indicated on drawings may be incorrect due to re-grading of the area by others after installation or may not simply be the required depth.
- Services may have been moved without the authority or asset owner's knowledge and so the records may be incorrect.
- Not all services e.g. street lighting cables and individual property connections maybe shown on drawings, the presence must be assumed even if not shown on the records.

Using the asset records already obtained, the routes between inspection points and other services can be accurately located using:

### GROUND PENETRATING RADAR (GPR)

GPR does not trace services but instead indicates the presence of voids, disturbed ground, trenches pipes, cables and other anomalies in the sub surface.

GPR is an echo sounding method whereby a transmitter/receiver is passed over the area to be investigated, capable of detecting metallic and non metallic services, its effectiveness can be affected in conductive soils such as wet clay or reinforced concrete. GPR is capable of producing an image of the subsurface, including the services depths, effectiveness of trench compaction and pavement construction.



It is unable to identify a particular service only its likely location and so should be used in conjunction with Radio Detection Equipment. GPR surveys are usually conducted by external companies, who will map the services and produce a site plan; ideally this will then be plotted on the contract drawings.

### RADIO FREQUENCY OR CABLE AVOIDANCE TOOLS (CATS)

Cable Avoidance tools do not work like metal detectors contrary to popular belief; instead they are capable of operating in two ways: -

Passive: the area is scanned for passive signals which already exist from buried pipes and cables. There are two types, a power signal emitted from power cables or a radio signal emitted from telephone and other communication cables.

Active: in conjunction with a signal generator or Genny as it is commonly known, a unique signal can be transmitted along a pipe or cable and then traced using the CAT at regular intervals. The transmitter can be attached direct to the cable or a valve, hydrant on the line using a clip supplied or an additional attachment; alternatively the transmitter can be placed directly above and parallel with the service and used to trace the service.

The accuracy can be affected if the service comes into contact with another service or reinforcing, electrical fields emitted from other services such as HV cables.



Figure: 4

Figure 4: Shows a national grid marker post, some of which have a nut on the side which allows a signal generator to be connected too, allowing you to trace the line of the main when used in conjunction with a cable avoidance tool.

#### **⚠ TIP**

*Individual property connections e.g. Gas and Water are typically not shown on records, for water connections, look for a surface box within the foot path containing a stop valve which will be on the line of the connection, typically perpendicular to the main, for Gas connections: look for a connection into the property on an elevation.*

### DIAL BEFORE YOU DIG

Some authorities such as British Telecom and National Grid offer a contact service, where they will discuss and give advice about working near their plant and may also locate and mark their plant for you. Some contact information is listed in figure 5; however check with individual asset owners to check if your works are likely to affect the plant and contact details.



| Asset Owner  | Telephone     | E-mail                                    |
|--|---------------|---|
| Openreach BT   | 0800 917 3993 | dbyd@openreach.co.uk                      |
| National Grid: Gas                                       | 0800 688 588  | plantprotection@uk.ngrid.com              |
| Scotia Gas Networks (Scotland and Southern Gas Networks) | 0845 070 3497 |   |
| Northern Gas Networks                                    | 0845 634 0508 |   |
| Wales & West Utilities                                   | 0292 027 8912 | plantprotectionenquires@wwutilities.co.uk |

Figure 5

### LINE SEARCH

Linesearch.org is a free online based enquiry system which is open to use by any registered members, the purpose of the website is to provide a single point of contact for initial enquiries about its member's underground owned or operated apparatus, which totals some 25,000 km's of pipelines and fibre-optic cables.

Line search will supply information about apparatus within your selected area of interest along with the contact details of the owner/operator to make further enquires to locate its exact position and discuss your works. To review the full up to date list of members and to start an enquiry visit: [www.linesearch.org](http://www.linesearch.org)

### PERMIT TO DIG

A permit to dig system should be used to control all excavation works, including trial holes, they should detail the exact location of the excavation works and any required control measures, many companies will have their own standard formats and procedures for issuing permits to dig. When issuing a permit to dig, you must ensure that all the services within the permit area have been located and marked on site; copies of all relevant drawings should also be attached.

### TRIAL HOLES

In some instances it may be necessary to perform trial holes, the purpose of which is to accurately identify the service type and level to investigate possible clashes with proposed construction or to influence the design e.g. a pipeline. All cables and pipes should be isolated where possible and should be treated as live until confirmed otherwise.

Power tools should only be used to break up paved surfaces and not used within 0.5m of a surface. Spades and shovels are safer than the use of picks; picks should not be used in soft clays or other soft soils and should be used with care when used.

If a service is uncovered that cannot be identified the statutory authorities must be contacted to make a positive identification. If services suffer damage through the course of location, the asset owner must be informed however slight the damage and the area should be made safe until the service is repaired.



**⚠ Safety Tip**

*If a service is embedded in concrete and it is necessary to break away or disturb concrete in which a service is encased, the service should be made safe by isolation, alternatively an agreed method must be devised for the works to proceed with the asset owner. Working around a live Gas main or Electricity cable should be a last resort.*

When accurately located the service should be surveyed, a peg or paint be used to mark its position and or appropriate signage used.

**MARKING OUT**

When a service has been traced onsite the route should be clearly identified using marker paint on paved surfaces or in soft services pegs, the use of pins or large pegs could potentially damage services laid at shallow depth. Figure 6 below show the generally accepted marker spray colour scheme for marking out services.

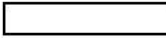





|   |  |
|---|--|
|    | WHITE - General marking                                  |
|   | YELLOW - GAS / General marking                           |
|  | BLUE - WATER   |
|  | RED - ELECTRICITY  |
|  | GREEN - CABLE  |
|  | GREY - Used by BT Openreach when tracing there own plant |

Figure 6

Alternatively signage and a site sketch produced and filed appropriately with the site records. A sign is attached in the appendix for printing and laminating if required.

**INSTALLATION OF NEW SERVICES**

On a project it may be necessary to install new services to serve the development, this will most likely be carried out by the utilities own contractor. The National Joint Utilities Group (NJUG) guidelines apply in this situation:

- In order for the installer to install the apparatus in the correct position foot paths and carriageways should be clearly marked out by:
  - Constructing a kerb or a permanent and substantial kerb brace
  - Marking the line and level of the back of kerb and any boundary lines.
- The footways or footpaths and other routes should be clearly marked out to final line and level with suitable pins or pegs, or brought up to the correct formation or final level.
- Ducts installed by the developer should be of the appropriate colour and level, see the appendix and figure 7 for footpath setting out.



- Ducts laid for cables should include draw cord.
- If ducts are laid at road crossings by the developer, each end should be clearly marked. Ducts laid by the developer should be clearly spaced to allow the installation of bends and joint boxes.

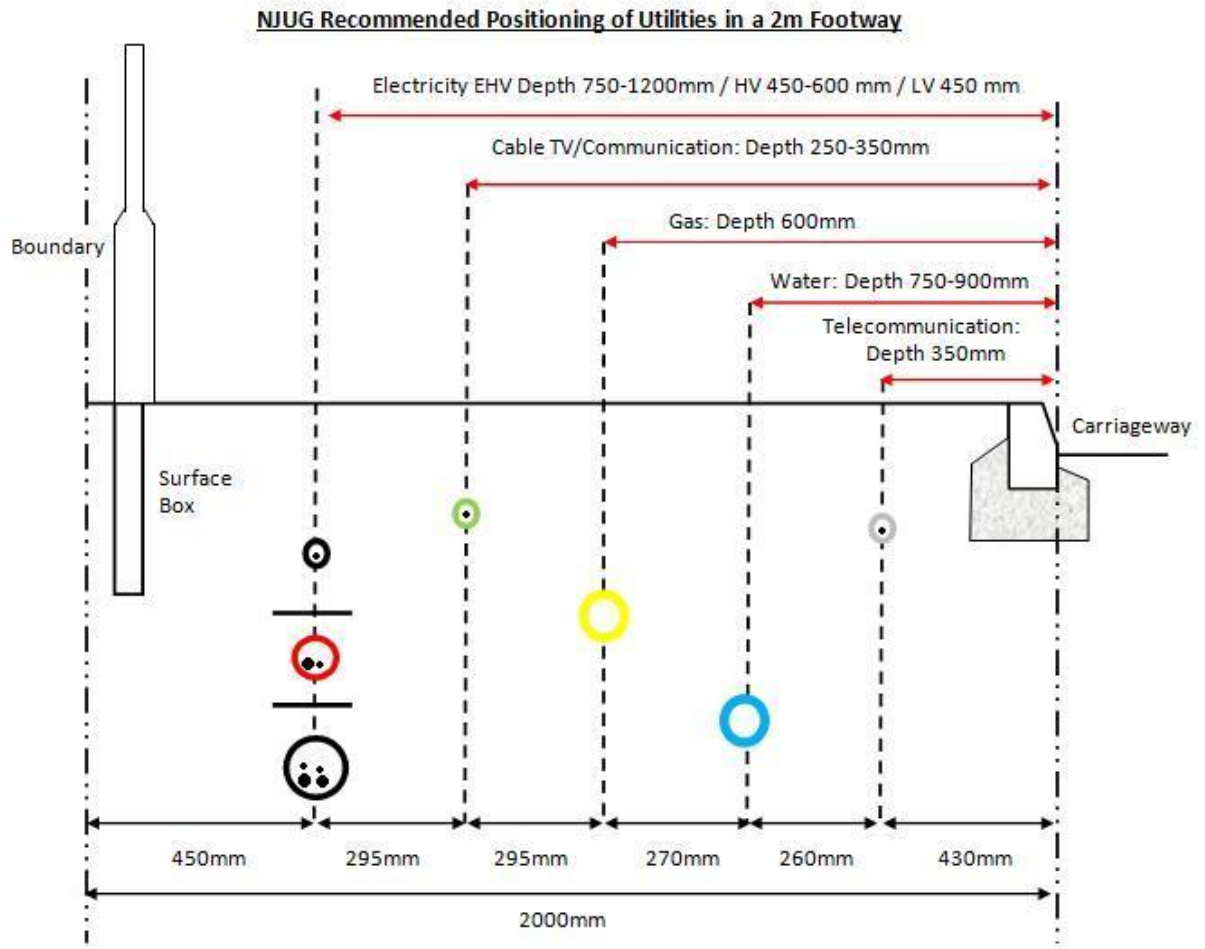


Figure 7



































# APPENDIX

NJUG recommended Colour coding and depth table  
Permit to Dig  
Existing Service Sign

### Recommended Colour Coding and Depth of Underground Plant

| Utility   | Duct   | Pipe  | Cable            | Marker Systems                                     | Recommended minimum depth   |   |
|---|--|---|------------------|--|---|---|
|   |  |   |                  |  | Footway / Verge   | Carriageway   |
| <b>Electricity EHV<br/>(Extra High Voltage)</b>   | Black   | N/A   | Black            | Yellow with Black and Red legend or concrete tiles | 750 – 1200mm  | 750 – 1200mm  |
| <b>Electricity HV<br/>(High Voltage)</b>  | Black or Red         | N/A   | Red              | Yellow with Black legend                           | 450-600mm   | 750mm   |
| <b>Electricity LV<br/>(Low Voltage)</b>   | Black or Red         | N/A   | Black or Red     | Yellow with Black legend                           | 450mm   | 600mm   |
| <b>Gas</b>  | Yellow    | Yellow or Yellow with coloured stripes that denote peel able skin. Pipe of various wall thickness | N/A              | Yellow with Black Legend                           | 600mm footway<br>750mm verge  | 750mm   |
| <b>Water non Potable &amp; Grey Water</b>   | N/A  | Black With Green Stripes  | N/A              | N/A  | 600-900mm   | 600-900mm   |
| <b>Water - Fire fighting</b>  | N/A  | Black With Red Stripes or Bands   | N/A              | N/A  | 600-900mm   | 600-900mm   |
| <b>Oil / Fuel Pipelines</b>   | N/A   | Black   | N/A              | Various surface Markers                            | 900mm<br>All work within 3m of oil fuel pipelines must receive prior approval | 900mm<br>All work within 3m of oil fuel pipelines must receive prior approval |
| <b>Sewerage</b>   | Black or Brown   | Typically Clay but can also be:<br>Ductile Iron – Red, PVC may be Brown,                          | N/A              | Red on Black Legend                                | Variable  | Variable  |
| <b>Telecommunication</b><br>     | Grey, White, Green, Black or Purple  | N/A   | Black/Light Grey | Various  | 250-350mm   | 450-600mm   |



|   |  |  |                 |                                    |           |         |
|---|--|--|-----------------|------------------------------------|-----------|---------|
| <b>Water - Potable</b>                          | Blue or Grey<br><br>                                       | Blue Polymer, Blue or uncoated Ductile Iron.<br>Blue Polymer with Brown Stripe | N/A             | Blue with Black Legend             | 750-900mm | 750-900 |
| <b>Street Lighting – England &amp; Wales</b>    | Black or Orange*<br>*See Electricity Company first<br><br> | N/A  | Black           | Yellow with Black legend           | 450mm     | 450mm   |
| <b>Street Lighting – Scotland</b>               | Purple<br>  | N/A  | Purple          | Yellow with Black legend or Purple | 450mm     | 450mm   |
| <b>Street Lighting – Northern Ireland</b>       | Orange<br>  | N/A  | Black or Orange | Various                            | 450mm     | 450mm   |
| <b>Other</b>                                    |  |  |                 |                                    |           |         |
| <b>Traffic Control</b>                          | Orange<br>  | N/A  | Orange          | Yellow with Black legend           |           |         |
| <b>Street Furniture</b>                         | Black<br>   | N/A  | Black           | Yellow with Black legend           | 450mm     | 450mm   |
| <b>Telecommunication</b>                        | Purple/Orange<br><br>                                      | N/A  | Black           | Various                            |           |         |
| <b>Motorway and Trunk Roads</b>                 |  |  |                 |                                    |           |         |
| <b>Communication– England &amp; Wales</b>       | Purple<br>  | N/A  | Grey            | Yellow with Black Legend           |           |         |
| <b>Communication Power– England &amp; Wales</b> | Purple<br>   | N/A  | Black           | Yellow with Black Legend           |           |         |
| <b>Road Lighting – England &amp; Wales</b>      | Orange<br>  | N/A  | Black           | Yellow with Black Legend           |           |         |
| <b>Communications - Scotland</b>                | Black or Grey<br><br>                                  | N/A  | Black           | Yellow with Black Legend           |           |         |
| <b>Road Lighting - Scotland</b>                 | Purple<br>  | N/A  | Purple          | Yellow with Black Legend           |           |         |

**Note: Colour coding and depth detailed above shown be confirmed with local utility operator as they may have their own specifications and guidelines.**



|  |                                   |                          |                          |
|--|-----------------------------------|--------------------------|--------------------------|
| Project Name:  |                                   | Permit<br>Number         |                          |
| Description of Works and<br>Location:<br>(Dimensions, depths, chainage)  |                                   |                          |                          |
| Are there known/charted services in the location? (Tick)   |                                   |                          |                          |
| <input type="checkbox"/>   | <b>Gas</b>                        | <input type="checkbox"/> | <b>Electricity</b>       |
| <input type="checkbox"/>   | <b>Property Connection</b>        | <input type="checkbox"/> | <b>Fibre Optic</b>       |
| <input type="checkbox"/>   | <b>Drains</b>                     | <input type="checkbox"/> | <b>Traffic Signal</b>    |
| <input type="checkbox"/>   | <b>Unknown (Picked up on GPR)</b> | <input type="checkbox"/> | <b>Water</b>             |
| <input type="checkbox"/>   | <b>BT</b>                         |                          | <input type="checkbox"/> |
| <input type="checkbox"/>   | <b>Street Lighting</b>            |                          | <input type="checkbox"/> |
| <input type="checkbox"/>   | <b>No services</b>                |                          | <input type="checkbox"/> |
| <p>Have all known services been traced and marked out on the ground?    <b>Yes</b> <input type="checkbox"/>    <b>No</b> <input type="checkbox"/></p> <p>If Electricity, gas or unknown services are present then trial holes <b>SHOULD</b> be dug using safe techniques (No breakers or mechanical equipment) and marked on the drawings to prove exact depth, location and direction.</p> <p>Have trial holes been done prior to this permit?    <b>Yes</b> <input type="checkbox"/>    <b>No</b> <input type="checkbox"/></p> <p>If electricity or Gas is found to be encased in concrete the service <b>MUST</b> be diverted or isolated before commencing with the excavation works. If the service is not diverted or isolated then confirmation to proceed with mechanical methods <b>MUST</b> be received from Site management.</p> <p>Have all known/charted services, been safely located and marked prior to works proceeding?    <b>Yes</b> <input type="checkbox"/>    <b>No Services Identified</b> <input type="checkbox"/></p> |                                   |                          |                          |
| <p><b>Additional Control Measures:</b></p> <ul style="list-style-type: none"> <li>Banksman present at <u>all times</u> when machine excavating</li> <li>Hand dig around all services and within 500mm of a known/charted service.</li> <li>Excavations to be battered or benched if no temporary works employed</li> <li>Excavations to be fenced off during breaks and at end of shift, unauthorised persons/trades kept from entering work/ machine slew area.</li> </ul>  |                                   |                          |                          |
| <p><b>Permit Approved by:</b></p> <p>Print / Signed: _____ Date: _____</p> <p>Valid from: _____ Valid until: _____</p>   |                                   |                          |                          |
| <p><b>Permit Accepted by:</b></p> <p>Print /Signed: _____ Date: _____</p> <p style="text-align: center;"><i>By signing you confirm that you have understood the contents of the permit and will brief your operatives on the contents of the permit.</i></p>   |                                   |                          |                          |

**Work must be suspended if services are damaged and reported  
immediately to site management**

***A copy of this permit must be kept with the machine operator involved  
in the excavation***

Works completed/permit superseded:      Initial / Date: \_\_\_\_\_

**PLANS/SECTIONS**

Show plan details (including known services), setting out details and trench details as applicable (attached additional sheets if required)



# EXISTING SERVICES

**Type**

**Size**

**Depth**