The National Joint Utilities Group (NJUG) is the voice of the Utilities in street works. NJUG promotes the interests of and seeks to influence the issues facing the main Utilities in street works and other relevant matters. It is jointly funded by its members: Water UK, Transco, BT, ntl, Electricity Association, Thus, Cable & Wireless and Telewest Broadband.
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1. **BACKGROUND**

1.1 The statutory right of undertakers to break open streets so as to provide and maintain their services dates from the mid-19th century. Though there is no specific legislation to dictate either the position or the depth at which apparatus should be laid within the street, undertakers have always sought to confine their apparatus to the footway.

1.2 The first guidelines, "Recommended Positioning of Utilities' Mains and Plant for New Works" (NJUG 7) were published by NJUG in 1986 and were closely based on the previous Institution of Civil Engineers’ recommendations.

1.3 The New Roads and Street Works Act 1991 (parts 3 and 4) sets down the legislative requirements to be adopted during the installation and maintenance of underground apparatus in roads and streets.

1.4 This document supersedes NJUG 4 “The Identification of Small Buried Mains and Services” and NJUG 7 “Recommended Positioning of Utilities’ Apparatus for New Works on New Developments and in Existing Streets”.

2. **SCOPE**

2.1 Utility apparatus can be vulnerable to damage from works carried out in the street. It is therefore in the interests of all to make every effort to minimise both the occurrence and effect of damage. The safety of operatives and the public is of paramount importance and is a major part of the need for damage prevention.

2.2 These guidelines are intended for application to all works on new developments and in existing streets. However, general guidelines cannot cover every eventuality and it must be recognised that the ideal solution may be more difficult to apply in practice, particularly when attempting to adopt the recommendations in existing streets, which may already contain utility apparatus.

2.3 Early consultation between Highway Authorities, planners, architects, developers and utilities is important to ensure that the utility service infrastructure is installed in the best possible manner, serving the future best interests of all parties.

2.4 These guidelines are mainly based on a two metre wide footway which reflects the existing traditional street layout. Where footways cannot be provided at this width, or the full range of utility services are not required, these guidelines offer further advice on accommodation of apparatus. In the case of innovative street design such as Home Zones the emphasis must be on early consultation between all involved to ensure adequate provision and maintenance of essential utility service in harmony with the street design.

2.5 Due to the complexity of layout and size of utilities’ and other services in the carriageway no firm guidance can be given on their positioning. Where recommendations are given in this document they must be treated as advisory.

2.6 These guidelines include a colour coding scheme primarily aimed at creating a safer environment for all operators. It is also intended to reduce the cost of damage caused to other plant and to optimise safety of individuals.

2.7 Specialist advice should be obtained in certain situations. These may include bridges, culverts, cellars, waterproof tanking, manholes, trees and railway level crossings. In other cases the local authority may be able to offer advice or indicate where advice may be obtained.

2.8 NJUG Publication No 10 gives advice on protection of trees.

2.9 The Code of Practice for the Co-ordination of Street Works and Works for Road Purposes and Related Matters (2nd edition) gives guidance where railway level crossings are encountered and also gives guidance on works near bridges, culverts and similar structures.
These guidelines reflect utility practice but operators must not assume that any mains or services encountered will conform to the recommendations for positioning or colour coding detailed in this publication.

3. IDENTIFICATION

3.1 Pipe/Duct Identification

The pipe or duct may have the owning utilities’ name stamped upon it.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Colour of Duct/Pipe/Cable Buried in Ground</th>
<th>Colour of Marker/Warning Tape Where Used</th>
</tr>
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<tbody>
<tr>
<td>Gas</td>
<td>Yellow</td>
<td>Yellow with black legend</td>
</tr>
<tr>
<td>Water</td>
<td>Blue</td>
<td>Blue</td>
</tr>
<tr>
<td>Water pipes for special purposed (e.g. contaminated ground)</td>
<td>Blue with brown stripes Polyethylene/also blue coated ductile iron Can be black in blue sheathing</td>
<td>Blue</td>
</tr>
<tr>
<td>Sewerage</td>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>&quot;Grey&quot; water</td>
<td>Black with green stripes</td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>Black</td>
<td>Black (Red for some HV)</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>White</td>
<td>Light grey, black</td>
</tr>
<tr>
<td>Communications</td>
<td>Grey, green</td>
<td>White with blue legend, Green and/or yellow with identification showing co-axial or optical fibre cable</td>
</tr>
<tr>
<td>Highway Authority Services</td>
<td>Duct</td>
<td>Pipe</td>
</tr>
<tr>
<td>Street lighting England and Wales</td>
<td>Orange</td>
<td>Black</td>
</tr>
<tr>
<td>Street lighting Scotland</td>
<td>Purple</td>
<td>Purple</td>
</tr>
<tr>
<td>Traffic Control</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Light grey</td>
<td>Light grey (or black)</td>
</tr>
<tr>
<td>Motorways, Trunk Roads - England and Wales</td>
<td>Communications</td>
<td>Purple</td>
</tr>
<tr>
<td>Communications power</td>
<td>Purple</td>
<td>Black</td>
</tr>
<tr>
<td>Road lighting</td>
<td>Orange</td>
<td>Black</td>
</tr>
<tr>
<td>Scotland</td>
<td>Communications</td>
<td>Black or grey</td>
</tr>
<tr>
<td>Road lighting</td>
<td>Purple</td>
<td>Purple</td>
</tr>
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TABLE 1: Colours of Ducts, Pipes, Cables and Marker/Warning Tapes
The primary method of identification of small buried mains and services and their ducts is by recommended colour coding to minimise danger (see Section 3.1 and Table 1). This should not be confused with the one contained in BS 1710, which generally applies to above-ground building and process services.

In addition to colour coding, other methods of identification may be used (see below) and HSE Publication "Avoiding Danger from Underground Services" HSG 47.

### 3.2 Colour

Each utility and other organisation should use the colour coding shown in Table 1 of this document. Where, for example, an electricity company lays gas plant, the colour should be that for the service not the owner, i.e. all gas pipes should be yellow.

### 3.3 Historical

It is important to remember that:

i) Old non-utility services or other pipelines may not conform to this system

ii) Colours may look different under poor or artificial lighting

iii) Ducts could include any of the services, though this is less likely to occur for telecommunication and cable television ducts

iv) Aggressive soils may discolour pigments in duct colourings over time

### 3.4 Legend

Although some plastic covered cables and plastic pipes are permanently marked, others carry only minimal markings or none at all. Any marking, although distinct on new plant, is much less distinguishable in the bottom of a trench.

### 3.5 Marker/Warning Tapes

Where used, plastic marker tapes are commonly laid some distance above the plant. Insulated wire, or tapes incorporating a metal strip, may sometimes be laid as an aid to the location of non-metallic pipes and ducts.

Whilst tapes may have value in warning an operator of the presence of buried plant, they are of strictly limited value as a means of identification. Because they are not integral with the pipe or cable, they can be easily displaced and therefore should not be taken as an accurate indication of buried plant.

It should be noted that it is unlikely that marker/warning tape will be present when the apparatus has been installed by moling, directional drilling techniques or by insertion into previously used, but now redundant, ducting/pipe work.

### 3.6 Protection Tapes/Tiles

The use of plastic strip tile, typically 2.5mm thick, affords a measure of protection for buried plant and is not so easily displaced as marker tape. A warning tape may be incorporated in the tile to identify the utility.

Protection tapes or tiles made out of concrete, clay or plastic may be used and, additionally, may provide a means of identification.

### 3.7 Buried Marker Systems

Devices incorporating passive electronic circuits may be used as a means of identification and location of buried plant. BS EN 12613:2001 “Plastic Warning Devices for Underground Cables and Pipelines with Visual Characteristics” specifies the requirements of warning devices for the manual or mechanised laying of cables and pipes. The triple aim of these devices is to warn of the presence of the pipeline or cable when opening a trench, indicating its orientation and identifying the equipment protected.
4. UTILITIES AND UNDERTAKERS

4.1 The number of undertakers with underground utility distribution systems installed beneath streets is increasing. Some systems have either changed their use or have become disused (e.g. hydraulic power and pneumatic systems could be used as conduits for other utilities). The introduction of competition in the utility market has resulted in an increasing number of individuals and organisations allowed to lay apparatus in the street.

4.2 For the purposes of this document the parties most likely to be involved, together with the types of apparatus involved are summarised in the following list:-

a. Telecommunications Operators

ducts, cables, jointing chambers, control cabinets, telecom masts, manholes;

b. Water Industry

pipes, ducts, valves, hydrants, sewers, manholes, meter chambers, service connections, telemetry cables and masts;

c. Gas Industry

pipes, valves, branch and service connections, ducts, telemetry cables, telecom masts, cathodic protection systems (which include cables), underground pressure reduction equipment;

d. Electricity Industry

cables, ducts, joints, link disconnecting boxes, protective coverings, control cabinets; buried substations, transformers and telemetry cables

e. Communications Operators

Ducts, cables, amplification points, control cabinets, joining chambers
NB: Cable TV is now superseded by combined telephone/internet/TV packages.

f. Local Authorities

street lighting columns and cables, highway drains, illuminated sign cables, traffic signal control cables;

g. Oil Pipelines

pipes, valves, cathodic protection systems (which include cables);

h. Other Underground Structures and Services

multi-service ducts, underground tunnels, traffic sensing equipment, driver information systems and associated cables

4.3 It should be noted that undertakers and local authorities do not own all the apparatus that may be found underground. Privately owned pipes and cables exist and their records are not widely available. The consequence of damage to all plant is dangerous and/or costly and should be treated in a similar manner to other plant in the highway.

5. THE IMPLICATIONS OF DAMAGE

5.1 Damage to underground apparatus may cause injury and in some instances death. It is in everyone's interests to make every effort to minimise both its occurrence and its effects. The safety of operatives and the wider implications of public safety, play a major part in the need for damage prevention.
Available statistics indicate that damage to underground apparatus is too widespread, too frequent and increasing. The cost to utilities is tens of millions of pounds per annum, but when consequential losses are considered, the true figure is likely to exceed £100 million. For all of the above reasons there is a major need for damage prevention.

5.2 Many factors combine to increase the real cost. These include:-

• the direct cost of repairs
• compensation to customers
• loss of income due to the interruption of supplies and the possible loss of production
• indirect costs associated with administration and damage prevention
• loss of opportunity due to the necessity of diverting resources to repair damage
• loss of customer goodwill
• increased insurance and contractual costs
• unquantifiable costs relating to unreported damage that subsequently leads to failure some time later

5.3 This publication seeks to improve this situation by heightening the awareness of practitioners in street and road works to the potential risk and inconvenience to themselves and others.

5.4 It is the excavator's responsibility to avoid causing damage to other underground apparatus encountered during excavation. This necessitates obtaining well in advance and prior to excavation, as much current information as possible about what apparatus can be expected to be found. Apparatus should be located and its position marked with biodegradable paint, so that plant can be protected during excavation and throughout the course of the works.

5.5 In the event of damage, it is the responsibility of the person causing the damage to contact the apparatus owner without delay, so that proper repairs can be made.

5.6 The Reporting of Injuries, Deaths and Dangerous Occurrences Regulations 1995 may require certain instances of damage to be reported to the Health and Safety Executive.

6. PLANNING AND LIAISON

The Construction, Design and Management Regulations and the Management of Health and Safety at Work Regulations, require adequate planning including Risk Assessments to be carried out in advance of any excavation. As part of the liaison with undertakers, plant protection advice should be sought to help develop safe systems of working.

6.1 As part of the Risk Assessment the undertaker should ensure that there is a safe system of working; that personnel have been adequately trained; that records of underground apparatus have been obtained, adequately examined and provided to personnel on site; and that the excavation will be carried out in a safe manner. The promoter should abide by HSG47 "Avoiding Danger from Underground Services" as a minimum standard.

6.2 The requirements for liaison and notification between undertakers and highway and roads authorities when excavating are set down under NRSWA 1991 and the Code of Practice for the Co-ordination at Street and Highway Works and Works for Road Purposes and Related Matters.

6.3 Records should be as clear and accurate as possible.
7. **EXCHANGE OF RECORDS**

7.1 Whenever it is proposed to excavate in the street, the owners of underground apparatus should be contacted for plans or other suitable information about buried plant well before excavation is due to start and the information obtained passed directly to the operatives carrying out the work.

7.2 Due to the varied methods of recording plant data, NJUG 9 sets down a series of standards to be applied to a limited number of options for records exchange. Utility companies are recommended to declare which option they will adopt by means of an agreement through the Regional HAUC or RAUC (Scotland).

7.3 The NJUG members agreement states that the costs of an initial copy of a record should lie where they fall so that no member utility should have to contribute towards the provision of another's records. A reciprocal arrangement exists between Highway and Roads Authorities and Utilities.

7.4 Current records are essential and updates and their timing are the responsibility of the owner utility. It is recommended that the updating of records should take place as soon as is practicable. The Code of Practice for Recording of Underground Apparatus in Streets sets a common standard for the establishment, maintenance and making available of records of underground apparatus.

7.5 Plans and other records can give an indication of what may be expected to be found. The location of all apparatus should always be confirmed by using a cable and pipe locator before excavation commences. Further advice on safe digging practices can be found in Section 9 of this document.

7.6 Records and plans vary considerably in scale, content and style. Plans may not be to scale and dimensions should not be relied upon for accuracy. Positions of reference points, such as kerbs, may have changed since the plans were drawn; regrading of the surface may mean that depths have changed; services, particularly cables, may have been moved by others. Services are not normally marked or recorded and, where they are, they may actually “snake” or “loop”.

7.7 When work has to start without records being available, as may be the case for an emergency, it must be assumed that underground apparatus will be present and every effort should be made to locate it using cable and pipe locators and adopting safe digging practices.

8. **TRAINING**

The New Roads and Street Works Act 1991, requires that the supervisor and at least one operative, at each street works site shall have relevant training and accreditation.

9. **SAFE DIGGING PRACTICE**

9.1 Excavation teams should always use locating devices. These are extremely important tools and should be used prior to and frequently during excavation. Their use is most effective when used in conjunction with records of underground apparatus. Records should never be relied upon without using a locator to confirm the positions indicated. When records are not available it is essential that locating devices are used prior to and during any excavation.

9.2 The line of identified apparatus should be noted and marked on the pavement (using biodegradable markers) outside the limits of the area to be excavated. Locating devices may not be able to distinguish between cables or pipes running close together and they may be indicated as a single signal. Having found one cable or pipe does not mean that there are no others present.

9.3 Conventional pipe and cable locators do not detect plastic pipes or other non-metallic apparatus unless tracer wires or signal transmitters are present. Ground probing radar may be able to indicate the location of non-metallic plant. Other techniques should therefore be used as explained below.
9.4 It can be expected that all premises are supplied with electricity and water. Most are supplied with at least one telecommunications cable and the majority, particularly in urban areas, have a gas supply. It is safest therefore to assume that each premise is supplied with all the above services, until it can be confirmed by site investigation those which are present.

9.5 Main pipes and cables can be present anywhere in the street and are not always placed on both sides of the street.

9.6 Service pipes and cables are normally laid at shallower depths than mains. In most circumstances service pipes or cables are laid along the shortest possible route from the main to the service entry position or meter. It is therefore likely that the service will travel at right angles from the main to the premise. This may differ for electricity services, particularly where multi service joints are used. The routes will usually be the shortest between joint position and service (meter) positions.

9.7 Street lighting columns have an electricity service, usually supplied from cables situated in the footway. Speed and traffic light cameras, traffic lights, traffic monitoring equipment, driver information systems and some traffic signs may also have an electricity supply and may be connected to other ancillary equipment.

9.8 Other pipelines are used to convey a wide variety of fluids including oils, petrochemicals, ethylene, oxygen, nitrogen and other industrial gases and chemicals, sometimes in powder form. There are likely to be pipelines adjacent to chemical and petrochemical installations. Such pipelines are often laid across country in agricultural land and there should be marker posts indicating their position. Plans of their location should also have been deposited with the local authority. Guidance should be sought from the pipeline owner or their representative before excavating.

9.9 Indications of service routes may show on the pavement surface or at the boundary of the premises for example:

- Reinstatement from when the service was installed may indicate the route of the pipe or cable
- Gas and water services may include service valves or stopcocks respectively. Gas service valve boxes are situated in the street near the boundary of the premises. Water stopcock boxes may be situated either in a similar position to gas service valves or just inside the boundary of the premises
- Water services may also be fitted with an underground meter which may be situated either in the street or just inside the boundary of the premises
- Cable television services (where present) are laid to the curtilage of premises, whether or not a supply enters. The services terminate at a small junction box placed as close as possible to the boundary of the premises
- Gas, water and electricity meters may be placed in meter boxes situated on an outside wall of the premises
- Gas, electricity, cable television, communications and telecommunications services may enter the premises above ground level, giving an indication of the line of the service
- Where there are no external indications of service positions, it may be possible to check the entry positions from inside, thereby giving an indication of the likely service routes

9.10 HSG47 "Avoiding Danger from Underground Services" gives valuable guidance. All persons proposing to excavate in the street should consult this document, which stresses the need to use appropriate pipe and cable locating equipment and safe digging practices, in conjunction with all available relevant records information.

9.11 To reduce the number of latent damage reports, ad hoc audits and inspections should be undertaken as part of the management of the works. There is merit in keeping photographic records of the area prior to, during and after the works, so that damage may be reported and remedial works completed.
9.12 It is essential to note that cables supplying street lighting, traffic lights and other street furniture may not always be carrying a current. These cables are not easily detected, they are “live” at all times and will arc if struck.

9.13 Yellow polyethylene gas pipes and blue polyethylene water pipes have been known to have been erroneously used as ducts to carry electricity cables. Caution should be exercised when cutting any pipe or duct.

9.14 Some above ground electric cables are laid in a blue duct which could be mistaken for water pipes. Caution should be exercised.

10. POSITIONING OF MAINS IN A TWO METRE WIDE FOOTWAY

10.1 The disposition of pipes and cables shown in Figure 1 is for illustrative purposes only. The detailed text relating to each utility sector gives information on the position of apparatus in various situations.

10.2 The introduction of competition in utility operations has resulted in some duplicate main pipes and cables being laid, limiting the availability of space underground.

11. FACTORS INFLUENCING THE POSITION OF UNDERGROUND PIPES AND CABLES

11.1 Positioning In The Footway

Clustering of utilities' apparatus will occur near telephone exchanges, electricity sub-stations, governor houses, pumping stations etc.
The simple addition of a jointing chamber or valve installation in an otherwise normal footway layout may encroach on the space of other utilities. In these cases local diversions may be required.

11.1.1 There are several factors that determine the positions at which different utility systems are installed:

(a) Routes for mains pipes and cables should be as straight as practicable and located wherever possible in the footway on the side of the street which serves most properties. Mains serving more than one property should be located in land that is, or will be, adopted by the Highway Authority.

(b) Depth provides physical protection for apparatus against damage that may be caused by reconstruction or repair of the surface, or by damage from frost. This is balanced by the higher cost of constructing, maintaining and locating plant at greater depth. Additional depth may be appropriate for apparatus under carriageways. The depth of apparatus can affect adjacent structures, such as walls, buildings and carriageways; similarly, loads transmitted from adjacent structures can affect buried apparatus. Consequently, it is sensible to place the more flexible or shallower apparatus nearest to either boundary of the footway.

Drains and sewers are normally laid at depths that cause little interference with other utilities' apparatus. However, it should be noted that sewers are laid to lines and levels, which cannot be varied. Private sewers and drains will frequently cross the footway at right angles to reach the public sewer normally in the roadway.

(c) Clearance is required to allow excavation for access to buried apparatus. The need for sufficient clearance around other utilities' apparatus can lead to diversions at the installer's expense when valves, meters, hydrants, jointing chambers etc. are being installed.

(d) An adequate footway width of 2 metres should normally accommodate the full range of utilities' services in a traditional street layout. Narrower widths may be adequate where both footways on either side of a road can be utilised or where the full range of utilities' services is not required. If sufficient width is not available one or more of the utilities may be forced to install apparatus under the carriageway, incurring additional installation and maintenance costs as well as increasing the prospect of traffic disruption while maintenance work is carried out.

(e) Service strips are often used on new estates. Before planning these areas, the estate planner should consider the utilities' requirements for installation and future access. Service strips should be sufficiently wide to accommodate all utilities and should ideally be a minimum of 2 metres wide and constructed with readily replaceable surfaces (such as grass or macadam) and clearly delineated.

(f) Ideally, service strips should be sited in publicly adopted land but, where this is not possible, adequate provision must be made in conveyancing documents to ensure that undertakers are afforded perpetual rights to enter the strip in order to maintain their apparatus.

(g) In other circumstances, such as in innovative street design, early consultation between all the parties concerned is essential in order to facilitate safe and easy access for maintenance or emergency repair in harmony with the street environment.

(h) Frames and covers and other surface-mounted apparatus should, where practicable, be located to reduce the possibility of damage from heavy vehicles.

(i) Changes of level along prospective routes for mains and services should be gradual, and levels should not be altered after utilities' apparatus has been installed, except with the full agreement of those utilities concerned.
Some utilities lay looped or multi-way service connections in private land in order to supply adjacent dwellings. This may necessitate including in the conveyancing documents provision of rights of access to carry out repairs and maintenance.

11.1.2 The estate planner must ensure that neither trees nor utility services come into conflict. Shrubs selected for their limited root growth may provide useful ground cover for service strips but utilities should be consulted to ensure that the roots do not damage their apparatus.

11.1.3 NJUG Publication No. 10 "Guidelines for the Planning, Installation and Maintenance of Utility Services in Proximity to Trees" was produced in collaboration with the arboricultural profession and DEFRA. It provides advice regarding both the planting of trees adjacent to underground apparatus and precautions to be taken when working upon existing underground apparatus close to established trees.

12 INDIVIDUAL UTILITIES DISPOSITION

12.1 Telecommunications

The preferred position of telecommunications distribution cable ducts in the footway is shown in Figure 2. The depth must be sufficient to prevent damage by surface loading, surface repairs or reconstruction.

Telecommunication cables can be copper, co-axial or optical fibre and are currently laid in PVC duct that may be coloured grey, green, white or purple. Older duct may be earthenware, asbestos cement, iron or pitch fibre. Common cable colours include light grey, black, mauve, brown and orange. Fibre optic cables may additionally be laid in a sub-duct within the main duct. The duct ranges in size from 25mm to 110mm external diameter.

Jointing chambers are installed along the route of telecommunication cables. Such jointing chambers should not be built over nor should the chamber impede access to other utilities' mains, unless provisions for lateral access have been agreed with the other utility. Jointing chamber covers must be accessible at all times. Ideally the ducts should be so positioned as to minimise interference and damage from work carried out on adjacent mains. The preferred lateral position, adjacent to the kerb, takes into account the need to share the space under the footway and also that the telecommunications track, being shallow for the greater part of its length, is less influenced by the forces transmitted from the carriageway and at the same time is not likely to disturb kerbside stability.
12.1.1 Services may enter premises from below ground or overhead from cables supported by poles. Below ground services may rise up outside the wall before entering the premises.

12.1.2 Below ground cable services are normally laid from a supply cable situated in the nearest footway which is normally between 350mm and 450mm cover to the crown of the duct. However, site conditions may cause the duct to be laid shallower or deeper. Marker tape is sometimes laid above the duct and can be green, yellow with a blue legend or white with a black legend.

12.1.3 Duct laid in the carriageway is normally laid between 450mm cover and 600mm cover, dependent upon the type of carriageway and street authority requirements. Again, site conditions may cause the duct to be laid shallower or deeper.

12.1.4 Telecommunication companies will often assist with the location of their apparatus on site.

12.1.5 Free advice on the location of BT plant can be obtained by dialling their “Dial Before You Dig” service on 0800 917 3993.

12.1.6 Other telecommunication companies offer similar advice and guidance.

12.2 Communications

For new developments it is considered that where a dedicated cable television/communication duct route is required, the recommended position should be centrally between electricity and gas at 250mm depth of cover as shown in Figure 3. The shallow depth is justified on the basis that there is little risk of mechanical damage from overriding vehicles and that excavation for maintenance purposes should not disturb the other utilities’ apparatus. The lateral disposition is chosen to take advantage of the centre line distance between gas and electricity which is the greatest available within the 2m width. The shallow depth and lateral disposition allows access for maintenance around the adjacent services and subsequent construction of a footway crossover results in a minimal reduction of cover over the cable communication duct.

Cable communication cables can be copper, co-axial or optical fibre and are currently laid in PVC duct that may be coloured grey, green, white or purple. Common cable colours include light grey, black, mauve, brown and orange. Fibre optic cables may additionally be laid in a sub-duct within the main duct. The duct ranges in size from 25mm to 110mm external diameter.

12.2.1 Services may enter premises from below ground or overhead from cables supported by poles. Cable services are laid to the curtilage of every premise in the franchise area, whether or not a
supply enters the premises, and terminate at a small junction box placed as close as possible to the boundary of the premises. Other below ground services may rise up outside the wall before entering the premises.

12.2.2 Below ground cable services are normally laid from a supply cable situated in the nearest footway which is normally between 250mm and 450mm cover to the crown of the duct. However, site conditions may cause the duct to be laid shallower or deeper. Marker tape is sometimes laid above the duct and can be green, yellow with a blue legend or white with a black legend.

12.2.3 Duct laid in carriageway is normally laid between 450mm cover and 600mm cover, dependent upon the type of carriageway and street authority requirements. Again, site conditions may cause the duct to be laid shallower or deeper.

12.2.4 The companies will often assist with the location of their apparatus on site.

12.3 Water

12.3.1 The minimum depth of cover for a water main, as shown in Figure 4, is governed by the need to be compatible with the minimum depth of cover of the service connection (referred to as the communication pipe within the street) which is necessary to prevent freezing of the water. The main should also be at such a depth that the service connection can pass from the main to the boundary without encountering significant obstruction.  

(Note: 900mm generally but can be at lesser depths)

![Figure 4: Water position in a 2m footway](image.png)

The preferred lateral position for the water main in the footway takes account of the depth of lay and the possible effect on boundary walls and kerbside stability, factors which dictate a position towards the centre of the footway. Jointing space of 250mm is required around a main throughout its length. It is necessary to have sufficient room to be able to reach under the main for repair purposes and to be able to mount a drill and machine for service connections.

Concrete anchor blocks are usually necessary at all bends, tapers, stop ends and junctions and these will occupy at least the nominal width of the trench. It is important that excavators do not disturb these blocks.
The lateral position of the other utilities’ mains must also take account of the statutory requirement that the water undertaker must include a stop valve/meter on each communication pipe adjacent to the property boundary. This is generally fitted complete with vertical access sleeve and surface box and may be located immediately within or outside the property boundary.

12.3.2 Water mains are normally laid at a depth of 900mm cover and communication and supply pipes usually at a depth of approximately 750mm cover to avoid freezing in cold weather.

12.3.3 In different parts of the UK businesses are laying mains and services at varying depths and these may be encountered at between 0.9m and 0.75m of cover (for mains) and between 0.75m and 0.45m of cover (for services).

12.3.4 Older water services were laid in lead, copper galvanised steel or black polyethylene. Since 1980 most water service pipes are laid in blue polyethylene. Some are still laid in bare copper, blue or green sheathed copper or galvanised steel. Most pipes are laid directly in the ground but, where ducts are used, they are coloured blue. When marker tapes are used they are also coloured blue.

12.3.5 Excavators should be aware that blue polyethylene water service pipes may be wrongly used as ducts on building sites to carry electricity cables. However the current British Standard allows the use of other blue ducting for above ground electricity cables, but again this may be used underground erroneously.

12.4 Gas

12.4.1 The normal minimum depth of cover for a gas main in the footway is shown in Figure 5. The factors which determine the depth include the properties of the pipe, the materials used, construction methods, the possible effects of a hostile environment, and traffic loading.

![Figure 5](http://example.com/figure5.png)

**Figure 5**

Gas position in a 2m footway

The lateral disposition for a gas main is determined by the need to keep service pipes short for pressure purposes and to keep away from the kerb to avoid the surface loading of parked vehicles and heavy lorries overriding the footway. It is also necessary to maintain sufficient clearance (250mm) from boundary structures and other mains to permit subsequent excavation down to and around the main for maintenance or repair purposes.

Concrete anchor blocks are usually necessary at all bends, tapers, cap ends and junctions and their presence should be anticipated. They will occupy at least the nominal width of the trench. It is important that excavators do not disturb these blocks.
Protective covers or marker tape may be encountered over gas mains or services. Where marker tape is used it will be suitably marked.

12.4.2 Gas services are normally laid directly in the ground and are connected to the nearest suitable gas main, which could be on the opposite side of the street. Gas services are normally laid at approximately 600mm in the carriageway and 450mm in the footway, rising to approximately 375mm in private ground. However, there may be a number of circumstances that cause gas services to be laid at shallower depths. The actual depths of services should be determined by careful working practices.

12.4.3 Gas service pipes were traditionally made of iron or steel, sometimes encased in black bitumen or black PVC. During the 1970s new steel service pipes were encased in yellow PVC sheathing and yellow polyethylene pipe came into increasing use. During the 1980s yellow polyethylene became the most commonly used material for gas mains and services. In 1987 intermediate pressure mains made from High Density PE, which are orange in colour, were introduced. There were also a number of instances of mains made of asbestos cement.

12.4.4 Where ducts are used, they are usually coloured yellow or pale green, though in the past ducts, which were mostly used for street crossings, were made from a variety of materials, including pitch fibre, PVC, steel or clay. Where marker tape is used it is usually coloured yellow with a black legend.

12.4.5 It should be assumed that all properties have a gas service pipe. Many domestic premises will have an above ground service entry or external meter box which may give an indication of the line of the service. Commercial or industrial premises, flats and multiple occupancy dwellings, will have service valve boxes situated in the street and similar service valves are increasingly being used on new domestic services.

12.4.6 Most of the underground gas network is operated by Transco but private gas networks are increasing in frequency, particularly in connection with new housing or commercial developments. Transco records will not necessarily show private gas networks.

12.4.7 Excavators should be aware that yellow polyethylene gas mains and service pipes are sometimes wrongly used as ducts on building sites to carry electricity cables. This practice creates an unnecessary risk to health and safety and occurrences should be reported to the appropriate authorities.

12.4.8 All suspected gas leaks or possible damages to gas pipes should be reported to Transco on 0800 111999. Transco provides the initial point of contact for emergency services on all gas networks. The response to any report will be provided in accordance with the arrangements made with the owner of the affected network.

12.5 Electricity

12.5.1 Generally, electricity cables are laid direct in the ground and at sufficient depth to avoid undue interference or damage. The heat dissipation of electricity cables is affected by the depth at which they are laid and this in turn can alter their load carrying capacity. Typical depths are shown in Figure 6. The alternative low voltage (LV) cable position provides satisfactory clearances when the high voltage (HV) cable is also present.
If both LV and HV cables are present, then the HV cable may be at a greater depth. In some cases, there will be more than one LV and/or HV cable laid in the footway and/or carriageway. Increased cover is required where cables are ducted beneath the carriageway, and the usual installation depths may also differ from those shown where obstructions are met and at entries to buildings, street furniture and underground link disconnecting boxes. Some electricity companies use the dimensions indicated as an overall depth of trench, rather than depth of cover thereby slightly reducing cover.

The lateral position should allow a clear space around cables of approximately 300mm to enable jointing work to take place. This is particularly important for LV mains cables, from which there are frequent service connections to adjacent premises and which are usually jointed "live".

Underground link disconnecting boxes, permanently accessible from footway covers, may be provided for interconnection between cables for maintenance and other purposes and are located at intervals along the route. The lateral positioning of the cables must therefore have regard to the additional space required at these locations.

The comparatively shallow depth of LV cables as compared to gas and water mains renders them susceptible to damage by others. It is therefore preferable that electricity cables are positioned closer to the property line than other mains in order to avoid undue exposure and the possibility of damage in the course of other utilities' works.

12.5.2 Most electricity cables are coloured black, though some high voltage cables are red. Where ducts are used they are normally coloured black if of modern plastic construction. Protection tiles made out of concrete clay or plastic may be placed in the ground above a cable. Where marker tapes are present, they are usually coloured yellow with a black legend, but the absence of these must not be regarded as indicating that no cables are present. Marker tapes or tiles should not be removed or displaced.
12.5.3 Most electricity service cables are laid at a depth of 600mm cover under carriageways and 450mm cover in footways, though these depths can alter due to unforeseen circumstances or because of interference by other excavators some time later.

12.5.4 All dwellings, shops, offices and factories can be assumed to be served by an electricity service cable. Street lighting columns, telephone kiosks, street signs and other street furniture are also provided with electricity service cables.

12.5.5 Most electricity service cables belong to the local electricity company but some private cable networks may be owned by other bodies such as the highway authority, the street lighting authority, Government Departments, railway, tramway companies and private companies etc. These private cables will not normally be shown on electricity company plans.

12.6 Sewer Systems

12.6.1 Public sewers are the responsibility of the water businesses.

12.6.2 Private sewers and drains, which may or may not be in the street, are the responsibility of their respective owners who may, by deed, have certain responsibilities. Local authorities have, under public health legislation, power in certain circumstances to carry out work in such installations.

12.6.3 Sewer pipes and drains have to operate with a line and level which cannot be varied in order to provide a fall to aid gravity flow of the effluent and often have to cross the footway at right angles in order to reach the public sewer in the carriageway. Older sewers were usually of brick but smaller sizes were often of fired clay or earthenware. The most popular materials today are concrete, earthenware, ductile iron, asbestos cement and plastics.

12.6.4 Manholes at regular intervals in the carriageway will indicate the line of the main sewer in a street and manholes at the boundary of each premise will indicate the line of the private drain connecting with it.

12.6.5 In addition to the foul sewers there are drainage or surface water sewers that tend to consist of gullies and pipes connected at manholes. There may in some cases be culverts that may be a large pipe or of another type of construction, and which may lie only a little way under the road surface.

13. CARRIAGEWAY CROSSINGS

13.1 Carriageway crossings will occur at junctions and elsewhere, depending on the distribution design. Where main pipes and cables are situated only on one side of the street, crossings will be required to serve groups of premises on the other side.

13.2 Normally, apparatus will be installed below the carriageway construction unless special arrangements are made. Apparatus installed within the carriageway construction is significantly more at risk of damage from traffic loads and this practice should be avoided whenever possible.

The Specification for the Reinstatement of Openings in Highways states that no plant greater than 20mm diameter should be installed within the road structure, i.e. all larger sizes of plant must be below base (road base) level.

13.3 Where practicable, pipes and cables which cross the carriageway should be laid in ducts for ease of future maintenance.

14. MAINS IN THE CARRIAGEWAY

14.1 Due to clustering in the footpath or verge, normal distribution pipes, cables and ducts are often sited in the carriageway. Transmission and trunk main pipes and cable ducts are invariably of larger dimensions and as a consequence may also be located in the carriageway.
14.2 Undertakers usually avoid laying apparatus under motorways, unless the apparatus is directly associated with the motorway itself (e.g. lighting and signal cables, etc.). With the obvious exception of overhead electricity cables, where utility apparatus has to cross a motorway, this is usually accomplished by means of a duct or service tunnel.

15. **MODERN INSTALLATION METHODS**

Current trends in pipe and cable laying concentrate on the need to keep excavations to a minimum.

The installation of underground apparatus using trenchless methods is an alternative method to open cut excavation and has many benefits for other road users. However the following points should be considered:

- Viability and suitability of trenchless techniques at the planning stage.
- The risks associated with trenchless technology in areas where pipes and cables are congested.
- The use of trenchless techniques in pipe re-lining, reuse of abandoned pipes and ducts and use of service subways.

Some types of open cut and trenchless techniques are briefly described below. When these are employed, the layout shown in Figure 1 may not be relevant due to the congestion of apparatus or the technique used.

15.1 **Trench Sharing** When trench sharing is considered it is essential that early consultation takes place with representatives from all the undertakers concerned.

15.2 **Narrow Trenching** is a technique used for installing a utility's pipes or cables. This type of trench has to be dug using mechanical excavation equipment and it is essential that best endeavours are used to locate all services crossing the trench prior to the work.

15.3 **Trenchless Technologies** should be pro-actively considered by utilities. Some of the available techniques are listed below:

**Moling** can be a useful technique for installing pipes and cables under existing streets, when crossing carriageways and when laying lengthwise under the carriageway. It is essential plans are obtained, locating devices used and trial excavations should be carried out to locate existing services as for excavating methods. Care should be taken to avoid damaging other services. Generally, the minimum clearance between adjacent services should be either 250mm or one and a half times the diameter of the pipe being laid, whichever is the greater. For electricity cables, clearances for maintenance work should be approximately 300mm. Any special requirements of the owners of adjacent services should be taken into account, as well as factors such as the construction and position of adjacent plant, ground conditions, bore diameter, the accuracy and reliability of the technique/equipment being used and whether the other plant is parallel to or crosses the proposed line. Where necessary, if there are existing services in the vicinity, a mole tracking device should be used.

**Insertion** takes many forms, from simple insertion of pipes or cables into ducts laid at an early stage on building sites, to size-for-size methods used for replacing sewers, water mains and gas mains. Examples are given below:-

1. **Ducts** may be laid by the developer on new building sites where utility pipes and cables are to be installed crossing the new carriageway. This will enable construction of the carriageway to progress before utility service layouts are completed. It is advantageous to the developer and the undertaker, giving more flexibility in the development programme. It is essential that the intended positions for ducts laid in this way are discussed at an early stage with the undertakers involved and they should be suitably spaced both to avoid congestion and to facilitate the installation of joint boxes, fittings and other apparatus. The ends should be marked with pegs to facilitate identification and sealed to prevent the ingress of dirt and water.
(b) Disused pipes may be used in existing streets to accommodate insertion of new pipes and cables, either by the original owner making use of their own redundant pipe or by arrangement between the installer and the owner of the abandoned pipe. Water and gas mains are often replaced in this way and, on occasions, cables may be laid through abandoned water or gas mains by arrangement between undertakers. Long abandoned systems such as hydraulic or pneumatic systems have sometimes been utilised by arrangements made between the remaining owners and telecommunication undertakers.

This technique can offer significant savings in excavation and reinstatement costs as well as utilising underground space, which might otherwise be wasted. However, it also presents potential problems with regard to recording the position of the new apparatus, which is necessarily linked to the quality and accuracy of the record for the original pipe now acting as a carrier. It is essential therefore that existing records are transferred to the new owner and that these are supplemented with additional details obtained both from observation and from modern pipe-tracing methods.

(c) Size-for-size Insertion (pipe bursting) utilises a mole inserted into an existing cast iron pipe which then forces the existing pipe to break apart, leaving a lined hole which will accommodate a new pipe of the same size. This technique is used where the capacity of the old pipe cannot be reduced and is often useful for the replacement of sewers, water mains and gas mains in existing streets.

Since the technique is itself a combination of moling and the use of existing abandoned pipes, the planning work required is also a mix of those described above. The record for the existing pipes to be broken apart should be carefully examined and the points at which other existing underground services pass close to the old pipe should be accurately located and excavated before the mole commences its journey, in order to prevent damage occurring.

Transco and the water companies have developed a procedure "Damage Control Procedure for Pipeline Construction Involving Pipe Splitting" that identifies the potential for damage to grey iron pipes as a result of this type of work.

(d) In-situ Pipe-lining involves the insertion of a liner to the inside of an existing pipe, either bonded or close-fitted to the wall of the pipe. There are many proprietary systems that are utilised for sewer, water, and gas pipes. The techniques increase the useful life of the existing pipe without having to completely replace it either in the same line or in a new line by open-cut methods.

15.4 Combined Service Ducts, Subways and Tunnels are not a new feature; examples have existed in cities in the UK and Europe since the middle of the last century. In the right circumstances, they can prove useful but there are a number of considerations which must be taken into account before deciding to use them.

Due to their high capital cost, they are most likely to be installed on new building sites. Existing streets with utility networks already established will undoubtedly prove difficult and expensive to adapt in this way unless as part of a very extensive improvement scheme which involves significant diversions to utility apparatus in any case.

Combined ducts, subways and tunnels provide obvious relief from traffic disruption during simple maintenance work on utility apparatus. However, this relief only extends to the main pipes and cables. It remains necessary in most cases to excavate for separate service connections to individual customers since safety considerations usually prevent properties being directly linked to the subway. Also, replacement of equipment may necessitate removal of the subway roof from time to time.

Failure of a utility main pipe or cable in a subway is likely to affect the other services alongside and carries the risk of serious fire or explosion. Consequently entry to the subway must be strictly controlled with extra safety precautions and special working practices being strictly adhered to.
Because of the very careful consideration which must be given to these and other safety and procedural matters involved with the adoption of a subway, it is essential that very early consultation with all the relevant parties be instigated before a decision is taken whether or not one should be constructed on the development site in question.
### GLOSSARY OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>APPARATUS</td>
<td>Means any pipe, cable, duct or associated fitting and, as defined in Section 105 of NRSWA, includes any structure for the lodging therein of apparatus or for gaining access to apparatus.</td>
</tr>
<tr>
<td>BRANCH CONNECTION</td>
<td>A coupling piece or joint at which a spur pipe or cable is connected to a &quot;through&quot; main.</td>
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<tr>
<td>CABLE, HIGH VOLTAGE</td>
<td>An electricity cable operating at a voltage in excess of 1000 volts.</td>
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<tr>
<td>CABLE, LOW VOLTAGE</td>
<td>An electricity cable operating at a voltage in excess of 120 volts.</td>
</tr>
<tr>
<td>CABLE, EXTRA LOW VOLTAGE</td>
<td>A cable operating at a voltage not exceeding 50V ac or 120V dc.</td>
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<tr>
<td>CARRIAGeway</td>
<td>That portion of a highway intended primarily for vehicular traffic.</td>
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<tr>
<td>DUCT</td>
<td>A pipe or sleeve provided to facilitate the installation and replacement of pipes or cables.</td>
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<tr>
<td>FOOTPATH</td>
<td>A way or means of passage for pedestrians only, generally across fields or open spaces and not associated with a carriageway.</td>
</tr>
<tr>
<td>HAUC</td>
<td>The Highway Authorities and Utilities Committee which administers NRSWA and its associated Regulations and Codes of Practice. NJUG represents undertakers’ interests on HAUC and street authorities are represented by the Local Government Association.</td>
</tr>
<tr>
<td>HYDRANT</td>
<td>A valve, fitted to a water main, to enable water to be discharged at that point.</td>
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<tr>
<td>JOINTING CHAMBER</td>
<td>Any underground structure intended to house telecommunication cable joints and to give access to cables.</td>
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<tr>
<td>KERB</td>
<td>A border of stone, concrete or other materials formed at the edge of a carriageway.</td>
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<tr>
<td>LATERAL</td>
<td>Horizontal disposition from the kerb line.</td>
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<tr>
<td>LINK DISCONNECTING BOX</td>
<td>A structure giving access to electricity cables for the purpose of connecting, disconnecting or crossconnecting supply.</td>
</tr>
<tr>
<td>MAINS</td>
<td>Pipes or cables allowing interconnection or subconnection for supply purposes.</td>
</tr>
<tr>
<td>METER</td>
<td>A device for measuring the quantity of gas, water or electricity passing a given point.</td>
</tr>
<tr>
<td>NRSWA</td>
<td>The New Roads and Street Works Act 1991 is the primary legislation which governs the way in which street works are carried out.</td>
</tr>
</tbody>
</table>
PAVEMENT
That part of the carriageway or footway structure above the sub-grade.

PLANT
See "apparatus" (except where the term is used in a botanical sense).

REGIONAL HAUCS/RAUCS (SCOTLAND AND NI)
Regional Highway Authorities and Utilities Committees

ROAD
For the purposes of this publication a road and a street are one and the same. In Scotland NRSWA refers to “roads” rather than “streets”.

SERVICE STRIP
A dedicated route for utilities' apparatus in public or private land.

STOPCOCK
A valve by which the customer's service connection may be isolated from the remainder of the distribution system. This may include a meter.

STOP VALVE

STREET
As defined in Section 48 (1) of NRSWA, a street means any highway, road, lane, footway, alley, passage, square or court.

STREET AUTHORITY
As defined in Section 49 of NRSWA and means the authority responsible for maintaining the street. In the case of a maintainable highway the street authority is the highway authority.

UNDERTAKER
As defined in Section 48 (4) of NRSWA and, for the purposes of this publication, also includes any organisation installing or maintaining utility apparatus.

UTILITY
For the purposes of this publication utility means any of the public supply industries described in Section 4.

VALVE
A means of controlling the flow of gas or liquid through a pipe.

VERGE
The unpaved area flanking a carriageway, forming part of the highway and substantially at the same level.