Global Engineering Objectives

GEO 7
Buried Services Guidance

Document Status

☐ **Preliminary** ☐ **Comment** ☐ **Approval** ☑ **Final**

Issue Record

Revision	Date	Distribution
v1.0 – Created with Barclays CRES team.	August 2023	Document issued to xxxxx. GEO documents uploaded to online web platform.

Contents

Document Status 2
Contents 3
1. Introduction 4
2. Buried Services Guidance 4
2.1 Standards 4
3. Working Near Existing Services 5
3.1 Verification Step 1 - Desktop Utility Records 7
3.2 Verification Step 2 - Site Reconnaissance 7
3.3 Verification Step 3 - Detection (GPR Survey) 7
3.4 Verification Step 4 - Verification – Visual Identification 8
3.5 Verification Step 5 – Construction & Safe Working Practices 9
3.6 Excavation Review Board (ERB) 9
4. Design & Installation of new buried services 10
4.1 Service Protection 10
4.2 Pipe / Ducts Specifications and Positioning 10
4.3 Trenches 11
4.4 Chambers 11
4.5 Easements and Wayleaves 12
4.6 Trees 12
4.7 District Heating Systems 12
4.8 As Built Information 13

1. Introduction

This document forms part of a series of Barclays Design Guides defining the Global Engineering Objectives (GEO).

The Global Engineering Objectives provide guidance for the project design team on how to comply with Barclays requirements. These documents shall be used in conjunction with the client brief, which is set out as part of the Barclays Workplace Design Process. (WDP).

These documents shall also be used in conjunction with the Barclays Design Guidelines (BDG) documentation.

The specific (GEO) documents are as follows:

- GEO 1 - Barclays Engineering Resilience Requirements (BERR)
- GEO 2 - General Design Guidance
- GEO 3 - Reference Guide A – Commercial Buildings
- GEO 4 - Reference Guide B – Data Centres
- GEO 5 - Reference Guide C – Retail Buildings
- GEO 6 - Reference Guide D – Project Close Out
- Preferred Manufacturers Document

- GEO 7 - Buried Services Guidance ***(this document)***

Where additional guidance / clarification is required, these should be provided to and agreed with in writing to the Global Head of Engineering / CRES Engineering Team.

2. Buried Services Guidance

2.1 Standards

Buried services shall be designed, managed, and constructed in accordance with the relevant local design standards. The key standards for the UK which form the basis of this document are summarised below:

- **HSG47: Avoiding danger from underground services (Third Edition, 2014)** provides guidance on working on or near underground services to reduce health and safety risks.
- **Streetworks UK NJUG: Volume 1 (Issue 8, 2013)** provides guidelines on the positioning and colour coding of underground utilities' apparatus.
- **PAS128 (Second Edition, 2022)** is a specification for the detection, verification and location of underground utilities.

The designer and contractor shall ensure the most recent and locally relevant guidance is followed through the design and construction of buried services.

3. Working Near Existing Services

Where breaking ground in the presence of existing underground utilities, the area shall first be thoroughly investigated. A systematic approach shall be applied to recording the location of underground services, and the accuracy of the location of services shall be recorded in line with PAS128, as shown in Table 1.

Table 1: Overview of PAS128 underground service verification levels

Located Service Classification	Certainty/Risk → / Class ↓
Type A Verification - Visual identification	
Type B Detection - Typically GPR and EML techniques are used	
Type C Site reconnaissance - Physical surface features identified	
Type D Desktop utility records search	

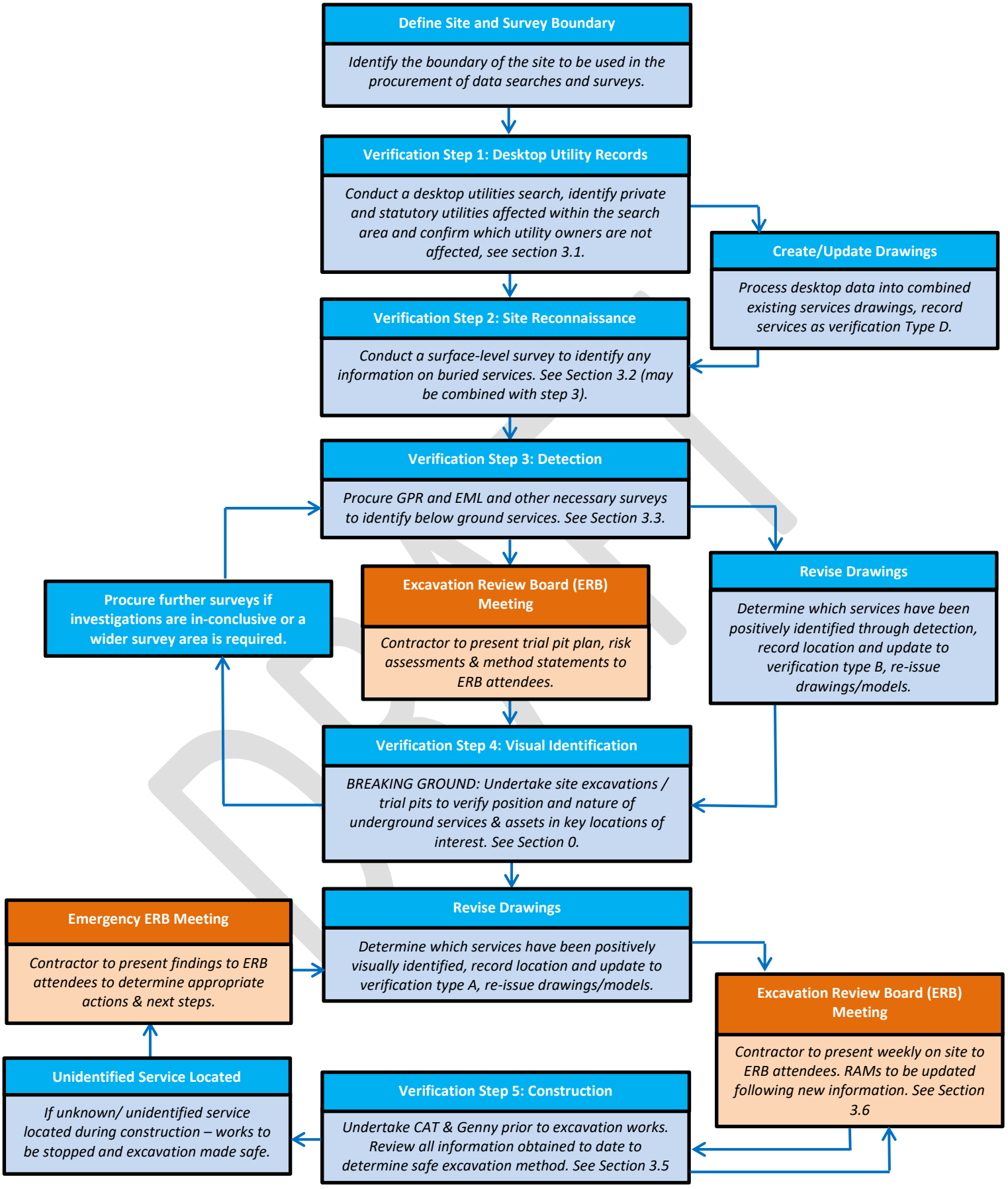
The classification of buried services shall be indicated on all drawings using an appropriate line style. Figure 1 shows an example of appropriate symbolism for buried services shown on plan, the example of electricity is shown where E indicates electricity, HV/LV indicate the voltage rating and A/B/C/D indicate the verification status of the service under PAS128.

Figure 1: Example of appropriate line styles to indicate the verification of buried services.

The recorded verification level and location of buried services shall be updated when the engineer is confident that a new classification can be made based on the available survey and statutory data. These changes shall be captured through separate drawing revisions and all versions shall be shared with Barclays CRES Engineering, and previous versions shall be superseded and saved for reference.

Prior to breaking ground in the presence of existing underground utilities, a systematic approach to investigations shall be carried out as per the procedure defined below. This procedure combines the verification methods set out in PAS128 (defined above), and the Barclays internal procedures in relation to the Excavation Review Board (ERB), to ensure that all planned excavation works are carried out safely, and with appropriate opportunities for Barclays to review and approve any works.

Procedure defined in diagram below:


Define Site and Survey Boundary
Identify the boundary of the site to be used in the procurement of data searches and surveys.
Verification Step 1: Desktop Utility Records
Conduct a desktop utilities search, identify private and statutory utilities affected within the search area and confirm which utility owners are not affected, see section 3.1.
Create/Update Drawings
Process desktop data into combined existing services drawings, record services as verification Type D.
Verification Step 2: Site Reconnaissance
Conduct a surface-level survey to identify any information on buried services. See Section 3.2 (may be combined with step 3).
Verification Step 3: Detection
Procure GPR and EML and other necessary surveys to identify below ground services. See Section 3.3.
Procure further surveys if investigations are in-conclusive or a wider survey area is required.
Excavation Review Board (ERB) Meeting
Contractor to present trial pit plan, risk assessments & method statements to ERB attendees.
Revise Drawings
Determine which services have been positively identified through detection, record location and update to verification type B, re-issue drawings/models.
Verification Step 4: Visual Identification
BREAKING GROUND: Undertake site excavations / trial pits to verify position and nature of underground services & assets in key locations of interest. See Section 0.
Emergency ERB Meeting
Contractor to present findings to ERB attendees to determine appropriate actions & next steps.
Revise Drawings
Determine which services have been positively visually identified, record location and update to verification type A, re-issue drawings/models.
Excavation Review Board (ERB) Meeting
Contractor to present weekly on site to ERB attendees. RAMs to be updated following new information. See Section 3.6
Unidentified Service Located
If unknown/ unidentified service located during construction – works to be stopped and excavation made safe.
Verification Step 5: Construction
Undertake CAT & Genny prior to excavation works. Review all information obtained to date to determine safe excavation method. See Section 3.5

3.1 Verification Step 1 - Desktop Utility Records

Desktop utility records shall be obtained in the first instance through a desktop utility records search, in line with PAS128 with the aim to:

1. Identify known utility owners within the specified survey area;
2. Request asset information from identified utility owners;
3. Collate all data on utility owners and their assets.

All information obtained through the desktop search shall be shared with Barclays CRES Engineering and recorded as Type D in line with Table 1.

3.2 Verification Step 2 - Site Reconnaissance

Survey of all visible surface features shall be undertaken and, where these features align with the information obtained through the desktop utilities search, utilities shall be recorded as Type C in line with Table 1. The features which shall be recorded as part of a site reconnaissance survey are:

1. Manhole and inspection chamber covers;
2. Valve covers;
3. Utility markers;
4. Control and distribution pillars and columns;
5. LV power, street lighting, traffic lights;
6. Historic excavation scar lines; and
7. Any other indications that utilities are present such as meter boxes and overhead cables.

3.3 Verification Step 3 - Detection (GPR Survey)

Geophysical techniques shall be undertaken to detect underground utilities within the survey area. As a minimum, Ground Penetrating Radar (GPR) and Electromagnetic locator (EML) shall be used to detect utilities.
The following shall be recorded as a minimum:

1. Site name and location;
2. Time and date of the site interpretation;
3. Detection techniques used, including the model and serial number of equipment;
4. Weather conditions;
5. The names, qualification and experience of the operator(s);
6. Calibration method and calibration data obtained;
7. Modes of detection for each geophysical survey instrument used;
8. Photographs of the site (e.g. of on-site mark out, obstructions);
9. Notes on site limitations (e.g. overgrown);
10. Utility records available at time of the survey;
11. A polygon representing where any search sweep has been undertaken;
12. All geophysical data (including all GPR data whether post-processed or not) together with the accurate georeferenced location of data (lines or grids as appropriate to the survey design);
13. Where data analysis (post-processing) is not employed, the coordinate at any point where a buried service has been detected and marked on the ground; and
14. EML data and locations where the instrumentation used has this capability.

GPR survey data shall be shared with Barclays CRES Engineering in .dwg/.dgn and .pdf format drawn in 3D and to the correct global positioning using OSGB 1936 British National Grid, or equivalent global standard.

Additional detection techniques may also be used to provide further confidence in buried services location, or where full traces could not be picked up through GPR and EML survey. A summary of potential techniques is given in Table 2.

Table 2: A summary of detection survey techniques for underground utilities

Technique	Usage
Ground Penetrating Radar (GPR)	To detect buried utilities using a transmission and receiving antenna at the surface.
Electromagnetic Locator (EML)	To detect buried electromagnetic and radio frequency signals present in metallic utilities as a result of current flow.
Acoustic transmission (Sounding)	To demonstrate connectivity of open drains only, to be used where other methods to trace drains have failed.
Borehole Geophysics	Geophysical technologies are configured from a borehole, allowing an instrument to be deployed closer to deep targets that might not be detected at the surface.
CCTV	Where information on the connectivity, configuration and condition of open pipes and ducts is required.
Drain tracing dye	To demonstrate connectivity for foul, combined or surface water drainage.
Earth Resistance	Detects variations in earth electrical resistance caused by shallow variations in soil, such as trench backfill.
Electromagnetic (EM) ground conductivity	To detect subsurface features over large areas (>0.5 hectares).
Infrared (thermal) imaging	To detect anomalies at the surface associated with underground features.
Magnetometry	To detect subsurface features, in particular ferrous based and fired clayware pipes, often used over large areas (>0.5 hectares).
Metal detectors	To detect shallow ferrous objects.
Microgravity	To detect density contrast between the ground and pipes.
RFID detection	To relocate utilities that have been previously tagged with an Radio Frequency Identification (RFID) device.
Vibration acoustic	To detect horizontal position (not depth) of pipework where a vibration can be induced along the pipe.

3.4 Verification Step 4 - Verification – Visual Identification

Verification of underground utilities shall be made through visual inspection, either at access points (manholes and chambers) or by excavation and exposure of the service. For all excavations it shall be assumed that utilities are present and safe working practices shall be applied in line with section 3.5.

Excavations shall be either a single spot excavation (commonly known as a trial hole or inspection pit), or a trench excavation for the verification of multiple utilities. As a minimum, the depth to the top of the buried service and a reference point at surface level shall be recorded as part of the survey. Additionally, the following shall be recorded where safe working practices allow:

1. nature of buried service (i.e. pipe, cable or other);
2. configuration of multiple services layout;
3. diameter of buried service (external diameter only);
4. material type;
5. backfill materials used;
6. observation of the condition of buried service;
7. prevailing ground conditions; and
8. appropriate imagery to be captured of the exposed asset and environment.

Where Barclays are operating on pervious 3rd party land, redevelopment plans involving substantial excavation works shall include a notification process for unexpected material discovery. For example:

1. Drummed waste
2. Old PPE such as coveralls / lab coats / rubber gloves / overshoes (shoe covers) / forms of RPE
3. Metal swarf / chips;
4. Oily residues that may contain flecks of metal particulate;
5. Cloth Rags / wipes.

If any of the above items are discovered, then works shall stop immediately and the Barclays Project Director shall be informed. This notification shall trigger the consideration of a radiological response.

3.5 Verification Step 5 – Construction & Safe Working Practices

A thorough risk assessment shall be carried out by the contractor undertaking the works prior to any excavation works, including during site investigation. The verification level of each buried service shall be noted on all drawings, as well as hazards relating to all utilities. Both direct and indirect risks (e.g. service outages) of working on or near existing services shall be recorded and mitigated through an appropriate risk assessment.

Safe systems of work shall be employed by all contractors, including the use of suitable equipment, safe digging practices and the establishment of emergency response procedures in the case of a service strike. Prior to visual verification confirming no utilities are present, only vacuum excavation (vac-ex) or hand dug methods shall be applied during any excavation works.

During any excavation works, cable avoidance tools (CAT) and signal generators (Genny) shall be used in line with HSG47 to mitigate the risk of cable strikes.

Should any unknown services/utilities be identified during excavation works, the depth and location inclusive of geo-spatial coordinates shall be documented on the as built drawings to mitigate the risk of further service strikes in the future.

3.6 Excavation Review Board (ERB)

To monitor progress and ensure the procedures set out in this document are followed, an excavation review board shall be set up during the construction stage of the project. For all projects, Barclays will hold ERB meetings unless stated otherwise by the Project Director. The contractor must allow time, resource and programme to accommodate all the requirements of the ERB process. Dependant on the extent of excavation works to be carried out on a particular site, ERB meetings may be required on a weekly basis.

The ERB meetings will be an opportunity for the Contractor to present their current understanding of site constraints, the risks associated with the proposed works to be undertaken that week, and the proposed methodology of how these works shall be undertaken. This includes proof of surveys, photographs, drawings and RAMs.

The aim of the ERB is to provide the opportunity to limit the risk to the personnel on-site and the business. This will allow for all parties involved to raise concerns/potential coordination issues relating to any of the items brought forward by the Contractor and provide opportunity to alter working arrangements or advise if further risk reduction measures can be put in place e.g. service isolation, out of hours/ weekend work, non-intrusive excavation methods etc.

Once all parties are satisfied the correct procedures have been followed by the Contractor and the risks have been fully considered, understood and any mitigation measures added, all parties involved shall agree to proceed under the agreements set out during the meeting.

Failure to comply with the agreements set out in the ERB meetings will result in all excavation works being temporarily stopped and require an emergency ERB meeting to further review the Contractors safe working methods.

These meetings shall be held at regular weekly intervals; however, emergency meetings may be called to address urgent on-site occurrences which need to be immediately actioned and acknowledged by all parties involved.
The ERB meeting attendees shall be the following personal (as a minimum):

- Project Director
- Project Manager
- Barclays Engineering
- Client Technical Advisor
- Site Operator(s)
- Contractor(s)

The meeting minutes shall be collated and distributed by the Project Manager. All actions shall have an estimated date of completion, and minutes shall be reviewed at the next ERB meeting.

4. Design & Installation of new buried services

Where new services are proposed, minimum design standards shall be met, unless location specific constraints make this unfeasible. Where the standards cannot be met, evidence that the risks of departing from these standards have been mitigated shall be submitted as part of the design, and the designer shall get written approval of this deviation from Barclays CRES Engineering prior to any works commencing on site.

If assets are proposed to be adopted by third parties or statutory undertakers, additional design standards may apply as defined by the third party, the design should also aim to meet those design requirements. The following sections summarise the design requirements for new buried services including electricity, telecoms, gas, water and wastewater.

4.1 Service Protection

To protect proposed services across their lifetime, protection methods shall be included in the design. The below sections summarise the potential protection measures which may be applied.

Ducting

All services shall be laid in ducts with the exception of sewerage pipes. Rigid PVC and HDPE ducting provides protection from structural and physical damage to the service cable or pipe encased within.

Ducting shall comply with ENATS 12 - 24 Classes 1,2 and 3, the Electrical Supply Industry Specification for Cable Protection or global equivalent standards.

Cable Projection Covers

Cable covers can be in the form of boards or tiles. These provide physical protection during construction as well as a clear visible warning marking the route of utilities. Cable covers shall be installed above any proposed high voltage or high-pressure buried service.

Detectable Warning Tape

Detectable warning tape or mesh can be wrapped around utilities ducts. This provides a visual warning to the presence of utilities, and the integrated tracer wires make the buried service easier to detect from ground level using detection survey techniques. Detectable warning tape or mesh may be fitted retrospectively to existing utilities if they are exposed through survey or construction.

Cable Troughs

Cable troughs provide a precast concrete casing through which multiple utilities may be routed. These may be applied to protect utilities from weather changes, to provide additional access to underground utilities, to allow shallower installations in areas of vehicle loading, or to route cables above ground. Cable troughs shall only be installed at the request of the Client.

4.2 Pipe / Ducts Specifications and Positioning

All service ducts shall be British Board of Agreement (BBA) approved, or have global equivalent certification. Ducts shall have a smooth internal bore without any sharp edges to the ends of the pipes and shall be PVC-U or HDPE, unless agreed otherwise with the asset owner and Barclays CRES Engineering. A standard polypropylene draw cord shall be installed in all new ducts (except gas and water) and shall be terminated at ground level, inside draw pits or the top of signal poles.

Table 3 shows the recommended colours and minimum recommended depths to top of the duct for each service type.

Table 3: Minimum recommended buried services requirements

Buried Service	Duct/ Pipe Colour & Markers	Carriageway depth (mm)	Footway/verge depth (mm)	Offset to other services (mm)
Electricity High Voltage (HV)	Red duct, yellow markers with black and red legend.	750-1200 (depending on voltage)	450-1200 (depending on voltage)	300
Electricity Low Voltage (LV)	Black duct, yellow markers with black legend.	600	450	200
Gas	Yellow duct, black legend on PE pipes every linear metre.	750	600 (footway) 750 (verge)	250 (LP), 500 (MP)
Water (potable)	Blue	750	750	300
Water (non-potable, grey water, firefighting)	Black with green stripes.	600-750	600-750	300
Sewerage (foul and surface water)	Black, pipe colours may vary	1200	900	300, 1m clearance to kerb line
Telecoms	Grey (BT), white, green (CATV), black, purple	750	750	200
Street Lighting	Black (electricity company serviced), Orange (Private/public highway adopted)	600	450	200

The offsets and depths shown in Table **3** are the recommended minimum dimensions for service installations. Where sites are significantly constrained or services are heavily congested, relaxations to these dimensions may be necessary, refer to Figure 1 in NJUG Volume 1 for further guidance. Where relaxations to the recommended offsets or depths are proposed, these shall be agreed with Barclays CRES Engineering and any relevant private utility owner prior to works commencing.

4.3 Trenches

Utilities shall be laid in trenches which shall extend 150mm to either side of the pipe/duct face and be backfilled appropriately with consideration of the loading conditions on the buried service. Trenches in existing carriageways, vehicle access routes, car parks and footways shall be reinstated in accordance with the requirements of the highway specification.

Trench sharing may provide benefits in terms of reducing construction costs and disruption, where trench sharing is identified as an option, this should be discussed with all intended asset owners at the earliest opportunity.

4.4 Chambers

A duct chamber shall be one-piece, structured wall design and rotationally or injection moulded in polyethylene. The chambers shall be 600mm x 600mm in size unless specified otherwise. Each point of entry shall have 54, 63, 110 and 118mm pre-trepanned cut-outs. The access box should provide a 150/450/750mm depth of cover as a single/double/triple height unit. Ducts into chambers shall be terminated internally within 25mm of the chamber wall. Contractor to conform with manufacturer requirements.

Sewerage chambers shall be designed in accordance with the *Sewerage Sector Guidance Appendix C – Design and Construction Guidance,* or the relevant local sewerage design guidance.

Duct and sewerage chamber covers within vehicle areas shall have a minimum loading class of D400, and for those within footways shall have a minimum loading class of B125.

4.5 Easements and Wayleaves

Asset owners may require easements or wayleaves to be applied to underground utilities. These shall be agreed with statutory bodies and utilities accesses shall be designed to always ensure access to services.

4.6 Trees

Tree root protection zones apply to the areas around existing trees, works within these zones shall be undertaken in accordance with *NJUG Volume 4: Guidelines for the planning, installation and maintenance of utility apparatus in proximity to trees.* The protection zones are summarised below:

- **Prohibited Zone (1m from the trunk):** Excavations of any kind must not be undertaken within this zone unless full consultation with the local authority tree officer is undertaken. Materials, plant and spoil must not be stored within this zone.

- **Precautionary Zone (4x trunk circumference):** Where excavations must be undertaken within this zone, the use of mechanical excavation plant shall be prohibited. Precautions shall be undertaken to protect any exposed roots. Materials, plant and spoil shall not be stored within this zone.

- **Permitted zone (outside precautionary zone):** Excavation works may be undertaken within this zone, however caution shall be applied and the use of mechanical plant limited. Any exposed roots shall be protected.

Local authorities have the power to make trees and woodlands the subject of tree preservation orders (TPOs) under the Town and Country Planning Act 1990. Trees covered under a TPO shall not be wilfully damaged or destroyed without the local planning authority's consent.

Utilities may be damaged directly or indirectly by tree roots. Direct damage may be caused by annual increase in root thickness resulting in eventual contact with the asset. Indirect damage may be caused through soil shrinkage which is increased by vegetation growing in the same area of soil. Where the internal conditions of the buried service duct or pipe are moist and aerated, root proliferation may occur and block the pipe or duct. Root proliferation is unlikely to occur at distances 3 metres or more from the trunk. Statutory utility owners have specific requirements regarding offsets to trees which will also depend on the tree species, these requirements should be understood and incorporated into the design of new utilities or new trees.

4.7 District Heating Systems

District heating systems typically consists of flow and return pipes which distribute heating water or steam to multiple buildings connected via junction points. District heating network distribution pipework shall be constructed in line with the manufacturer's guidance.

District heating pipework is typically made up of a carrier pipe, an insulation layer and an outer jacket. As these are specialist systems, the required sizes, cover depths and installation requirements must be checked by the designer with the manufacturer.

District heating apparatus may affect other underground utilities' efficiency or operation, existing asset owners shall be consulted in the design of district heating.

4.8 As Built Information

The Contractor shall create and provide CAD file(s) (.dwg format) with the obtained utility record information drawn to the correct global position using OSGB 1936 British National Grid (or equivalent global standard) to create as-built drawing information. The required OS background mapping will be supplied by Barclays CRES Engineering upon appointment. This OS mapping is to be used only to create the buried services CAD files and is not to be amended in any way.

Where required the Contractor shall include any layers in accordance with the industry standards AEC (UK) Protocol for Layer Naming v4, and NBS Uniclass 2015 (or equivalent global standards).
All as-built information shall be recorded using surveying equipment to global coordinates for reference into the as-constructed CAD models.

As-built information is to be submitted to Barclays CRES Engineering Team upon completion of the works.