BUROHAPPOLD ENGINEERING

SELCHP DHN Extension to Lewisham

SELCHP DHN Extension to Lewisham - Route Feasibility

0043008

28 February 2020

Revision 01

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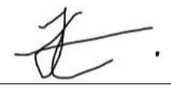
approved	**Justin Etherington**
signature	
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1 Executive Summary

1.1 Overview

Veolia SELCHP Ltd commissioned BuroHappold alongside contractors 3D-TD and Technics to undertake the detailed design of district heating pipework through Surrey Canal Road and around Arch 95 / 95A area within the London Borough of Lewisham. The design was to take account of in-situ below ground services as well as any structural impacts to the Surrey Canal Road bridge and Arch 95 / 95A.

A route has been identified, however a finalised design will require further stakeholder engagement and trial holes to be undertaken in numerous locations to verify the location of existing services and structures. Three key areas of concern are:

- The junction between Surrey Canal Road and Landmann Way, due to high congestion of services requiring district heating pipework to cross HV services and an IP gas main.
- The area beneath Surrey Canal Road Bridge due to the potential proximity of the district heating pipework to the influence zone of supporting sub-structures
- The area beneath the archway (Area 5b) due to:
    - Spatial constraints within the archway itself (5m width).
    - The presence of 6 no. HV cables installed centrally within the carriageway.
    - The potential proximity of district heating pipework to the influence zone of the sub-structures supporting the archway.

Changes to pipework routing are considered possible for areas of concern along Surrey Canal Road, pending the conclusion of the trial hole assessment and further stakeholder engagement. However, following the conclusions of trial holes and further engagement with UKPN in area 5b, it may be deemed infeasible to install pipework within this area. Therefore, a separate study has been commissioned to survey the area around the underpass between Surrey Canal Road and Grinstead Road to determine the potential for district heating pipework to be installed in this location as an alternative and to mitigate against risk to programme.

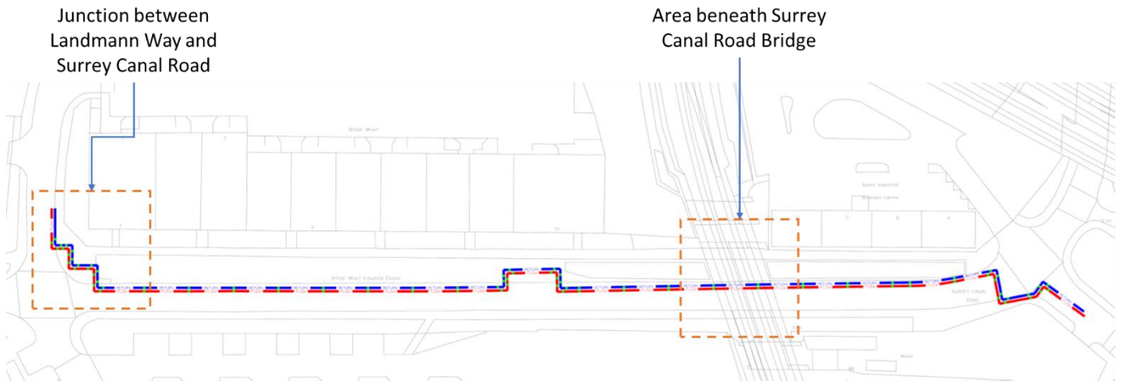

Figure 1 Identified routing on Surrey Canal Road (Areas 2 a / b and 3)

The proposed route shown in **Error! Reference source not found.** and Figure 2.

The design has been undertaken based on received utility information as part of a record search and GPR / Topographic surveys undertaken by sub-contractor, Technics. The quality of the outputted information in specified areas will however require trial holes to confirm more precise location of services.

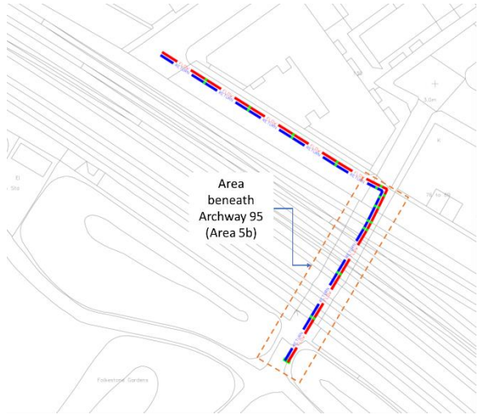

Figure 2 Identified routing around archway 95 / 95A (Areas 5 b / 6b)

An engagement process with utility providers UKPN, SGN and Thames Water was undertaken to determine any assurances or consents required and to initiate the processes for diversion of required services along the proposed route. Further engagement with these parties will be critical to ensure the route is feasible. Further information on the stakeholder engagement has been provided in Appendix H.

An assessment of the impact to assumed sub-surface structures on Surrey Canal Road bridge and within the railway arches in Arch 95 / 95A has been undertaken. Actual structural record drawings were requested as part of this study however no information was received. As such, trial holes are strongly recommended to identify location and type of sub structures which may require alterations to the proposed pipework routing.

Constructability and traffic management has been considered along the proposed route. Maintaining a single carriage way on Surrey Canal Road will be critical to ensure vehicles can continue to use this road and should be coordinated further with Lewisham Council. The archway within Arch 95 / 95A is a relatively confined space and more specialised installation methods for district heating pipework will be required in this area.

1.2 Key Identified Risk Areas

Three high risk areas have been identified along the proposed route, in addition to other locations highlighted in the HAZID drawings (Appendix C),

Area 2A – Junction between Surrey Canal Road and Landmann Way

The junction between Landmann Way and Surrey Canal road is heavily congested with below ground services. This includes High Voltage (HV) cabling and an Intermediate Pressure (IP) gas main. The proposed design involves pipework installation routed beneath existing services and passing over an IP gas main before routing down the northern carriageway of Surrey Canal Road. Numerous trial holes shall be required in this area to verify the location of services.

Area 3 - Surrey Canal Road Bridge

The proposed pipework route beneath Surrey Canal Road Bridge resides on the edge of the assumed influence zone of the supporting structures for the bridge. Sub structures have been assumed as no structural information on the bridge supporting structures has been received as part of this study. Trial holes will be required to identify the precise location of supporting structures before a final design can be determined. It may be necessary to locate the district heating pipework more centrally Surrey Canal Road to ensure the pipework does not reside within the structural influence zone.

Area 5B –Arch 95 archway

The area beneath the archway presents significant difficulties for the installation of district heating pipework. There are a series of existing UKPN HV power cables which reside centrally within the tunnel. The proposed design allows for a clearance of ~168mm from the edge of the district heating trench to the edge of UKPN trench. Following the conclusion of trial holes in this area there is a risk that the current clearance could further reduce, creating further design complications.

Furthermore, the substructures of the archway are yet to be fully understood and as such are based on assumptions. The current design resides on the edge of the assumed archway sub-structures. Pending the conclusion of the trial holes, possible alternatives for the pipework installation in this are discussed in section 4.3.

2 Introduction

BuroHappold Engineering, alongside sub-contractors 3d-TD and Technics have been commissioned by Veolia SELCHP Ltd to complete a detailed pipework route design within Areas 2A, 2B, 3, 5B & 6B as shown in Figure 3.

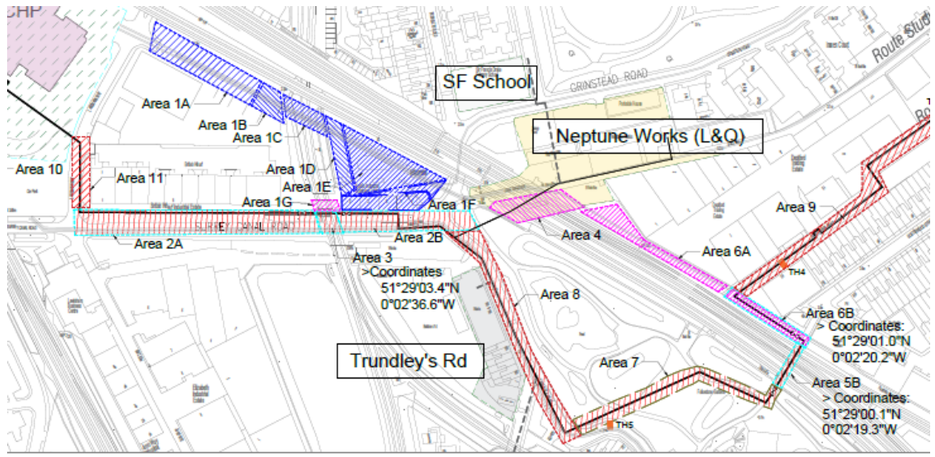

Figure 3 Areas of study focus (2A/B, 3, 5B and 6B)

Technics were commissioned by BuroHappold to undertake GPR and topographic studies of the required areas and gather existing utilities information. The utilities survey and associated drawings and reports were completed as per PAS:128 specifications and where feasible the data was outputted to a QL-B1P level.

Detailed services drawings were issued to 3D- TD to carry out the underground assessment and determine initial route feasibility while considering installation methods.

BuroHappold structures team provided an assessment of the impact of the district heating pipework on substructures supporting the Surrey Canal Road Bridge and the archway structure in Arch 95 / 95A. This assessment was based on assumed structures as, no detailed information was received. BuroHappold performed overall QA on the study and lead the consultation process with relevant utility providers and other key stakeholders to progress the route feasibility.

A series of drawings have been produced and are appended to this document:

- GA 3000 series over all route design for scope of works
- GA 3100 series for route design
- GA 3200 series route design with utility overlay and proposed trial hole location
- GA 3800 series with pipe route and identified HAZID's
- Detailed design 4000 series, design phase layout drawing
- Detailed design 4100 series, detailed phase design drawings
- Detailed design 4200 series, selected cross section detail.
- Route constructability 7200 series

Other Key documents include:

- HAZID Report
- Navis works model with utilities and DH detailed design route.
- Stakeholder engagement matrix

3 Summary of works undertaken

3.1 Phase 1 Surveying

3.1.1 Overview

Non-intrusive utility surveys were undertaken by Technics using multiple geophysical techniques to conform with PAS:128:2014 requirements for underground utility detection, verification and location. Surveys were conducted within areas 2A / 2B, 3, 5B and 6B as presented in Figure 3.

Ground Penetrating Radar (GPR) and Electromagnetic Location (EML) were used to locate all detectable services, achieving the highest possible PAS:128 quality levels for each utility segment.

Outputs of the survey were presented digitally as CAD drawings and recommendations were provided for any further works. C2 STATS information was also collected and overlaid to inform surveyed Information.

3.1.2 Key Findings

The key findings from the surveyed areas are summarised as follows: The full survey report, provided by Technics, has been appended to this document within Appendix I - The report outlines the limitations of the surveyed areas and provides background to quality levels for surveyed information.

3.1.2.1 Surrey Canal Road (Areas 2A / 2B & 3)

The key findings from the surveyed areas are summarised as follows:

1. Due to the congestion of services, particularly around the junction between Landman Way and Surrey Canal Road, there is no direct or obvious route to install pipework.
2. There is a 600mm IP gas service located within the northern grass verge in area 2A running parallel with the road which prohibits the situation of pipework in this location due to proximity issues. The IP gas main migrates from the verge to the southern carriageway through area 3 and 2B.
3. Situating pipework within the footpath immediately above the grass verge is problematic due to the presence of HV cabling.
4. There is a 300mm MDPE Thames Water potable water service that crosses into the northern carriageway within area 2A.
5. There are numerous gulley's and storm drainage services along the length of Surrey Canal Road.

3.1.2.2 Railway Underpass (Area 5B)

The key findings from the surveyed areas are summarised as follows:

1. There is congestion of services in this area which will present challenges for installation of pipework.
2. 132kV oil filled cabling was identified which presents challenges for the installation from both for installation (health and safety) perspective as well as operational issues with the potential for district heating pipework to thermally de-rate the cables if situated nearby.
3. A foul drainage chamber located at the southern entrance to the tunnel hinders access for the pipework route.
4. There is a drain running across the northern exit of the tunnel which will present challenges for installation.

3.1.2.3 Adjacent to Archway (Area 6B)

The key findings from the surveyed areas are summarised as follows:

1. This area presents good potential for pipework installation due to the layout of existing services, however consideration will need to be given to maintaining access to adjacent businesses and vehicular access during installation.

3.2 Phase 2 – Route Design

The surveyed information was provided to 3D-TD to undertake the 2D and 3D design of the pipework route and identify constraints and risks that should be considered as well as the relevant stakeholders that should be engaged.

A pair of district heating pipes (flow and return) were routed to avoid existing services and potential clashes with existing structures where feasible. More information on the structural considerations is provided in within sections 5 and 6 of this report.

The following technical pipework parameters were considered during the design:

Table 1 - District Heating Pipe Design Parameters

Parameter	Value
Design Temperature Range	120°C (max) Typical system operating temperature of 85°C flow and 50°C return
Design Pressure	16 bar
Normal Operating Pressure Range	6 to 8 bar
Temperature Differential (typical)	30°C
Maximum Acceptable Stress Level	190 MPA
Pipework Insulation size / series	DN 350 Series 2 within areas 5B and 6B DN 400 Series 2 within areas 2A/B and 3
Project Class	C
Friction Coefficient between pipe casing and backfill material	0.4
Number of full action cycles	250

A suite of drawings was produced alongside a corresponding HAZID register outlining areas of potential risk and suggested control measures. Services that potentially require diversion to accommodate the proposed district heating pipework route were highlighted as well as requirements for trial pits. Drawings and HAZID registers appended to this study are as follows:

Table 2 Route Drawings and associated HAZID assessments

Overall General Arrangement Drawing	
6376-3DTD-PC-DH-DR-Y-2700	Additional Utility Survey area for Lewisham District Heating Project
Overall General Arrangement Drawing	
6376-3DTD-PC-DH-DR-Y-3000	Scheme Arrangement District Network Pipe Route 1 of 1
6376-3DTD-PC-DH-DR-Y-3101	General Arrangement District Network Pipe Route 1 of 3
6376-3DTD-PC-DH-DR-Y-3102	General Arrangement District Network Pipe Route 2 of 3
6376-3DTD-PC-DH-DR-Y-3103	General Arrangement District Network Pipe Route 3 of 3
General Arrangement with GPR and Trial Hole Information Drawing	
6376-3DTD-PC-DH-DR-Y-3201	General Arrangement Route with Utility Survey and Proposed Trial Hole Details 1 of 3
6376-3DTD-PC-DH-DR-Y-3202	General Arrangement Route with Utility Survey and Proposed Trial Hole Details 2 of 3
6376-3DTD-PC-DH-DR-Y-3203	General Arrangement Route with Utility Survey and Proposed Trial Hole Details 3 of 3
6376-3DTD-PC-DH-DR-Y-3801	Design Phase HAZID's 1 of 3
6376-3DTD-PC-DH-DR-Y-3802	Design Phase HAZID's 2 of 3

6376-3DTD-PC-DH-DR-Y-3803	Design Phase HAZID's 3 of 3
6376-3DTD-PC-DH-DR-Y-3900	Thames Water Mains Diversion
Combined Civil & Mechanical Construction Drawing and Setting Out Detail	
6376-3DTD-PC-DH-DR-Y-4000	Design Phase Layout and Detail Design Reference Detail - 1 of 1
6376-3DTD-PC-DH-DR-Y-4101	Design Phase 1 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4102	Design Phase 2 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4103	Design Phase 3 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4104	Design Phase 4 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4105	Design Phase 5 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4106	Design Phase 6 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4107	Design Phase 7 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4108	Design Phase 8 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4109	Design Phase 9 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4110	Design Phase 10 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4111	Design Phase 11 Construction Drawing and Setting Out Detail
6376-3DTD-PC-DH-DR-Y-4112	Design Phase 12 Construction Drawing and Setting Out Detail
Civil Construction Drawing and Setting Out Detail	
6376-3DTD-PC-DH-DR-Y-4200	All Design Phase Cross Section Views
6376-3DTD-PC-DH-DR-Y-4301	Design Interface Between UKPN and District Heating Network 1 of 2
6376-3DTD-PC-DH-DR-Y-4302	Design Interface Between UKPN and District Heating Network 2 of 2
Constructability	
6376-3DTD-PC-DH-DR-Y-7100	Constructability Surry Canal Road 1 of 5
6376-3DTD-PC-DH-DR-Y-7101	Constructability Surry Canal Road 2 of 5
6376-3DTD-PC-DH-DR-Y-7102	Constructability Surry Canal Road 3 of 5
6376-3DTD-PC-DH-DR-Y-7103	Constructability Surry Canal Road 4 of 5
6376-3DTD-PC-DH-DR-Y-7104	Constructability Network Arch Cross 5 of 5

A 3D model of all areas has been included within Appendix G.

Relevant stakeholders were contacted to determine requirements for service diversions or to initiate the approvals process for situating district heating pipework near their services. An overview of the stakeholder engagement is summarised in section 5. A stakeholder engagement matrix is provided in Appendix H which outlines relevant contacts, the status of the engagement, associated risks and suggested next steps with each stakeholder.

3.3 Phase 3 – Structural considerations

The proposed route for the district heating pipework passes below Surrey Canal Road bridge and through and alongside Arch 95 / 95A. The BuroHappold structures team provided input throughout the process as follows:

- Conduct a site walkover and undertake a superficial examination of the Surrey Canal Road and Archway Arch 95 / 95A structures from street level
- Undertake a review of the utility information gained from Technics during phase 1
- Determine the ownership of the various structures
- Request structural related drawings from relevant parties to identify the sub structures within the areas of concern
- Provide a structural review based on the information received making recommendation for additional work.

It should be noted that Network Rail have provided inspection reports for the archway at area 5B (Details Examination Report (2013) and Visual Examination Report (2017)), but no record or survey drawings describing the substructures and foundations have been located. Similarly, TfL have provided inspection reports for the bridge at Surrey Canal Road (Visual Examination Report (2017) and Detailed Examination Report (2016)), but no record or survey drawings have been located. These studies have been provided in Appendix J.

The structural review has therefore based on a qualitative study.

4 Route Overview

4.1 Overview

This section provides an overview of the proposed route for the pipework in areas 2 a/b and 3 along Surrey Canal Road as well as Areas 5b and 6b within the Arch 95 / 95A area. This section should be read in conjunction with the drawings and HAZID register included within Appendices A to E. Key risk areas are further elaborated on in section 8.

4.2 Areas 2 A/B & 3 - Surrey Canal Road

Route feasibility was assessed along Surrey Canal Road to the back edge of footpaths and the extent of highways, the topography and utility survey also covered private land at the extents of the footpaths.

The footpath and the grass verge to the north of the carriageway was assessed to situate district heating pipework. Assets identified in this area include an HV cable drifting across the area with the IP gas main crossing from the southernmost carriageway of Surrey Canal Road into the grass verge. A Thames Water supply also runs parallel to the IP gas within the grass verge, before crossing into the southernmost carriageway and passing beneath the bridge. The installation of district heating pipework in this area was deemed to be infeasible.

A potential route has been identified in the northern and southern carriageways of Surrey Canal Road. The proposed route for district heating pipework is as follows:

- The district heating pipework enters Surrey Canal Road at the Landmann Way junction and passes under a cluster of HV/LV cabling, communication cabling, mains water, storm drainage and unknown GPR detected services via a series of straight sections and 90-degree bends. The design maintains a clearance from HV cabling of ~600mm.
- The route passes over an IP gas main with a clearance of ~250mm before proceeding straight within the northmost carriageway of Surrey Canal Road, parallel to the IP gas main but maintaining a clearance of ~3000mm until the expansion loop where the IP gas service crosses from the grass verge to the southbound carriageway. The district heating pipework crosses the IP gas service at the expansion loop at 90 degrees with a clearance of ~300mm before returning to the northmost carriageway.
- The route passes underneath the railway bridge before crossing to the southernmost carriageway at the eastern end of Surrey Canal Road and passing beneath further services including HV cabling before entering Folkstone Gardens.

Figure 4 Aerial image of Surrey Canal Road and proposed pipework routing

EHV and HV oil filled cables at the junction of Surrey Canal Road and Landmann Way have been recorded as QLC or D, taken form asset owners records. A route has been identified however multiple trial holes will be required to identify a clear route in this area. The trial holes can be targeted to the QLC & D assets which are uncertain and will form a more complete model of the underground assets in this location, after the trial hole survey. Due to the complexity of services in this area, additional trial holes may be required if the recommended trial holes outlined in the HAZID register in Appendix C are not conclusive.

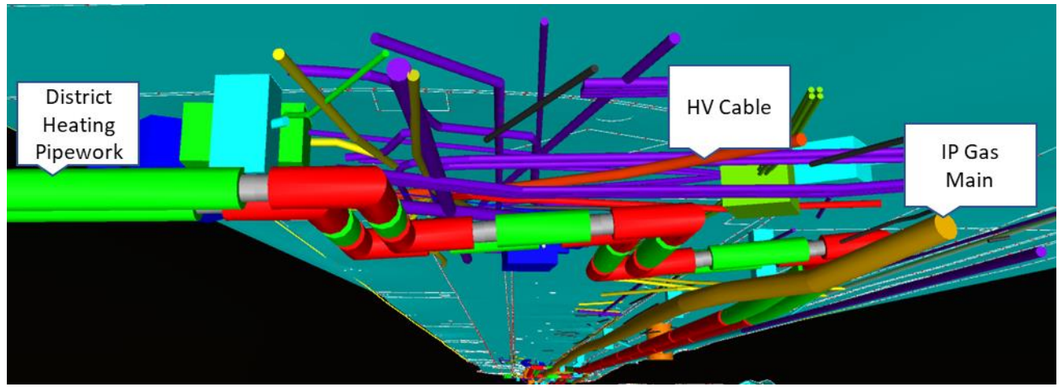

Figure 5 Congested services at the junction of Surrey Canal Road and Landmann Way

As the route approaches the rail bridge, an expansion loop has been designed into the grass verge before the pipework returns and continues down the northern carriageway.

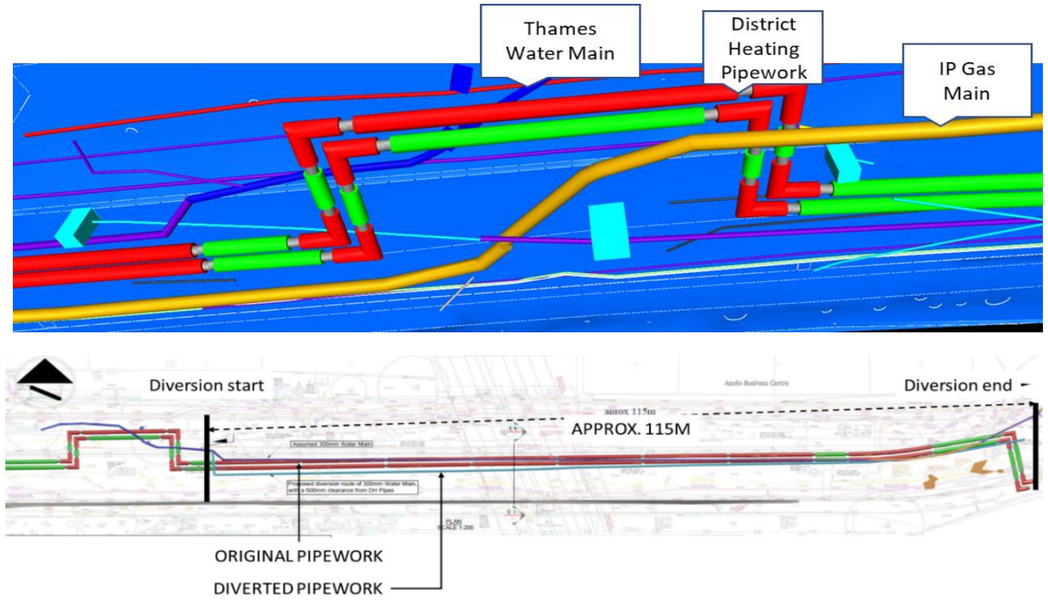

Figure 6 Services located around expansion loop and proposed Thames Water main diversion

To accommodate the proposed route, approximately 115m of Thames Water potable water pipework will require diversion. The proposed diversion of the water main is shown in Figure 6 and elaborated on in appendix K. Further information on the engagement process with Thames Water is included in section 7.1.3.

Each crossing of the IP gas main may pose significant challenges; trial holes shall be required to determine final clearances from these services. District heating pipework has been designed to cross these high-risk assets at 90 degrees to minimise asset exposure.

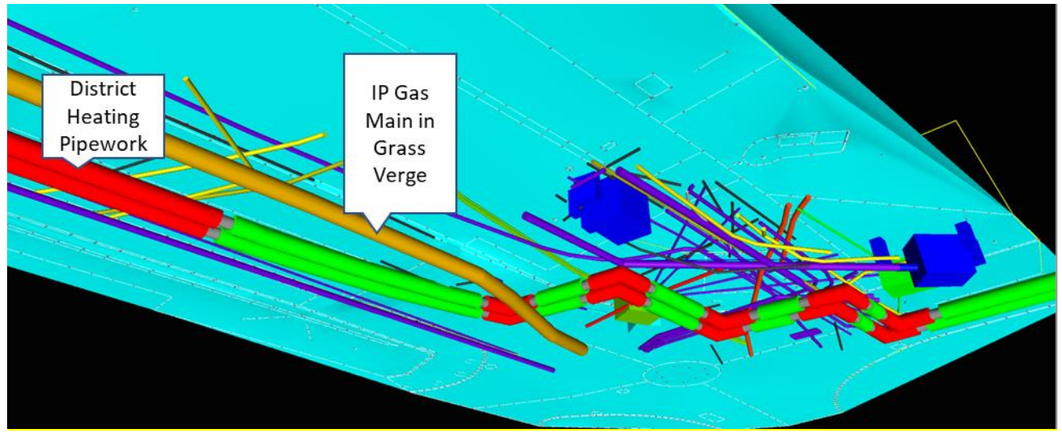

Figure 7 Gas main (large yellow) located within grass verge

The proximity of the excavation to the kerb line along much of the northern side of Surrey Canal Road will require certain road gullies to be removed and replaced. The current strategy has allowed for a 1500mm deep construction, as the utility survey did not identify the depth of the gullies as most were silted or blocked to the surface. If road gullies of 1200mm are presently installed, then district heating pipework will need to be installed deeper. Alternatively, approval from the Highways Authority should be acquired to replace the existing road gullies with 750mm deep gullies.

Figure 8 Trees located with grass verge to north of carriageway

Due to the proximity of trees to the working area, access to the verge and path may be required to allow positioning of plant to undertake welding and sleeving installation. A tree survey should be carried out to confirm the protection requirement and pruning that may be required, when a detailed installation methodology has been developed. If pruning is required, this should be planned to ensure nesting birds are not affected.

Along the grass verge there are several trees from saplings to semi mature trees, a tree survey has not been provided or carried out as part of this design, it is not expected these trees would cause significant issue for the installation as replacements could be arranged. When the trees were assessed, with the existing assets there was no identifiable clear route in the footpath or grass verge.

During the design several existing services have posed a design challenge, and a direct route has not been identified down Surry Canal Road. It is recommended that the route remains within the northern carriageway of Surrey Canal Road, to allow a single lane of traffic to be maintained.

As the proposed route passes under Surrey Canal Road Bridge in the northmost carriageway it will pass close by to the supporting sub structures which may mean the pipework will be located within the structural influence zone. Further context is provided in section 6. Trial holes will be required to determine actual location of sub-structures. Following this, it may be necessary to locate the pipework more centrally within the carriageway, closer to the IP gas main.

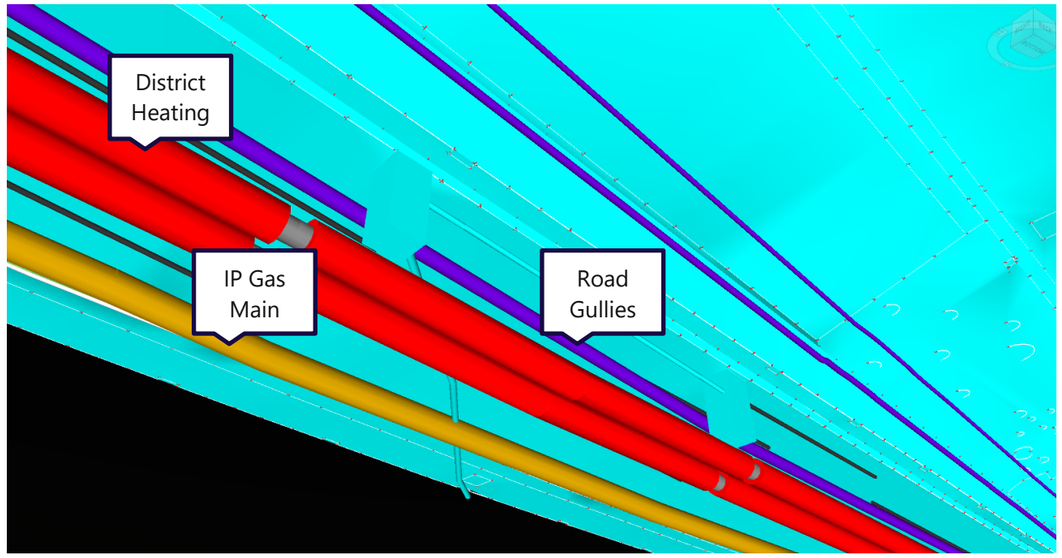

Figure 9 Pipework passing beneath Surrey Canal Road Bridge

At the eastern end of Surrey Canal Road, the pipework depth reduces to navigate around services before passing under HV / LV cables and entering Folkstone Gardens. Trial holes will be required in this location to determine the exact location of services and finalise pipework routing.

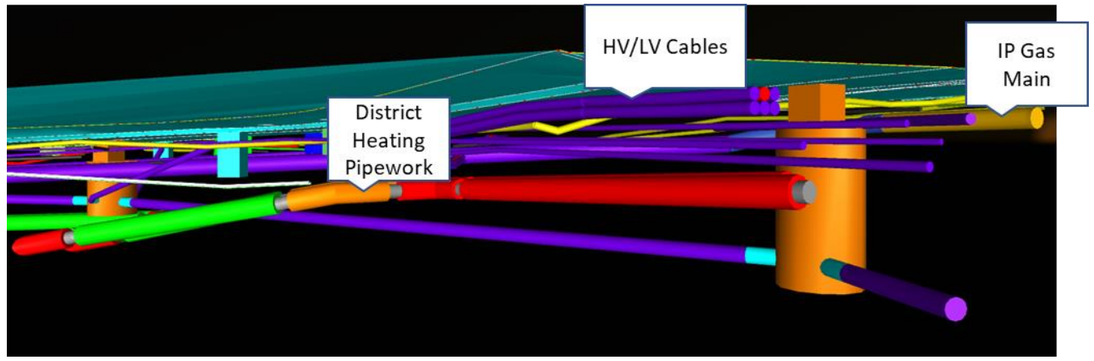

Figure 10 Pipework routing at eastern end of Surrey Canal Road - Heading towards Folkstone Gardens

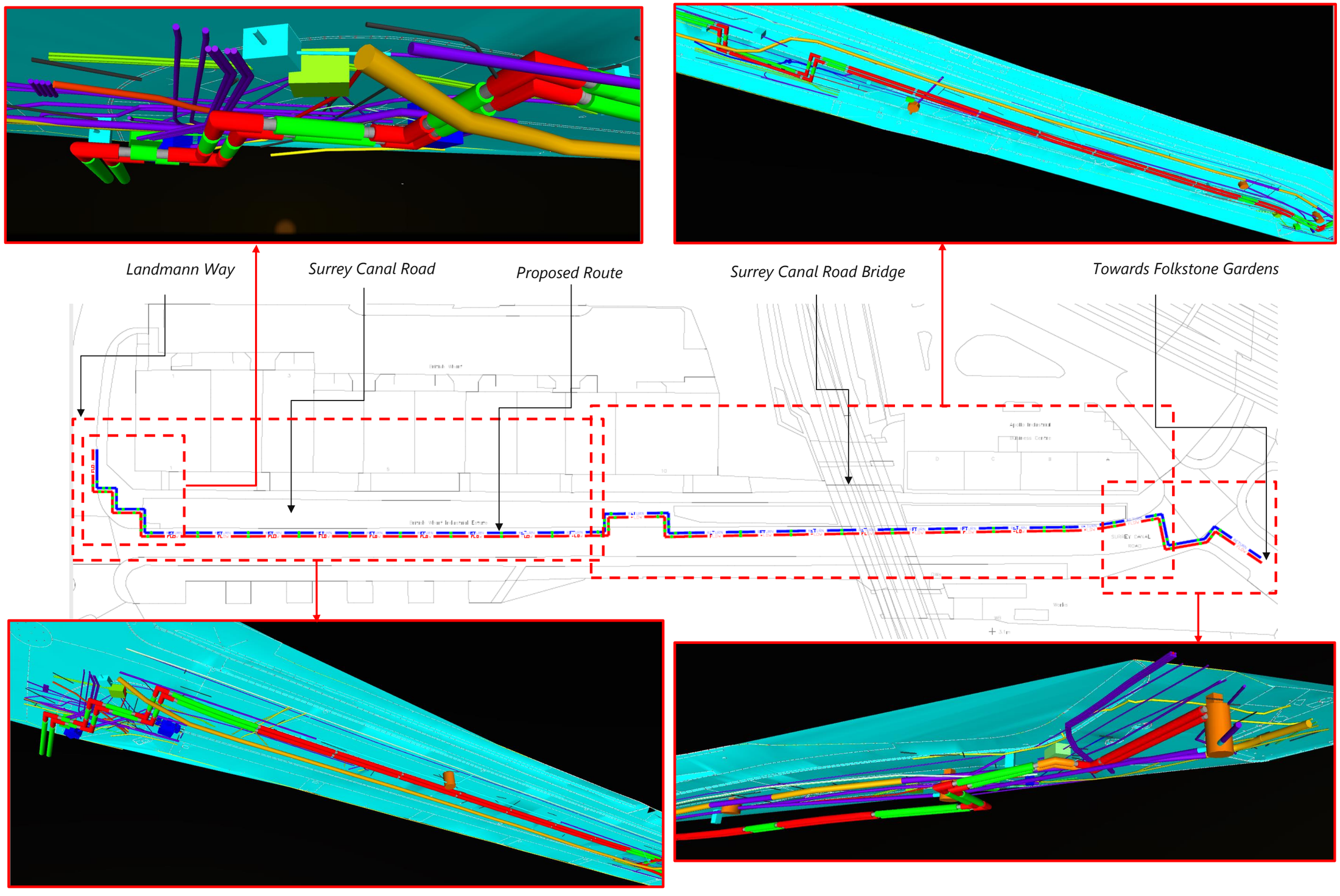

Figure 11 Surrey Canal Road Overview / Sections

4.3 Areas 5B and 6B – Arch 95 / 95A

4.3.1 Overview

The proposed route for district heating pipework emerges from Folkstone gardens and passes beneath the railway arches before turning and running parallel with the archways towards Blackhorse Road. Installation of pipework in area 5b is challenging due to the presence of HV cabling and the supporting sub-structures for the archway. To determine route feasibility in area 5b, trial holes to identify sub-surface structures and further engagement with UKPN will be required.

Possible mitigation measures to install pipework under the archway include positioning flow and return pipes closer to the edge of the runnel wall, installing the district heating pipes closer together or stacking them one on top of the other. Should district heating pipework be deemed infeasible beneath the archway then an alternative location to route the pipework should be considered.

Figure 15 Area beneath the archway (5b)

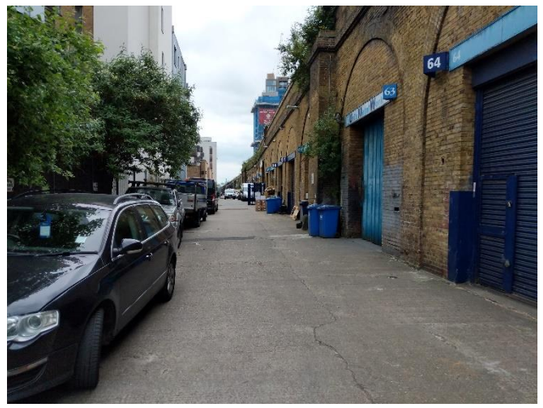

Figure 13 Area running parallel to the archways (6b)

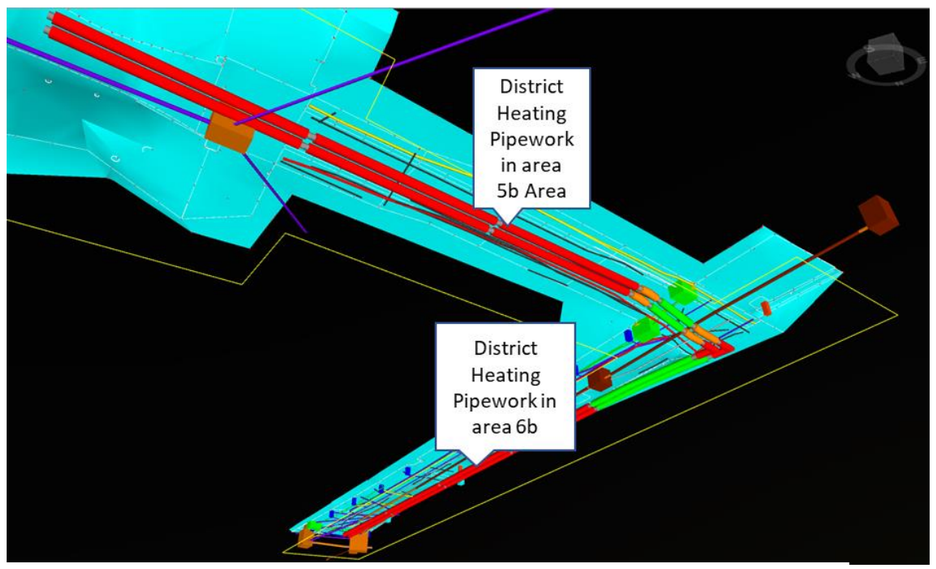

Figure 14 District Heating Pipework Route Isometric

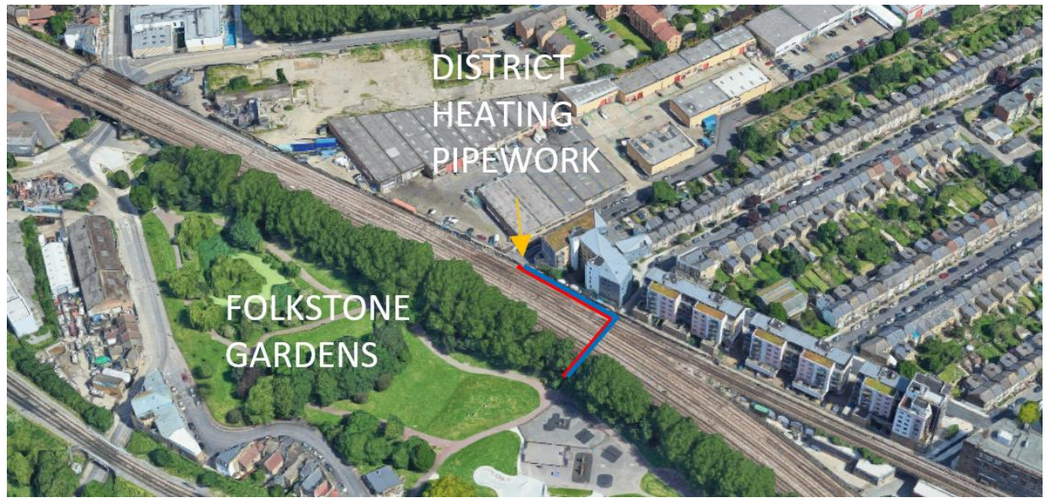

Figure 12 Aerial view of route

The pipework enters the archway from Folkstone Gardens passing through a drainage manhole. This chamber restricts the pipe route and is recorded on the asset records as a foul system. This chamber requires relocating and a new chamber installed to divert the route of the foul system, to allow the network to be installed. The pipework enters the tunnel running parallel to 6 no. buried HV cables with an assumed clearance of ~168mm from the edge of the trench to the closest cable.

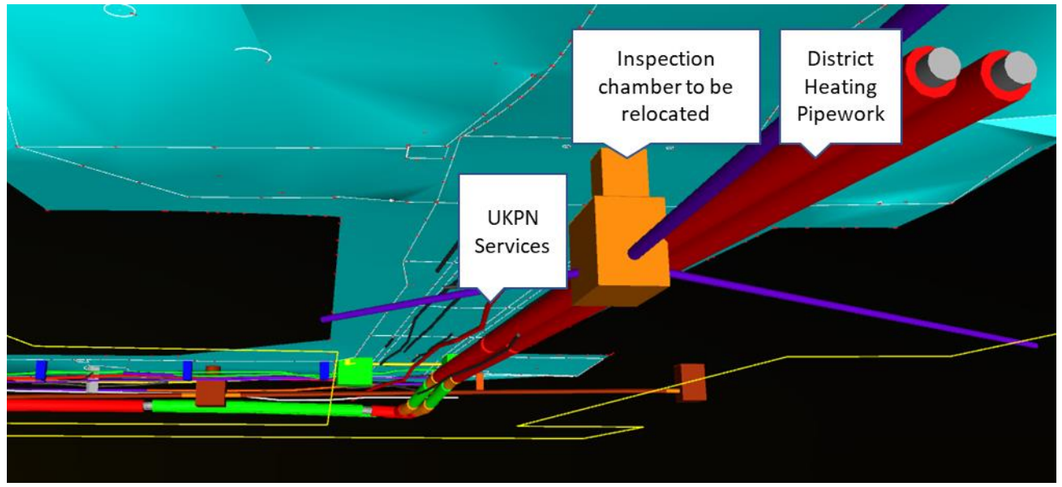

Figure 16 Location of chamber to be relocated at south entrance to the tunnel in relation to district heating pipework

As the pipework emerges from the north side of the tunnel there is a drain that crosses the exit and clashes with the current depth strategy, this can be resolved with the use of bends which allows the change of level and direction over a short distance. These bends restrict the maximum installation length of the pipe design and will restrict the straight length entering the tunnel from the south before an expansion loop will be required. This maximum length should be confirmed at later design stages when the route through the tunnel is confirmed, following trial hole assessment.

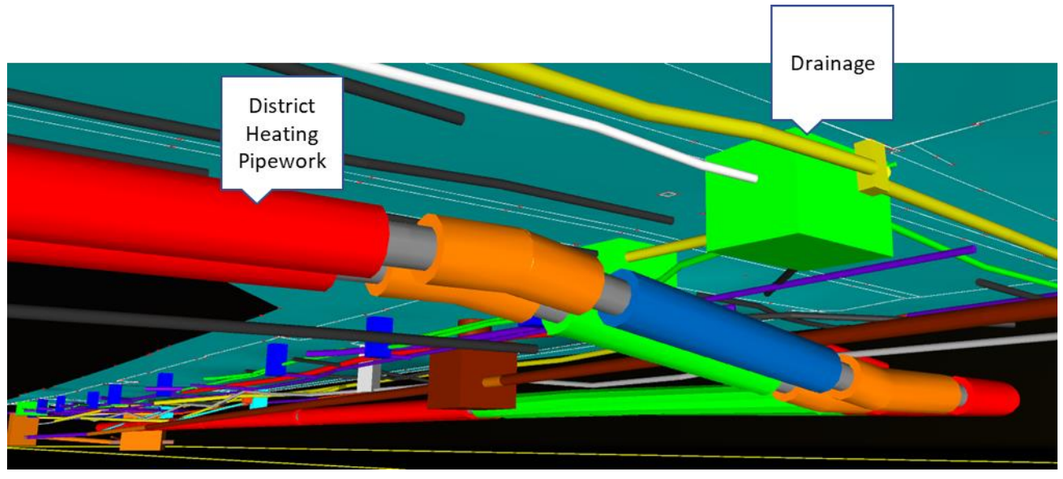

Figure 17 Drainage chambers at northern entrance to tunnel

The pipework is then routed parallel to the arches in Area 6B passing beneath multiple services. The pavement running along the length of the arches in this location is of concrete construction and likely to be steel reinforced. A route has been identified on the opposing side of the road from the arches.

There are no design issues identified within area 6B as the proposed design runs parallel to most existing services however there are electrical services crossing at several locations. The location of the route will likely result in some installation and access issues which are further elaborated on within the provisional construction methodology for this area included within appendix L.

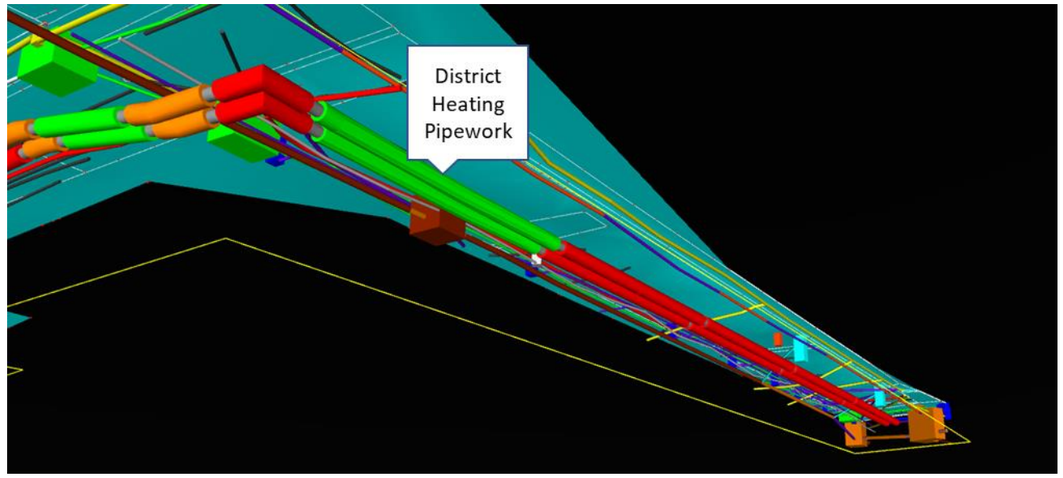

Figure 18 Pipework in area 6b

The area within the network rail arches presents significant difficulties for the installation of district heating pipework due to its limited width of ~5,000mm, and brick arch construction.

4.3.2 Key constraints and mitigation

Key constraints within the archway include the assumed positioning of the archway foundations as well as a series of 132kV HV oil filled power cables which are located centrally within the underpass. Further context on the assumed subsurface structures is given in section 5. It should be noted that trial holes will be required to confirm the position of foundations as presented in Figure 24.

Given the constraints within the archway area, there is the potential that the proposed design will require alteration following clarity gained when trial holes are concluded. Should the current design no longer be feasible then three mitigation measures to install the pipework should be considered:

1) Situate the flow and return pipework closer together – traditionally pipework spacing is ~250mm from the outside of the insulation, this could potentially be reduced to 150mm but may present issues with regards to maintenance of the pipework. Further investigation will be required to determine if there is sufficient space to install sleeves and undertaking welding.

2) Relocate the district heating pipework closer to the southern side of the tunnel. An unknown GPR has been identified to the eastern side of the trench which is assumed to be LV electric due to the depth. It may be possible to move the trench closer to these cables however trial holes will be required to confirm this. Relocating the pipework closer to the tunnel walls may pose an issue due to the depth of the tunnel abutments which could cause a structural concern as discussed in section 5. To locate the pipework, it would likely be necessary to relocate or remove a junction box on the eastern side of the tunnel which would require a request for an asset diversion or consent to remove and replace post works.

3) Stack the district heating pipework in a vertical formation. The extra trench depth required to stack the pipework could potentially present a structural issue due to the increased depth and place the pipework within the influence zone for the tunnel foundations. See section 5 for further discussion on this.

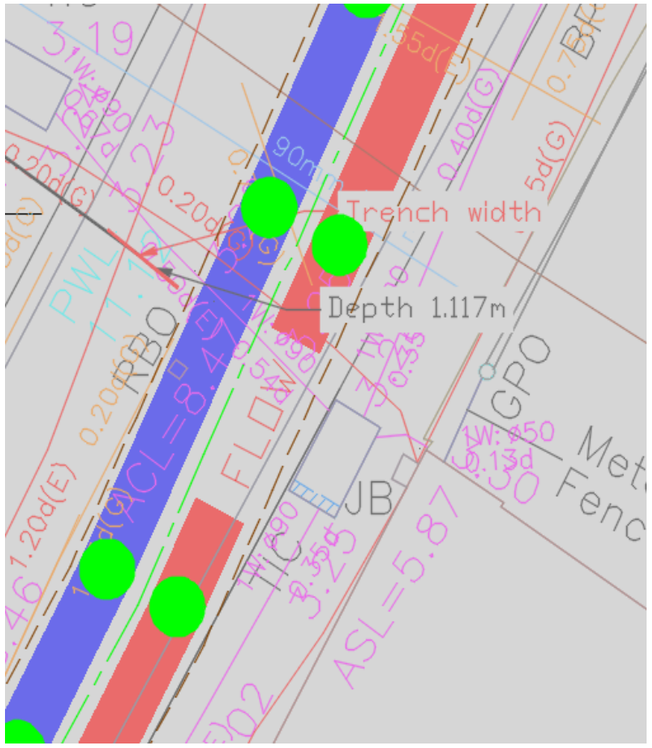

Figure 19 location of Junction Box in relation to proposed district heating pipework trench

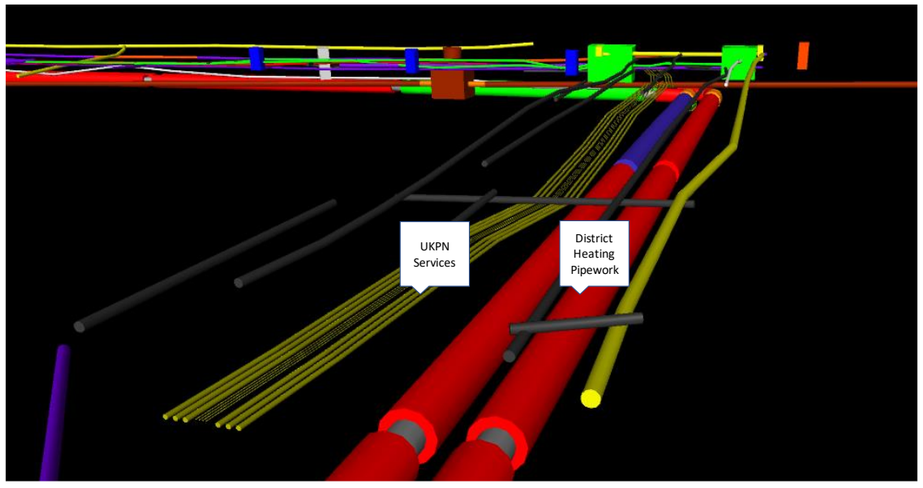

Figure 20 - UKPN services and proximity to proposed district heating pipe trench

Figure 21 Archway area looking south west prior to resurfacing. Ground scarring indicates location on UKPN cables

Figure 22 Manhole to be relocated next to Folkstone Gardens

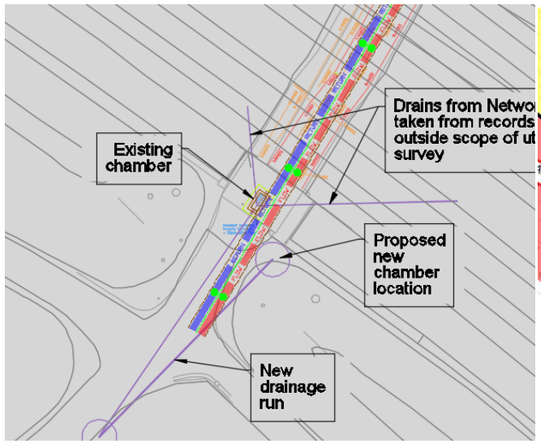

Figure 23 Suggested relocation of drainage chamber

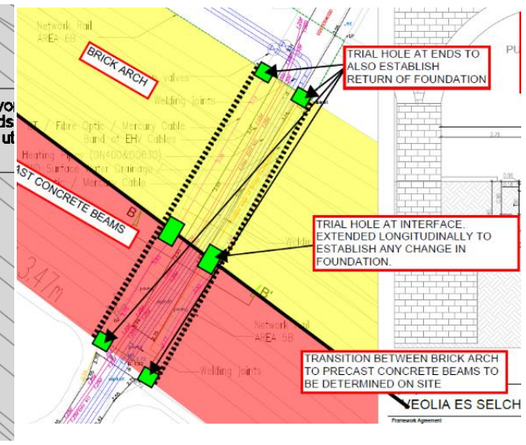

Figure 24 Suggested trial hole locations within archway area

5 Structural Assessment – Area 5B / 6B

The proposed route for the district heating pipework passes below Arch 95 / 95A. This section of the report documents the structural impact on the structure based on the proposed route. The structural review is based on available information at the time of writing.

An initial site walk over survey was carried out to assess the existing condition of the structures and establish possible areas of concern associated with the proximity of the pipes.

Based on the site walk over survey, the arch is constructed from brick masonry, and forms part of a longer viaduct comprising similar arches. The structure is extended on the south-west side with precast beams supported on masonry piers.

It is noted that the proposed route for the District Heating pipes will potentially affect the foundations of the bridge piers due to their proximity.

Network Rail have provided inspection reports for the bridge (Details Examination Report (2013) and Visual Examination Report (2017)), but no record or survey drawings describing the substructures and foundations have been located. These have been included within Appendix J.

The structural review is therefore based on a qualitative study.

5.1.1 Highway details

Type of highway

Under: Pedestrian access between Glosterwood Street and Folkestone Gardens

Over: Charing Cross and Dover Western Docks Line (Engineers Line Reference XTD)

Permitted traffic speed

Under: Not applicable

Over: Not known

Existing Restrictions

Not applicable.

5.1.2 Site details

Obstacles crossed

Pedestrian/cycle route.

5.1.3 Existing/proposed structure

Description of structure and design working life

The arch forms part of the railway viaduct carrying the Charing Cross and Dover Western Docks line. The exact date of construction is not known but is assumed to be in the 19th century. The age of the bridge suggests it has already exceeded a modern design life of 120 years.

As part of the District Heating network expansion, the proposed route passes beneath this arch and is located within the pedestrian and cyclist passage.

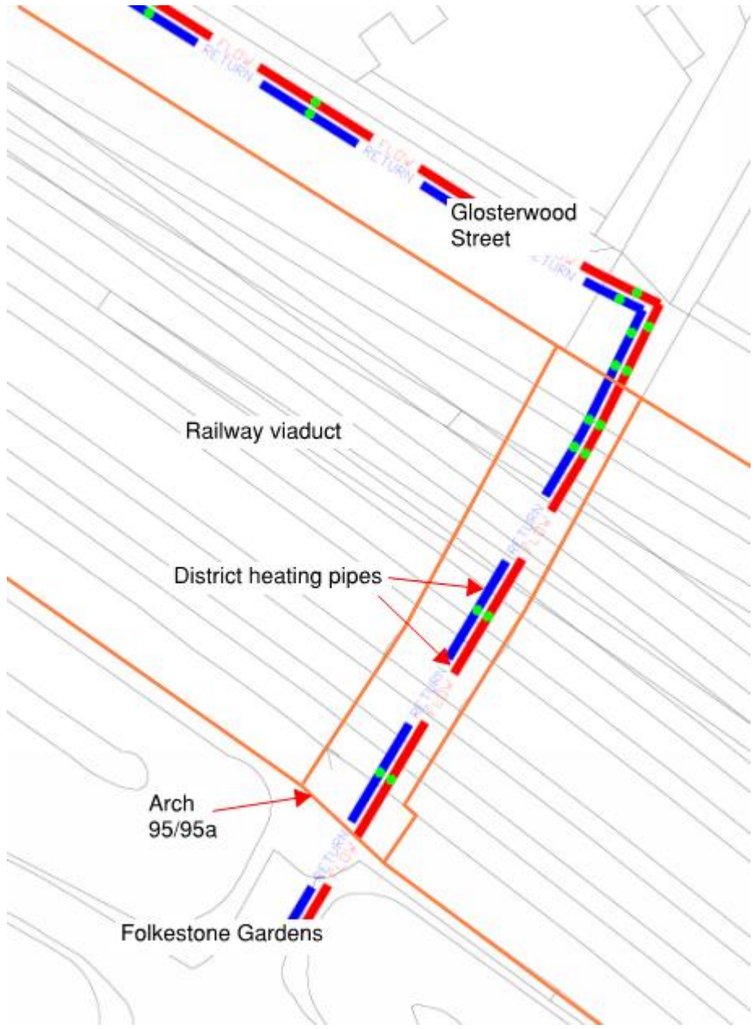

Figure 25 Plan of proposed route and Arch 95 / 95A

Figure 25 above illustrates the proposed route for the District Heating pipes in relation to the arch in plan.

Arch 95 / 95A is one of the many arches that form part of the railway viaduct. Arch 95 / 95A is currently used as a public access route.

The proposed pipes are to be located approximately 1.15m below the existing ground level. The existing ground level is to be reinstated after installation.

Figure 26. Arch 95 / 95A including indicative location of proposed pipes (looking south-west). Image: Google Streetview

5.1.4 Structure type

Existing

The existing arch structure is constructed from brick masonry. Towards the south-west side, the arch has been extended with precast beams on masonry piers (refer to Figure 27).

Figure 27. Arch 95 / 95A precast beam extension

The pedestrian/cycle route through the arch comprises tarmac, concrete and block paving.

5.1.5 Foundation type

Existing

No record or survey information has been provided for the foundations of the existing structure. It is assumed the masonry piers are founded on either a concrete or masonry spread foundation. The base of the pier is assumed to spread in a stepped arrangement to distribute vertical loading over a greater area. Figure 28 illustrates the assumed foundation arrangement. Depending on the exact size and depth, these may be influenced by the construction and installation of the District Heating pipes.

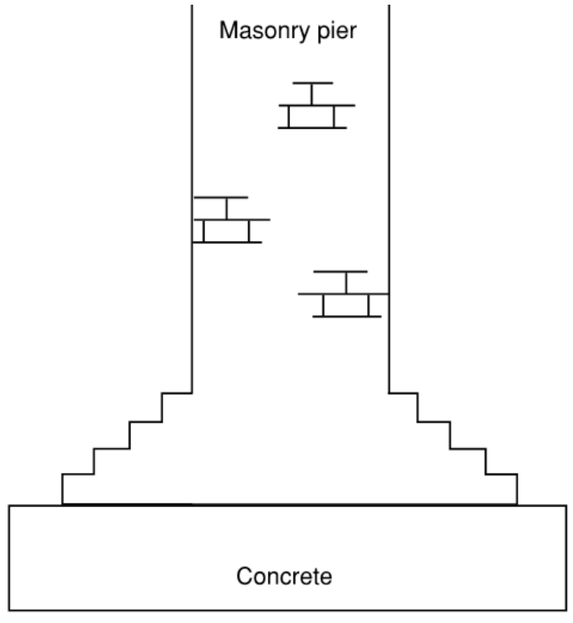

Figure 28. Assumed masonry pier foundation arrangement

5.1.6 Loading

Permanent loads

The existing loads applied to the pier foundations comprise self-weight of the masonry, spandrel walls, arch backfill, permanent way (track and ballast) and ancillaries.

It is considered that the proposed buried District Heating pipes will have no overall effect on permanent loading.

Live loads

The live loads applied to the pier foundations are principally due to loading from the railway line above.

The existing footway beneath is subject to pedestrian and cyclist loading.

The proposed District Heating route will not impose any additional live loading on to the area.

5.1.7 Assessment

The assessment will primarily focus on the proximity of the masonry piers to the location of the district heating pipework. No information on these structures was provided and therefore, a qualitative assessment will be carried out as permitted by *CS 459 – The assessment of bridge substructures, retaining structures and buried structures*.

A topographic survey has been carried out to establish nearby underground utilities within the pedestrian/cycle corridor.

Assumptions

- The size and depth of the foundation is unknown. The foundation is assumed to increase in size at a 1:1 splay angle.
- It is assumed that the influence zone in the ground below the footing also spreads at 1:1.
- 500mm clearance from finished ground level to top of pier foundation spread.
- Top of district heating pipes located 1.15m below finish floor level with total excavation depth of 1.76m.
- External diameter of each district heating pipe (including insulation) is 560mm.
- District Heating pipes have been designed to resist applied permanent loading and pedestrian/cyclist live loading.

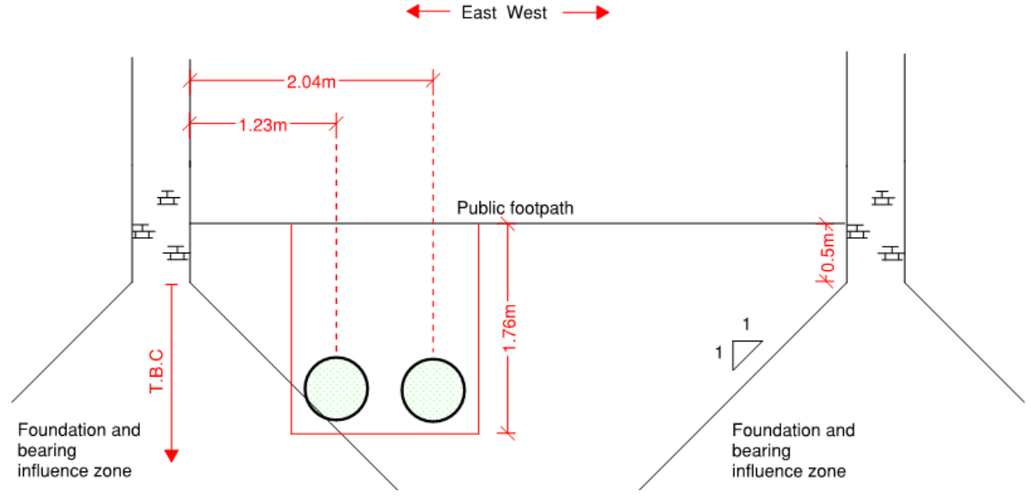

Figure 29. Indicative section through Arch 95a

Figure 29 illustrates an indicative section through Arch 95 / 95A. The position of the District Heating pipes is shown relative to the face of the nearest masonry pier. All dimensions are approximated based on available information and are subject to confirmation.

It is apparent that the extent of excavation will either clash with the foundation or fall slightly within the zone of influence of the foundation.

5.1.8 Results

Following the site visit, the proposed location of pipes is located within the pedestrian/cycle corridor. Based on assumptions and estimations of the foundation extent and bearing influence zones, the location of the pipes and excavation, the extent of the excavation may undermine or clash with the foundation of the eastern pier. The section is checked at the minimum clearance south-west of the arch. It is noted that the horizontal alignment of the underpass is skewed and clearance to the pipes increases towards the north end of the arch.

5.1.9 Recommendations

Based on the assumptions and results presented, the excavation for the installation of the pipes may undermine or clash with the existing foundation of the eastern pier.

To fully evaluate the situation and confirm assumptions, trial holes should be carried out along the eastern pier to establish the extent and depth of foundation. This will justify whether undermining or clashes are a potential risk.

In the absence of any survey being carried out, the following is recommended to minimise the potential effect of undermining the existing foundations:

- Relocation of the pipes closer to the centre of the footway (approx. 0.5m west) – this will bring the excavation outside of the potential influence zone/foundation structure.
- If practical, install temporary/permanent sheet piles along the southern edge of the excavation – this will provide resistance for the bearing of the foundation slab.

6 Structural Assessment – Surrey Canal Road

The proposed route for the district heating pipework passes below the Surrey Canal Road bridge (EL 40). This section of the report documents the structural impact on the structures based on the proposed work. The structural reviews are based on available information at the time of writing.

6.1.1 Outline of assessment

An initial site walk over survey was carried out to assess the existing condition of the structures and establish possible areas of concern associated with the proximity of the pipes.

Based on the site walk over survey, the bridge structure spans over Surrey Canal Road, which is situated within a retained cutting. The bridge abutments are located above and well behind the road and retaining walls forming the retained cut.

It is noted that the proposed route for the District Heating pipes will potentially affect the retaining walls due to the proximity. Effects are considered negligible to the remote bridge abutments.

TfL have provided inspection reports for the bridge (Visual Examination Report (2017) and Detailed Examination Report (2016)), but no record or survey drawings have been located.

The structural review is therefore based on a qualitative study.

6.1.2 Highway details

Type of highway

Under Surrey Canal Road

Over London Overground railway

Permitted traffic speed

Under 20 mph (Surrey Canal Road)

Over Not known

Existing Restrictions

Not applicable.

6.1.3 Site details

Obstacles crossed

Surrey Canal Road (unclassified).

6.1.4 Existing/proposed structure

Description of structure and design working life

The bridge is a railway underbridge carrying the London Overground across Surrey Canal Road. Based on limited information it is assumed the deck of the bridge was completed in the early 2000s and made use of previously existing abutments. It is assumed the new deck structure was designed for a 120-year life.

The proposed route passes beneath this bridge and is located within the northern carriageway.

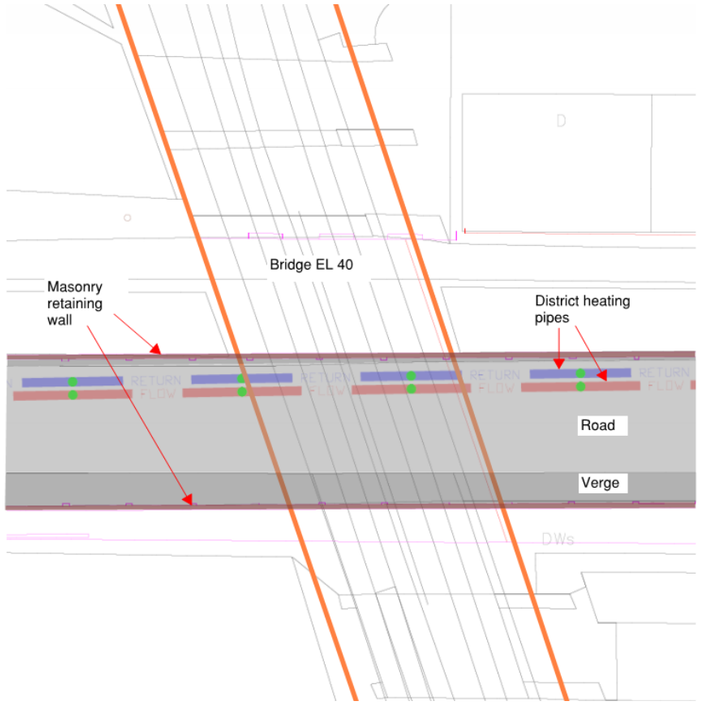

Figure 30. Plan of proposed route and Bridge EL 40

Figure 30 above illustrates the proposed route for the District Heating pipes in relation to the road in plan.

Surrey Canal Road is situated within a retained cutting (see Figure 31). The proposed pipes are located approximately 1.5m below the existing road level. The existing road level is to be reinstated after installation.

Figure 31. Surrey Canal Road and retaining wall including indicative location of proposed pipes (looking east). Image: Google Streetview

6.1.5 Structure type

Existing

The existing bridge structure comprises a steel superstructure supported on masonry arch abutments. The superstructure is arranged with longitudinal edge girders and several intermediate transverse cross beams in a ladder arrangement.

Surrey Canal Road is located within a retained cutting supported by retaining walls finished with brick masonry. The masonry includes intermediate pilasters. The form of construction is otherwise unclear.

6.1.6 Foundation type

Existing

No record information was provided for the existing bridge abutment foundations. However, as the abutments are remote from the highway, it is assumed that the foundations are not influenced by the construction and installation of the District Heating pipes.

No record or survey information is provided for the existing retaining walls and their foundations. It is assumed for this review that the walls are supported on spread foundations. Depending on the exact size and depth, these may be influenced by the construction and installation of the District Heating pipes.

6.1.7 Loading

Permanent loads

The permanent loads from the bridge are not considered to affect the district heating pipework.

The existing retaining walls are subject to permanent loads from self-weight and retained earth. These loads are considered to transfer directly into the ground.

It is considered that the proposed buried district heating pipes will have no overall effect on permanent loading.

Live loads

Live loads on the bridge are not considered to affect the district heating pipework.

The existing retaining walls should be considered subject to pedestrian live load surcharge at retained level. The area in front of the retaining walls (i.e. verges and carriageway) should be considered subject to traffic loading.

The proposed District Heating route will not impose any additional live loading on to the area.

1.1.2 Assessment

The assessment will primarily focus on the proximity of the retaining walls either side of the carriageway. No record information on these structures has been provided and therefore a qualitative assessment will be carried out as permitted by *CS 459 – The assessment of bridge substructures, retaining structures and buried structures*.

The level difference has been determined based on a topographic survey that has been carried out to establish nearby underground utilities and visible structures.

Assumptions

- The retaining walls are assumed to comprise inverted T cantilever walls supported on spread foundations.
- The size and depth of the foundation for the walls are determined by general “rule of thumb” based on the retained height.
    - *Base width ~ 2/3 of retained height.*
    - *Toe ~ 1/3 of base width.*
    - *Heel ~ 2/3 of base width.*
- Top of base slab is 500mm below finish level of the road.
- The foundation bearing influence zone is assumed to distribute load at a 1:1.
- Proposed top of pipes are located 1.5m below road level with total excavation depth of 2.23m.
- External diameter of pipes is 630mm.
- Pipes have been designed to resist applied permanent loading and vehicular live loading.

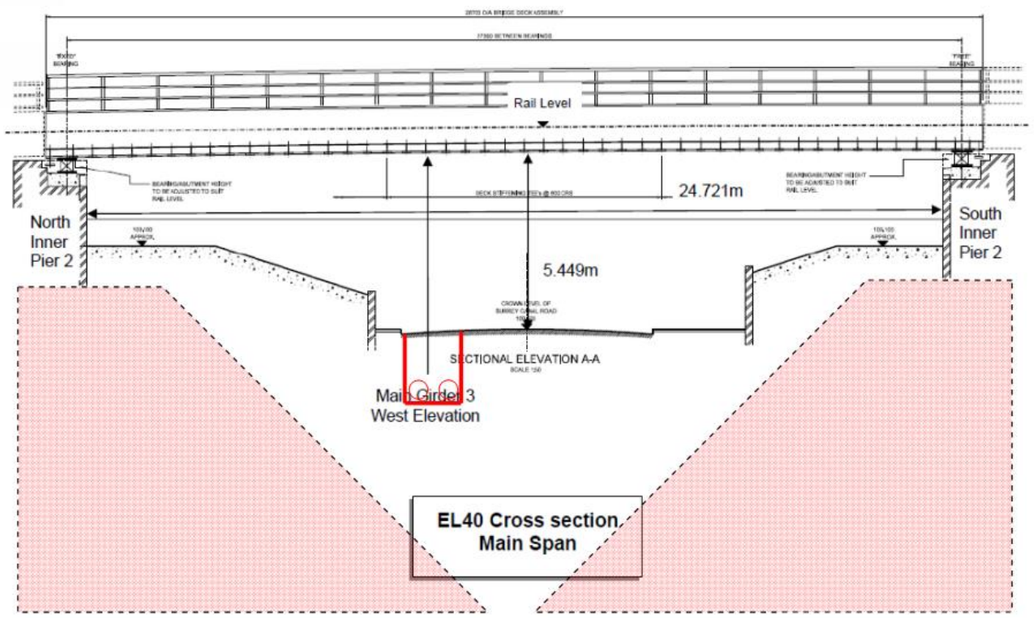

Figure 32. Extract from TfL Detailed Examination Report potential influence zone of bridge abutments

Figure 32 above illustrates that the assumed influence zone of the bridge abutments is located well behind the retaining walls and the proposed excavation for the district heating pipes. This reinforces the assumption that the excavation works for the pipes is unlikely to influence the bridge abutments.

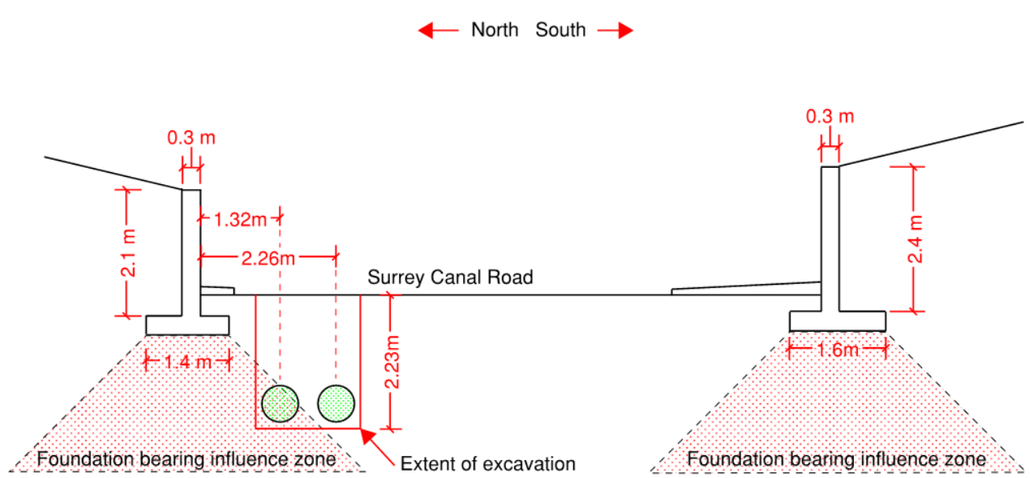

Figure 33. Indicative section through Surrey Canal Road

Figure 33 above illustrates an indicative section through Surrey Canal Road. The position of the district heating pipes is shown relative to the front face of the masonry retaining wall. All dimensions are approximated based on available information and are subject to confirmation and design development.

It is apparent that, with the current assumptions, the extent of excavation will fall within the zone of influence of the retaining wall's foundation.

6.1.8 Results

Following the site visit, the proposed location of pipes is located within the carriageway. This is considered far enough from the main bridge structure that any effects due to construction and installation will be negligible. Effects on the bridge are therefore not considered in this assessment.

The adjacent retaining walls are near to the proposed route. Based on estimations of the size of the retaining wall, the location of the pipes and excavation as well as the foundation for the northern wall would be undermined. This potential issue is likely to occur across the length of the wall as the pipes run substantially parallel with the wall.

6.1.9 Recommendations

Based on the assumptions and results presented, the excavation for the installation of the pipes potentially undermine the existing foundation of the northern retaining wall.

To fully evaluate the situation and confirm assumptions, trial holes should be carried out along the northern wall to establish the form of construction and foundation arrangements. This will justify whether undermining is a potential risk.

In the absence of any survey being carried out, the following is recommended to minimise the potential effect of undermining the existing foundations:

- Relocation of the pipes closer to the centre of the roadway (approx. 1m south) – this will bring the excavation outside of the potential influence zone of the foundation.
- If practical, install temporary/permanent sheet piles along the north edge of the excavation – this will provide resistance for the bearing of the foundation slab.
- If practical, reduce the width of excavation by vertically stacking the pipes above one another – this will bring the excavation outside the potential influence zone however, the depth of excavation may increase. A combination of relocating the pipes further south and stacking of pipes may be considered.

7 Stakeholder Engagement

7.1 Overview

This section presents an overview of the engagement with key stakeholders and utility providers to determine route feasibility as well as suggested next steps for further engagement. A stakeholder matrix has been included within Appendix H which outlines contacts, the status of the current engagements as well as associated risks and potential mitigations. The stakeholder matrix should be read in conjunction with the HAZID register in Appendix C

The following key stakeholders have been engaged with as part of this study:

- UKPN
- SGN
- Thames Water (potable water & drainage)
- London Borough of Lewisham
- The Arch company (ArchCO)
- Network Rail
- TfL

7.1.1 UKPN

There are several instances where the proposed pipework route is close to UKPN services. As such UKPN were engaged to understand any concerns.

A meeting was held on 21/10/2019 with UKPN to discuss the proposed route and interaction with UKPN services with a focus on the Archway area (5B) where the pipework route runs parallel with HV cabling. The following should be noted from the meeting:

- There was discussion around locating district heating pipework in area 5B within proximity to UKPN HV cables - the primary concerns of UKPN were related to potential thermal de-rating of their cables.

- BuroHappold provided thermal modelling results for series 2 pipework using Logstor tool. Results indicate minor impact to the cabling. The return leg of the pipework is situated closest to the UKPN services which will typically operate at a temperature of 50°C. The modelling indicated that there was a ~2-3°C increase (above ambient air temperature) on the closest UKPN cable. Figure 34 illustrates the heat transfer from the district heating pipework to soil with an average thermal conductivity. In this example, a "worst case" is assumed with an external ambient temperature of 30°C and a temperature on the return leg of the pipework of 85°C. The red dot represents the location of the nearest UKPN service in relation to the pipework which is at a temperature of 33.3°C under these conditions. UKPN signified during the meeting that this temperature increase was acceptable to the cabling, however they would need to undertake their own modelling. As such route layout drawings have been supplied to UKPN to undertake this process.

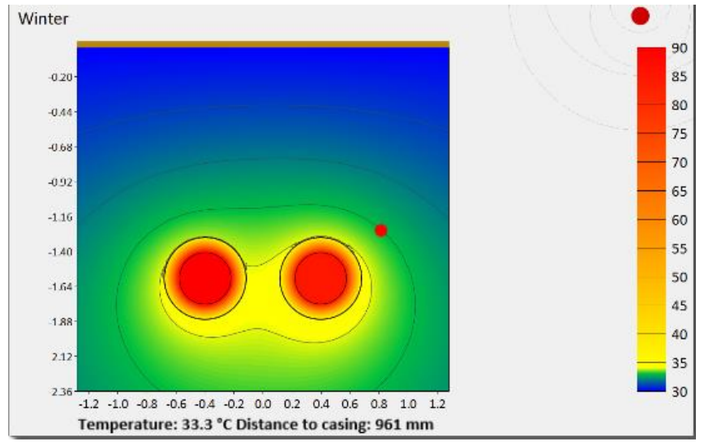

Figure 34 Thermal interaction of buried pipework with surrounding area

- During the meeting, UKPN provided record drawings of the cable installation within the tunnel which indicated 6 no. cables in parallel which conflicts with what had been picked up on the GPR survey.

- The 6 no. cables are covered with reinforced concrete slabs and occupy a trench approximately 914mm wide (3.0 ft) wide at a depth of between 1.12 to 1.18m BGL through the tunnel while the results of the GPR survey indicated depths around 1.25mm. Detail received from UKPN can be found in Appendix J.

- When overlaying these new details, the clearance from the end of the district heating trench to the UKPN trench reduces from 240mm to 169mm at the closest point.

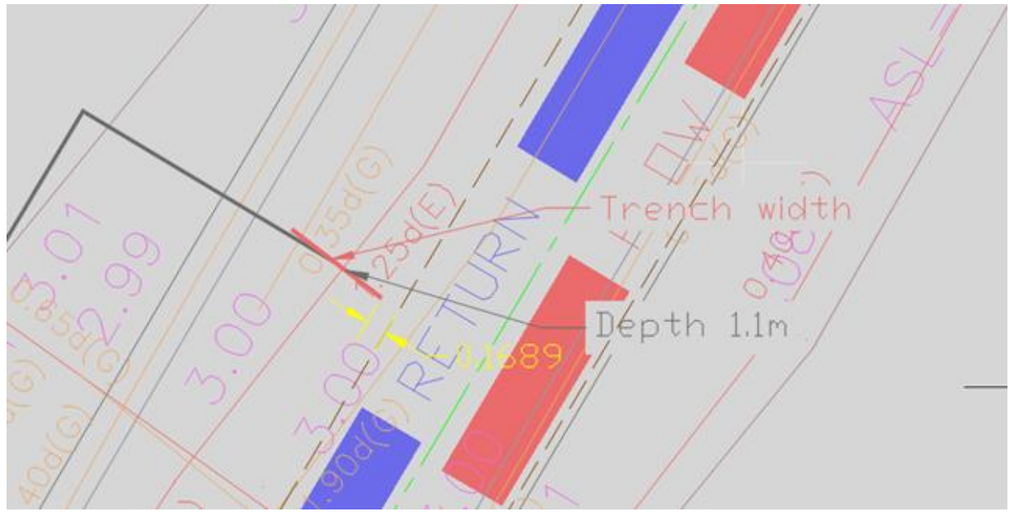

Figure 35 Distance between UKPN services trench and proposed district heating pipework

- While this clearance should not present an issue from the point of view of thermal derating of the cabling, it could present an issue with regards to installation of the pipework due to the requirement for 75-100mm allowance for shoring / temporary works.

- UKPN will need to continue to be engaged with regards to the excavation works and proximity of the district heating pipework installation around their services, around both Surrey Canal Road and around the Archway Area.

7.1.2 Southern Gas Networks (SGN)

Within Surrey Canal Road, there are three instances where the proposed pipework route crosses Southern Gas Network (SGN) gas services. SGN were engaged to understand concerns related to the installation of district heating pipework and details of the proposed route have been issued to SGN for review and comment.

A meeting was held on 07/11/2019 with SGN to discuss the proposed route and interaction with their services with a focus on crossings in the Surrey Canal Road area. Crossing of these high-risk assets have been designed to pass at 90 degrees to the gas to minimise asset exposure during installation of the district heating pipework.

The following should be noted from the meeting:

- Ideally, SGN require a minimum of 600mm clearance from their IP gas services. Final clearances between district heating pipework and IP gas mains will need to be determined following completion of trial holes at crossing points.
- A key concern noted from SGN was the maintenance of their pipework. It was requested that any crossings of their services be located away from elbows and bends should they have to perform welds to maintain their services. When crossing their pipework, it is advisable to cross above rather than below. This is reflected within the route design.
- The SGN plant protection team must be notified when excavation works will be undertaken nearby to their asset and may require a watching brief while these works are being undertaken.
- Layouts received from SGN indicate slightly different depths of the gas main than were noted on the GPR survey. Information received from SGN on the depth and location of their services along Surrey Canal Road can be found in Appendix J.
- SGN will assess any contractor RAMS before works commence on preconstruction trial holes nearby to their services. RAMS should be submitted to the individuals given within the stakeholder engagement matrix in Appendix H.
- SGN noted that they have an approved list of contactors for undertaking trial hole works. They will require a minimum 1-month lead time to engage contractors and would likely be present on site during the excavation works.
- It will be necessary to continue to engage SGN as the design progresses to address any issues and concerns.

7.1.3 Thames Water (Potable Water)

Thames Water Mains design Team have been engaged regarding the diversion of the potable water mains on Surrey Canal Road and to initiate discussions on acceptable proximity of the district heating pipework to their services. Guidance was received and has been included in Appendix J.

The proposed design of the potable water diversion has been issued to Thames Water and will be assessed by their design teams to determine suitability and impact to their network. The proposed diversion of their services is included in Appendix K. Relevant contacts to continue the engagement on this matter are included within the stakeholder engagement matrix.

7.1.4 Thames Water (Drainage)

Thames Water drainage have been engaged regarding the required drainage diversions around the archway in area 5b. A response has been received indicating that a Section 185 application will be required. Further engagement with Thames Water should be undertaken as the design progresses following the conclusion of the trial holes to identify the exact location of services.

7.1.5 The London Borough of Lewisham

A meeting was held with Lewisham Council on 27/06/2019 to discuss issues around the proposed route with a focus on traffic management and reinstatement of surfaces that would be disturbed by the works.

Maintaining a flow of traffic along Surrey Canal Road by keeping one lane of traffic open to vehicles is considered essential. Further engagement with Lewisham council should be undertaken as the design progresses to ensure an effective traffic management programme.

The council own the carriageway and footpaths on Surrey Canal Road. The supporting base of the bridge abutments on Surrey Canal Road are highway walls and Lewisham Council have stated that they would require assurances that the pipework does not unduly overload or undermine the wall structure.

Beneath Arch 95 / 95A, Lewisham council noted that an easement from Network Rail to access their land would be required and that it may be possible to link this with any easement / licence for the section parallel to the railway outside the arches. The council noted that it would be necessary to liaise with Network Rail Outside Parties group.

Assistance was requested with regards to ascertaining Information on the retaining wall structures around Surrey Canal Bridge and the Network Rail arches to allow more accurate modelling of structural impacts from the district heating pipework, however no response was received.

Continued engagement with London Borough of Lewisham will be required to gain the required consents and assurances before pipework installation may commence within their land.

7.1.6 The Arch Company (ArchCO)

The ArchCO have been engaged directly by Veolia SELCHP to understand ownership and consent requirements within area 5b and 6b. The Arches are under a long lease from Network Rail to the Arch Company but the land itself belongs to Network Rail. During a meeting on 07/05/2019, the Arch Company noted their desire to minimise impact to tenants and that the proposed route may cause issues from a commercial management perspective. A provisional construction methodology was prepared by Veolia for submission to the Arch Company to clarify timescales, engineering activities and trench dimensions. This report can be found in Appendix L.

Continued engagement will be required to understand consent requirements for pipework installation between Network Rail and the ArchCO.

7.1.7 Network Rail & TfL

Network Rail and TfL were contacted to gain clarity on the sub-structures within Surrey Canal Road Bridge and The Railway arches to determine any potential impact to pipework installation. Detailed information on these structures were not received during this study. Continued engagement with these parties should continue to take place to ascertain the required information, pending trial holes to identify actual sub-surface structures.

Contacts have been provided within the stakeholder matrix in Appendix H. These stakeholders should continue to be contacted to progress easement requirements and consents.

8 Identified HAZIDS and associated mitigation

8.1 Overview

A HAZID assessment has been prepared along the proposed route, this has been included within Appendix C. The HAZID register outlines the area of the identified risk, an overview of the risk itself as well as suggested control measures.

Trial holes shall be required to clarify feasibility of the proposed design in specified locations. It should be noted that trial holes can be inconclusive in the information they provide as such, additional trials holes should be allowed for than those noted within the HAZID register.

8.2 Key Identified HAZIDS

The key identified risk areas to the installation can be summarised as follows:

Area 2A – Junction between Surrey Canal Road and Landmann Way

The junction between Landmann Way and Surrey Canal road is heavily congested with services which includes HV cabling and an IP gas main. The current design involves pipework installation routed beneath existing services and passing over an IP gas main before routing down the northern carriageway of Surrey Canal Road. It may be necessary to increase the buried depth of pipework in this area.

Area 3 - Surrey Canal Road Bridge

The proposed pipework route beneath Surrey Canal Road Bridge resides on the edge of the assumed influence zone of the supporting structures for the bridge. Trial holes will be required to identify the precise location of supporting structures before a final design can be determined. It may be necessary to locate the district heating pipework more centrally Surrey Canal Road so as the pipework does not reside within the structural influence zone.

Area 5B – Arch 95 / 95A archway

The area beneath the archway presents significant difficulties for the installation of district heating pipework. There are a series of existing UKPN HV power cables which reside centrally within the tunnel. There is little clearance between the edge of the district heating trench and the UKPN trench with the proposed design. Following the conclusion of trial holes, there is a risk that the current clearance could further reduce, creating further design complications. Possible mitigation measures have been summarised in section 4.3.

9 Construction Methodology

9.1 Overview

This section outlines the proposed construction methodology and traffic management considerations for the proposed route. This section should be read in conjunction with the constructability and phasing drawings within appendices D to F.

9.2 Proposed Construction Methodology

9.2.1 Surrey Canal Road

Installation of district heating pipes in Surrey Canal Road is restricted by the width of access from the road and soft verge to the north with established trees and new saplings.

As part of this study, four operations have been considered to allow the works to be undertaken:

1. Excavation
2. Pipe layout to the trench
3. Pipe welding and sleeving
4. Backfilling.

9.2.1.1 Excavation

The design has considered excavation and traffic management to allow the maximum trench opening at any one time, as this will speed the excavation and installation process.

It is anticipated that dumpers will be loaded behind the excavators, slewing over the grass verge side rather than over a live traffic lane. The backfill strategy, welding and sleeving will influence the temporary works design and edge protection, and this should be coordinated with the Principle Contractor when appointed.

9.2.1.2 Pipe Layout to trench

Figure 36 - "rubber duck" excavator

Owing to the restrictive nature on the work area, three potential options to load pipe into the trench have been identified. These are as follows:

1. The preferred option would utilise a "rubber duck" wheeled excavator suitable for lifting operations. This would allow for pipes to be transported from a local storage area to the trench using the live traffic lane and loading into the trench. This operation normally takes 15 to 30 mins per load depending on the complexity of the utilities, when considering this installation, a 15-minute operation is anticipated. This operation would likely need to be carried out during night time periods when short road closures and holding of traffic can be carried out.

2. As the routing of the pipework within Surrey Canal Road is predominantly straight and direct with the exception of the far east and west ends, a second option could be to load out the pipes at the end of the trench, make the welds at the ends and pull the connected pipes through the trench, or pull single pipes and weld in position This method has inherent risks as if any unknown assets affect the design and curved or angle pipes are require to navigate the obstruction, this pulling method would not work. The loading out would have to revert to the first option.

3. A third option would be to transport the pipes along the foot path and across the grass verge before loading into the trench from the grass verge, this option would require agreement with the arboriculture officer as damage may be caused to the trees and compaction to the ground in the root areas, if restrictions were imposed, access to the whole length for installation would be prevented. Also taking plant and materials along the footpath may cause damage that would require repair/replacement.

9.2.1.3 Pipe Welding and Sleeving

Should the trench along Surrey Canal Road remain open, welding equipment could be placed on the grass verge as required from the live lane, and sleeving could be carried out using extended leads from the vehicle. This installation process is subject to the plant and equipment used by the installation company and should be developed during the pre-contract stage.

An alternative option is to provide strategic locations where the trench is covered with steel plates to allow parking of the service vehicles, it is not envisaged this operation will cause significant difficulties.

9.2.1.4 Backfilling

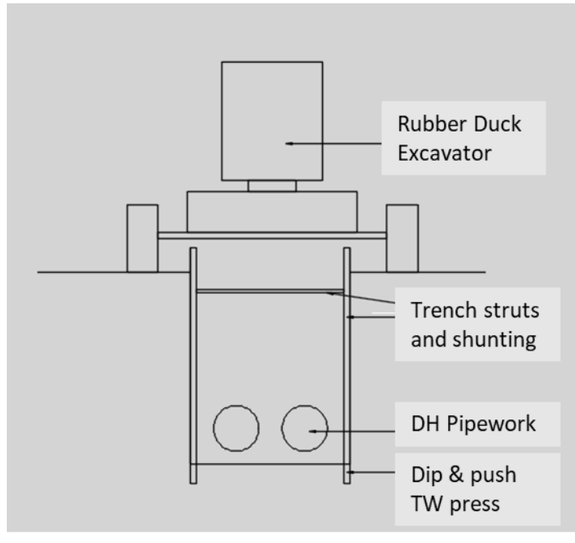

Figure 37 Backfilling diagram

As the installation is a linear design with restricted width within the working area, there are different two identified options for backfill:

1. Fill and push
2. Side fill and manual distribution

Fill and Push requires the "rubber duck" excavator to straddle the trench when the sheet piles are installed to allow access to move the backfill along the trench. This method has an additional advantage as pipes may also be able to be loaded out and welding plant could be positioned along the verge.

A disadvantage with this method relates to the sheet piles requiring to be cut above ground level, clear of the excavator, which will add additional cost to the temporary works.

Proceeding with a side fill requires a dumper to access the side of the trench for minimum time to discharge the load to the trench, over the raised edge sheet pipes to act as edge protection.

A disadvantage relates to the first loading of the sand having to be distributed in small quantities as a full load discharge directly onto the pipe supported on sand bags could damage the pipework and may not adhere to the pipe manufactures normal backfill procedure, by placing the sand material around the pipe.

9.2.2 Area 5B / 6B

Installation of pipework in this area should commence from the southern end of the tunnel. The trench will require to be over excavated at this end to install the pipe as shown in Figure 38 and Figure 39. Ventilation systems will likely be required due to the nature of the confined space. The preferred and safest option is to prevent all other access to the tunnel during installation works. Excavation will be undertaken via hand dig where required with mechanical assistance from a mini excavator and dumper similar to those shown in Figure 41 and Figure 40.

Figure 38 Installation method - south end

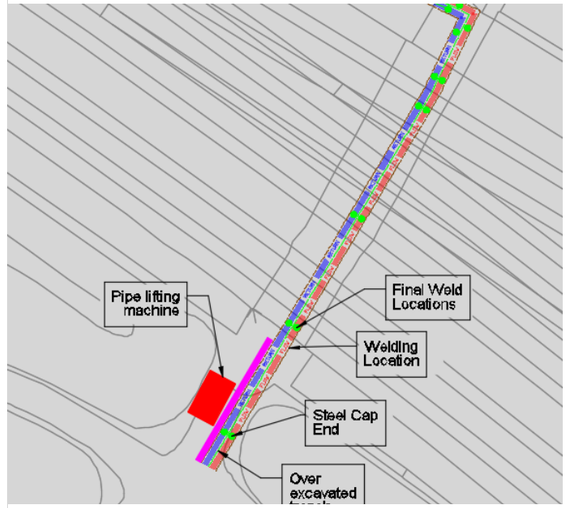

Figure 39 Installation method - north end

Installing the pipes from the north side of the tunnel was considered but not taken forward due to maintaining access to the arches in area 6B as well as the confined working areas between the arches and adjacent buildings and the difficulty in navigating the installation of the DH pipe past the drainage and services crossing the tunnel.

The installation method developed requires the trench to be over excavated on the south side of the tunnel. The initial pair of pipes would be lowered to the trench as indicated in the magenta area in Figure 38.

A second machine would be located at the north side of the tunnel to pull the first pair of pipes. Alternatively, this machine could be used as an anchor and a pulling winch used to reposition the pipes.

When the initial pair of pipes (flow and return) are repositioned the second pair would be lowered into the trench and the welding completed externally to the archway. The weld can then be tested. The phased array method is recommended as standard ultra sound and X-ray would not be permitted in this location.

The pipe weld is then sleeved and foamed. The pipes can now be pulled through the tunnel once again via the same process to allow the third pair of pipes to be installed. The same process of welding, testing and sleeving would be carried out.

The final adjustment of the pipe position would be made using the same pulling method, to locate the pipes in their final designed position.

The final bends which navigate the drainage and services to the north of the tunnel could be lowered in from the north side of the bridge and welded in-situ to ensure correct alignment.

Access and approval will be required from the parks authority to deliver pipes to the south entrance to the tunnel.

Figure 41 Mini excavator

Figure 40 Mini dumper

Two potential methods of backfilling have been identified.

1. Back fill along the pipe by sanding around the pipes, laying the sub-base to ground level, then moving to the next length that can be reached by the excavator.
2. Using a mini excavator to load material into the trench via a mini earth mover to bring the material to the excavator, to fill the trench and compact in individual layers throughout the length of the tunnel.

When considering the installation in area 6B, there is no identified civil restriction for excavation or installation. The restrictions come from the requirement to maintain access and this will be covered under traffic management. A separate report has been prepared by Veolia and submitted to the ArchCo detailing the proposed installation methodology within this region. This report is included in Appendix L.

9.3 Traffic Management

9.3.1 Surrey Canal Road

With the current network design entirely located within the northern carriageway, it is anticipated that either a one- or two-way system would be utilised to maintain traffic flow.

Should the pipework require to be moved more centrally within the carriageway to avoid potential issues with undermining the bridge substructures, then it should be feasible to maintain a traffic system through modification of the pavement on the south carriageway, thereby allowing a greater clearance for the trench. It will however be important to assess the impact this would have on the bridge clearance.

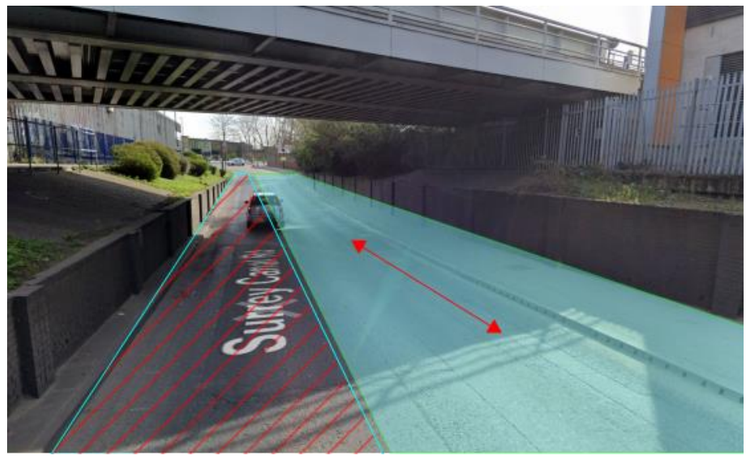

Figure 42 Southern carriageway extended to pavement area to allow wider carriageway during installation

The use of a one- or two-way system would allow for Surrey Canal Road to remain open to traffic, if required, which will likely increase the speed of installation through this section of the highway. The optimal solution shall require further discussion and approval from the local highways and traffic management departments.

9.3.2 Arch 95 / 95A (Area 5b / 6b)

The tunnel will likely require to be closed off to all pedestrian and bicycle traffic for the duration of the works, however this will depend on Lewisham Borough Council consent and consent of the contractor undertaking the works. It may be feasible to maintain a narrow channel for pedestrian access but this yet to be determined.

Traffic management for the area 6b is discussed in the report included in the Veolia report included within appendix L.

10 Material Take-off

10.1 Overview

The material take-off with the current design is shown within Table 3 and Table 4. The total length of installed pipework is approximately 732m (flow and return) pipework.

Table 3 Arch 95 / 95A material takeoff

Arch 95 / 95A DN350_560	
Pipe Type	**Quantity**
90° Bend	2
8° Bend 1mx1.5m	1
8° Bend 1mx2.5m	1
10° Bend 1mx1m	2
7° Curve	2
Straight Pipe (standard 12m)	15
Steel End Cap	2

Table 4 Surrey Canal Road material take-off

Surrey Canal Road DN400_630	
Pipe Type	**Quantity**
90° Bend	24
44° Bend 1.6m x 2m	1
44° Bend 1.6m x 2.5m	1
3° Curve	2
6° Curve	2
10° Curve	2
Straight Pipe (standard 12m)	46

11 Recommendations & Next Steps

11.1 Overview

This study has presented an appraisal of a proposed district heating pipework route through areas 2A, 2B, 3, 5B and 6B based on observed utility information received and a structural assessment at key areas. To finalise and further de-risk the design it will be necessary to conduct further stakeholder engagement and trial hole studies within selected areas of the route.

A route has been identified, however a finalised design will require further stakeholder engagement and trial holes to be undertaken in numerous locations to verify the location of existing services and structures. Three key areas of concern are:

- The junction between Surrey Canal Road and Landmann Way, due to high congestion of services requiring district heating pipework to cross HV services and an IP gas main.
- The area beneath Surrey Canal Road Bridge due to the potential proximity of the district heating pipework to the influence zone of supporting sub-structures
- The area beneath the archway (Area 5b) due to:
    - Spatial constraints within the archway itself (5m width)
    - The presence of 6 no. HV cables installed centrally within the carriageway
    - The potential proximity of district heating pipework to the influence zone of the archway supporting sub-structures

Changes to pipework routing are considered possible for areas of concern along Surrey Canal Road pending the conclusion of the trial hole assessment and further stakeholder engagement. However, following the conclusions of trial holes and further engagement with UKPN for area 5b, it may be deemed infeasible to install pipework within this area. Therefore, a separate study has been commissioned to survey the area around the underpass between Surrey Canal Road and Grinstead Road to determine the potential for district heating pipework to be installed and to mitigate against risk to programme.

A summary of the next steps is summarised below.

11.1.1 Stakeholder engagement

- UKPN and SGN should continue to be consulted as the design progresses to understand any concerns with proximity of the district heating pipework to their services in identified areas (particularly within area 5b) as well as any requirements for onsite presence during trial holes or district heating pipe installation.
- Thames Water (potable water and drainage) should continue to be engaged to understand timescales and ultimately gain consent for diversion of services, particularly the potable water supply on Surrey Canal Road and the possible relocation of the drainage chamber at the southern end of Arch 95 / 95A.
- Lewisham Council should continue to be engaged to gain assurances that there will be no structural impacts to the structures along Surrey Canal Road bridge. Phasing of works and traffic management will require agreement once the design is finalised.
- An agreement should be reached with Network Rail and the Arch Company to determine the required consents for installation of pipework within areas 5b and 6b.
- TfL will require further engagement when sub-structures are better understood on the Surrey Canal Road bridge to provide necessary assurances and gain any required consents for installation of pipework near their structures.
- A tree survey should be carried out to confirm the protection requirement and pruning that may be required, when a detailed installation methodology has been developed.

11.1.2 Finalising the design

Trial holes will be required to give confidence to the final design of the pipework route to ensure services are appropriately located along and sub structures are better understood. Deviations to the proposed route may be required following the trial hole process.

Appendices

The following Appendices have been included as separate submissions from this report.

- Appendix A - Overall General Arrangement Drawings
- Appendix B - General Arrangement with GPR and Trial Hole Information Drawings
- Appendix C - Design Phase HAZID Drawings
- Appendix D - Combined Civil & Mechanical Construction Drawing and Setting Out Detail Drawings
- Appendix E - Civil Construction Drawing and Setting Out Detail Drawings
- Appendix F - Constructability Drawings
- Appendix G - 3D Model of Proposed Route
- Appendix H - Stakeholder Engagement Matrix
- Appendix I - GPR & Topography Drawings and Associated Report
- Appendix J - Information received from Stakeholders
- Appendix K - Proposed Thames Water Diversion
- Appendix L - Provisional Construction Methodology for Area 6b
- Appendix M - Stakeholder correspondence

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