London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Report compilation (WP1A, WP1B, WP1C, WP1D, WP1E)

MAY 2020

CONFIDENTIAL

London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Report compilation (WP1A, WP1B, WP1C, WP1D, WP1E)

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70057109

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EXECUTIVE SUMMARY

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. One element of this is the potential development of a district heating network, where the aspiration would be to provide new and existing buildings a cost-efficient means of moving from natural gas as the dominant fuel, to a lower carbon and renewable fuel mix

A feasibility study was completed in 2017 which indicated that an initial scheme based on new development and existing public-sector buildings was economically viable. The council has allocated a site for the scheme energy centre. With new developments having to meet the London Plan Zero Carbon target, the best longer-term low carbon heat supply option would be to connect to the Beddington Energy Recovery Facility (ERF). This commission aims to provide greater confidence in the viability of this supply option, and an alternative based on gas-fired CHP in the identified energy centre.

The objective of the work is to develop a viable scheme that can proceed to procurement.

The scope of the overall commission therefore comprises:

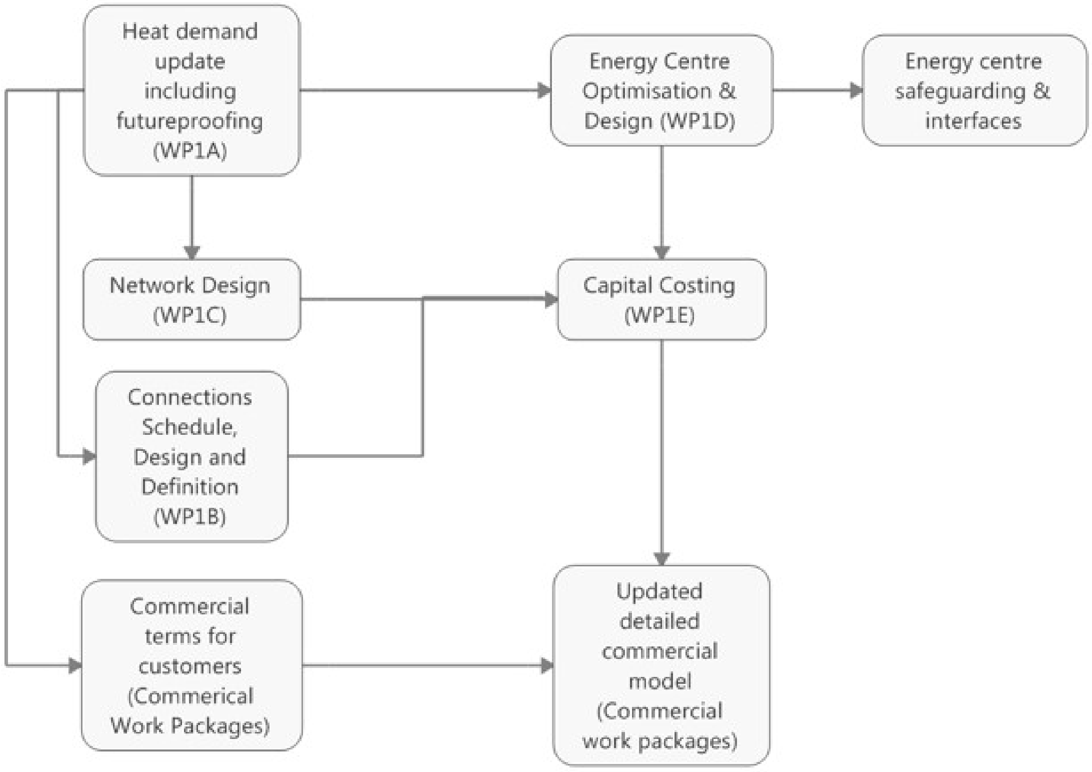
- A review of the 2017 feasibility study
- Updating the heat demands and techno-economics (according to the current phasing of new development)
- Establishing a preliminary system design, along with the capex and opex to a good degree of certainty – including the option of connection to the Beddington ERF plant
- Carrying out a commercial evaluation and identify the business models options that could be taken forward by the Council.

The scope of work is split into five work packages:

- **Work Package 1A:** Heat demands and consumptions. Power demand and consumption for potential 'private wire' supply to civic centre buildings.
- **Work Package 1B:** Distribution and supply to end users
- **Work Package 1C:** Heat network infrastructure
- **Work Package 1D:** Energy Centre
- **Work Package 1E:** Cost schedule for energy centre plant and pipe network

The workflow of the work packages and their relation to the commercial modelling work packages is summarised in Figure 1-1.

Figure Error! No text of specified style in document.**-1 - Flowchart summarising key outputs of Technical work pages and their relationship to Commercial work packages**



This document compiles the outputs of the technical elements of these workstreams (WP1A to WP1E).

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London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1A)

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CROYDON DISTRICT ENERGY SCHEME

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EXECUTIVE SUMMARY

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. This first report in a wider suite of documents represents a summary of the heat and power demand estimates that have been developed for the various developments and existing buildings of the study area.

For the purposes of this report, the project study area has been divided into notional zones, as illustrated in the following image:

Figure 1-1 - Notional demand zones

The overall heat and power demands estimated for the various notional demand zones of the project study area, as illustrated in the image above are shown in the table below:

Table 1-1 – Summary of demands by notional demand zones

	CORE – council loads	CORE plus EXT 1	CORE, EXT1, and EXT2	CORE, EXT1, EXT2 and EXT3
Annual heat[1] (MWh p.a.)	5,586	16,984	26,305	32,113
Peak heat (kW)	6,027	13,618	24,206	28,121
Annual elec (MWh p.a.)	9,138	11,105	24,843	27,214
Peak elec (kW)	2,162	2,409	5,668	6,235

The annual electrical demands shown here exclude residential demands, as these are not considered accessible to private wire sales - hence the figures shown only represent the non-domestic components of developments and existing buildings.

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[1] Including site internal heat losses

1 INTRODUCTION AND SCOPE

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. One element of this is the potential development of a district heating network, where the aspiration would be to provide new and existing buildings a cost-efficient means of moving from natural gas as the dominant fuel, to a lower carbon and renewable fuel mix

A feasibility study was completed in 2017 which indicated that an initial scheme based on new development and existing public-sector buildings was economically viable. The council has allocated a site for the scheme energy centre. With new developments having to meet the London Plan Zero Carbon target, the best longer term low carbon heat supply option would be to connect to the Beddington Energy Recovery Facility (ERF). This commission aims to provide greater confidence in the viability of this supply option, and an alternative based on gas-fired CHP in the identified energy centre.

The objective of the work is to develop a viable scheme that can proceed to procurement.

The scope of the overall commission therefore comprises:

- A review of the 2017 feasibility study
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The scope of work is split into five work packages:

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The workflow of the work packages and their relation to the commercial modelling work packages is summarised in Figure 1.

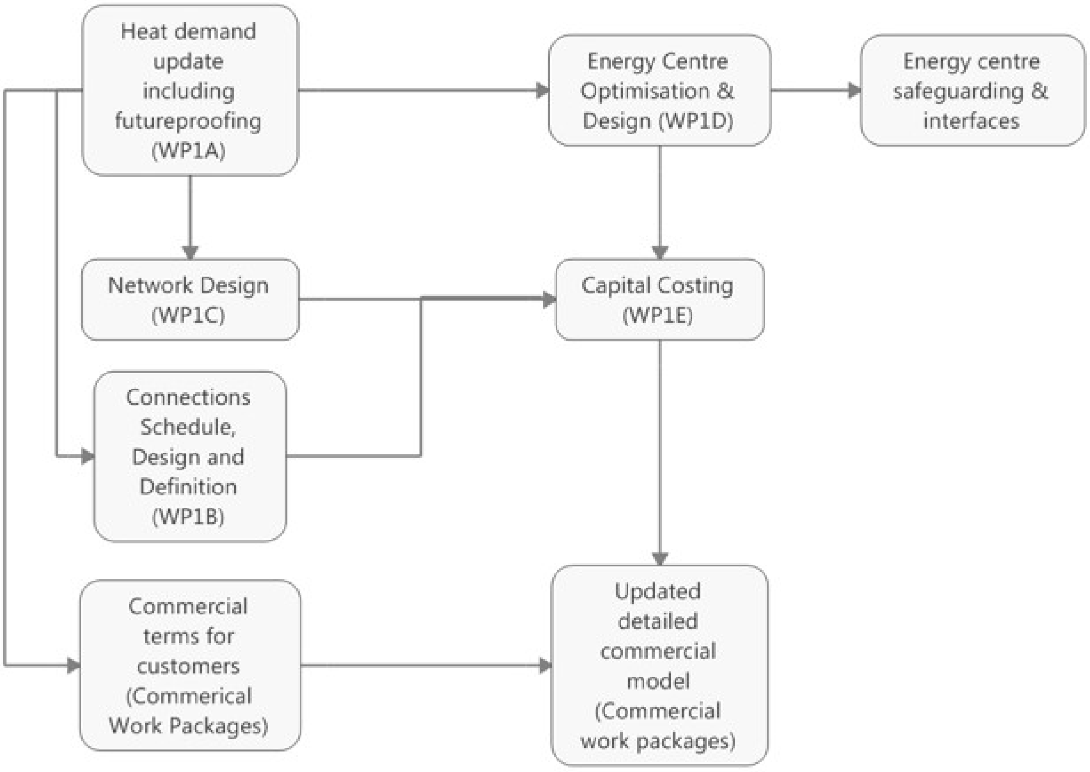


Figure 1: Flowchart summarising key outputs of Technical work pages and their relationship to Commercial work packages

This report represents the deliverable **Work Package 1A** of the project. The scope of this work package is:

- Review and confirm the list of buildings considered for connection in the Croydon District Energy Scheme Stage 2 report to identify any potential loads that may have been missed in the initial study. Agree the final list with LBC.
- To review and refine the heat and power demands as previously developed, to ensure that up-to-date figures are being used in analysis
- Establish hourly heat demand profiles for the buildings envisaged to connect to the heat network. These should be used to establish heat load duration curves for the different phases of the project and to establish the build-up of heat demand over time.

Required Outputs from this work package are:

- Updated demands and consumptions for base and extended scheme
- Hourly heat demand profiles for buildings in base and extended scheme as a minimum
- Report in Word document format to capture methodology, data sources, key findings, recommendations and conclusions, with executive summary.

2 BUILDINGS FOR CONNECTION

WSP has discussed with Croydon Council the potential developments currently underway within the Metropolitan Centre, and the initial list of sites that are considered for the project is as follows:

Table 2-1 – Buildings considered within Croydon Metropolitan

Building Name	New[2] / Existing?	Location area
28 - 30 Addiscombe Grove	New	EXT3
Addiscombe Square (former Post Office site)	New	EXT3
Barclay Road Annexe	New	EXT1
Bernard Weatherill House	Existing	CORE
Cambridge House	New	EXT2
Carolyn House	New	EXT2
Croydon College	Existing	EXT1
Croydon Combined Court	Existing	EXT3
Croydon Park Hotel (potential new load)	Existing	EXT3
Davis House	Existing	CORE
Fairfield Development	New	EXT1
Former Essex House, 101 George Street	New	EXT1
Former Job Centre Plus site, 17 -21 Dingwall Road	New	EXT2
Leon House	New	EXT1
Magistrates Court	Existing	EXT1
Mondial House	New	EXT1
Morello Tower (Cherry Orchard Gardens / Road)	New	EXT3

2 NB – 'New' also includes significant refurbishment projects in this list, and those developments where construction is not yet complete.

Building Name	New[2] / Existing?	Location area
St George's House, Queens Square	New	EXT1
Ruskin Square	New	EXT2
Taberner House	New	EXT1
Town Hall / Central Library	Existing	CORE
Wandle Road	New	EXT1

3 ENERGY DEMAND REVIEW

3.1 OVERVIEW

To refine the demands as previously developed under the 2017 study, a review of the heat and power loads with potential to be connected to the proposed Croydon District Energy Scheme was carried out.

The information presented in the following sub-sections has been used to create hourly heat and power demand profiles and load duration curves for the different notional phases of the project (for potential refinement in later project stages) and to establish the build-up of heat demand over time (see Section 4).

3.2 EXISTING BUILDINGS

There are a number of council-owned development sites which could form the 'anchor loads' for a new district energy network. Outline attributes of these key sites are discussed in the following section, in terms of the potential formation of a deliverable network, alongside some of the key non-council developments also emerging in the area.

Energy demands for the existing buildings have been estimated using a range of benchmarks, as described below.

Metered data or Display Energy Certificates (DECs) were available for some of the existing buildings which contained energy demand data specific to the buildings. In these cases, and where WSP believed the demand data to be appropriate, these documents were used to establish the energy demands, rather than relying on benchmark figures.

There are no existing residential customers that were identified in the project area.

EXISTING BUILDING DEMAND ESTIMATE METHODOLOGIES

Annual Heating Demands

Metered Data

The preferred estimation of annual heat demand is from metered data over an operational year of the buildings in question. However, annual heat demand data were not always available for the potential network customers.

Display Energy Certificates (DECs)

The Department for Communities and Local Government provide public access to DECs. Each certificate contains a value of energy use per m^2 for each building. The values for these certificates are calculated through metered consumption, utility billing and potentially other building survey elements. Elements displayed on DECs include:

- Building category
- Location of building
- Separable energy uses (if required)
- Total useful floor area
- Recorded hours of occupancy

- Results of previous DECs (if available)

Energy Benchmarks

The CIBSE document 'TM46: Energy Benchmarks (2008)' contains energy benchmarks for different building usage types in $kWh/m^2/year$. As it was published in 2008, the benchmarks refer to existing buildings at that time. It has therefore been assumed those benchmarks are representative of a building that has been constructed to 2006 Building Regulations. For the purposes of benchmarking existing buildings, it has been notionally modelled that the existing buildings comply with 2006 Building Regulations.

A notional existing boiler efficiency of 80% has been modelled to reflect the lifecycle efficiency of a typical, well-maintained boiler.

WSP has also informed its benchmark estimates from information provided by ESCos working in the current market, and from their feasibility level estimates of demand benchmarks. Both of these sources have been used and the benchmark figures used by WSP in this study for non-residential floor space are summarised below in the table below. For all other buildings, we have received either DEC or metered gas consumption data.

Table 3-1: Annual heat demand benchmarks for existing non-domestic buildings

Type of building	Annual Heat load ($kWh/m^2/yr$)
Hotel	150

Peak Heating Demands (existing buildings)

To estimate the peak heat demand for the existing building loads multiple approaches are utilised, depending on the provided information:

- Benchmarked based on the area using the BSRIA Blue Book
- Installed plant capacity (taking utilisation and resilience capacity into account)
- Assumed annual boiler utilisation (load factor) for the type of building applied to the annual load, to give an estimated peak

Annual & Peak Electrical Demands

The economics of the scheme can be significantly improved by supplying any on-site electrical generation to a private wire network rather than exporting it to the grid. As such, an assessment of potential private wire demands from the customer base was undertaken. It is also the case, of course, that PW sales could be potentially be made to other premises that are not served by the DH network. Private wire is generally not considered for residential property as residential electrical consumers must have a choice between electricity suppliers. For this reason, residential electrical demands have not been assessed.

As with the heat demand profiles developed within this study, the total annual electricity consumption data is distributed on an hourly basis throughout the year using normalised electricity demand profiles. To calculate the annual electricity demand profile an annual assessment of electrical energy demand was undertaken.

The annual electrical demand of new developments was estimated based on benchmark data shared by a leading ESCO in the District Energy Sector, where the benchmark data are understood to be based on metered sites. These data are presented in the table below:

Table 3-2 – Annual electrical demand benchmarks

Building	Annual Electrical Demand Benchmark (kWh/m^2)
Offices	95
Hotel	105

A separate calculation of peak electrical demand was undertaken to size electrical connections. BSRIA provides guidance on the peak electrical load benchmarks for different building types. The table below shows the BSRIA benchmarks.

Table 3-3 – Peak electrical demand benchmarks

Building	Peak Electrical Demand Benchmark
Offices	$87W/m^2$
Hotel	3.1kW/room

SUMMARY – ALL EXISTING BUILDINGS

A summary of the total estimated energy demands of the existing building, is provided in the table below.

Table 3-4 – Total energy demands by development

<table>
<tr><th>Building</th><th>Annual Heat Demand – Total (kWh)</th><th>Peak Heat Demand (kW)</th><th>Annual Electrical Demand (kWh)</th><th>Peak Electrical Demand (kW)</th><th>Annual Heat Data Source</th><th>Peak Heat Data Source</th><th>Annual Electrical Data Source</th><th>Peak Electrical Data Source</th></tr>
<tr><td>Bernard Weatherill House</td><td rowspan="2">3,974,893</td><td rowspan="2">3,865</td><td>5,687,211</td><td>1,579</td><td rowspan="2">Metered Gas</td><td rowspan="2">Load Factor</td><td>Metered Elec</td><td>Metered Elec</td></tr>
<tr><td>Town Hall</td><td rowspan="2">2,238,419</td><td>240</td><td rowspan="2">Metered Elec</td><td>Metered Elec (50% 50% split)</td></tr>
<tr><td>Central Library</td><td>1,176,482</td><td>1,487</td><td>240</td><td>Metered Gas</td><td>Load Factor</td><td>Metered Elec (50% 50% split)</td></tr>
<tr><td>Davis House</td><td>434,690</td><td>400</td><td>1,212,455</td><td>328</td><td>Metered Gas</td><td>Load Factor</td><td>Metered Elec</td><td>Metered Elec</td></tr>
<tr><td>Croydon Combined Court</td><td>750,261</td><td>1,114</td><td>796,070</td><td>1,061</td><td>Monthly Metered</td><td>Load Factor</td><td>Metered Elec</td><td>Benchmark</td></tr>
<tr><td>Magistrates Court</td><td>667,250</td><td>862</td><td>457,159</td><td>709</td><td>Monthly Metered</td><td>Load Factor</td><td>Metered Elec</td><td>Benchmark</td></tr>
<tr><td>Croydon College</td><td>1,023,360</td><td>1,374</td><td>576,000</td><td>696</td><td>DEC</td><td>Load Factor</td><td>DEC</td><td>Benchmark</td></tr>
<tr><td>Croydon Park Hotel</td><td>2,057,100</td><td>2,348</td><td>1,439,970</td><td>654</td><td>Benchmark</td><td>Load factor</td><td>Benchmark (per room)</td><td>Benchmark</td></tr>
</table>

3.3 DEVELOPMENT SITES

Information request process

WSP attempted on multiple occasions to make contact and elicit data and design information directly from developers. This process is described below:

*On **26th June 2019**, Croydon Council made initial contact with Developers where the developments planning application was understood to include provision for future connection to the Croydon District Heating Scheme. The initial contact introduced the intention of WSP to refine the 2017 study's network scheme to provide evidence of the feasibility of a district energy scheme within Croydon's Town Centre, and to deliver a detailed project development plan that will lead to the Outline Business Case. Croydon Council discussed the requirement for the current status of the development, including the latest estimates for heat demand, plant layouts and future connection arrangements to be provided to WSP. The initial contact also highlighted how the district energy scheme design conducted by WSP could lead to benefits in terms of both financial and environmental savings for the Developer.*

*Following Croydon Council's introduction to Developers, on **4th July 2019** WSP re-iterated the necessity for dialogue with Developers to understand their site and discuss current plans.*

*WSP made email contact again with the developers on **18th July 2019.** This email re-iterated the importance of understanding the technical aspects of the developments as they will have an impact on the feasibility of connection to the district heating network. A spreadsheet was attached to this email which lists out key information required would help establish the suitability for connection and ultimately the level of benefit that the scheme might deliver. The key information that is required on the spreadsheet was as follows:*

- ***Development details:** Floor area, building type (e.g residential, office, retail etc.), construction phasing*
- ***Energy Demands:** Estimated peak and annual, heat and electrical demands*
- ***Proposed Heat Supply Plant**: Boilers, CHP, Air Source Heat Pump etc.*
- ***In building LTHW systems:** Building temperatures, LTHW systems served (e.g. hot water cylinders, air handling units, fan coil units)*

*A deadline of **26th July 2019** for response from the developer was stated in the email. A deadline was specified as it was vital to fix energy demands to progress with the TEM of the district energy scheme.*

From WSP and Croydon Councils contact with developers the following parties replied to the requests for information with technical information. The remainder of the parties did not offer responses:

- *Former Post Office Site*
- *17-21 Dingwall Road (Former Job Centre site)*
- *Cherry Orchard Road & Garden (Morello Tower)*

Timeline Summary

Croydon Council 1st contact and introduction to WSP on **26th June 2019**

WSP initial developer contact and request for information on **4th July 2019**

WSP follow up email with developer spreadsheet attached on **18th July 2019** with a developer deadline set for response by **26th July 2019**.

Energy Demand Estimation

Energy demands for the majority of the new development sites have been estimated based on energy statement documents, or where necessary, using a range of appropriate benchmarks, as described in the text below. See Appendix A for details of how the energy demands for each of the development sites were established.

Energy statements or similar documents were available for some of the new developments which contained energy demand data specific to the developments. In these cases, and where WSP considered the demand data to be appropriate, these documents were used to establish the energy demands, rather than relying on benchmark figures.

Residential and commercial floor areas have been taken from accommodation schedules, floor plans or other planning documentation.

RESIDENTIAL DEMAND ESTIMATE METHODOLOGIES

Annual Heating Demands

SAP Calculations

Prior to construction, a developer must demonstrate that new-build properties are compliant with Part L of the Building Regulations, which refers to the conservation of fuel and power. Designers must show, amongst other things that the building fabric complies with the maximum U-values stated in Part L. This is demonstrated using the Building Research Establishment's (BRE) Standard Assessment Procedure (SAP) for domestic properties, which sets out a methodology for calculating the energy performance of a dwelling based on the building fabric and energy sources.

Where dwelling-specific SAP calculations have been undertaken, the results of annual space heating and hot water demand calculations can be used in energy supply modelling, although it is noted that there is very little post-construction data available to verify the outputs of this process. Some studies have tried to evaluate this 'performance gap' (i.e. the difference between actual and predicted performance), and WSP's estimates of demands are also informed by its own experience as well as research data from organisations such as the Building Data Exchange.

For some of the new developments assessed in this study, SAP worksheets were available within the planning documents which included data that could be used within the annual heat demand estimates. It was noted in some of the SAP worksheets, however, that the demand figures did not seem realistic for the type of dwelling being assessed; in such cases WSP have reverted to using the residential benchmark figures described below.

Annual Space Heating Demands

The benchmarks used by WSP for estimating annual residential space heating demands are as follows:

- For new dwellings which are of standard construction, a fixed annual space-heating benchmark of 25 kWh/m^2/year (based on previous WSP project experience on projects involving new-build residential tower blocks within Greater London)
- For dwellings which are targeting fabric performance to Passivhaus standard, a fixed annual space-heating benchmark of 15 kWh/m^2/year.

Annual Hot Water Heating Demands

For domestic hot water, SAP provides a methodology for calculating hot water consumption as a product of occupancy, which is determined by floor area. The approach assumes that 25 litres of hot water is used per person per day, plus an additional 36 litres for the household. Seasonal variations in demand (slightly higher consumption in winter) are taken account of by the SAP method, and it also allows for the varying cold-water supply temperature across the year (i.e. mains water is slightly warmer in summer and therefore requires less heating). The SAP approach has been used where necessary to estimate the hot water demand for new dwellings in the Croydon District Energy Scheme.

Peak Heating Demands

The peak heat demand for residential properties is determined by the maximum space heating and hot water load for each dwelling. It is essential that the sizing also considers the impact of consumption diversity, i.e. the effect of different people using heat at different times. This is particularly important for hot water demand, where the instantaneous load is higher than the space heating demand, but the likelihood of simultaneous usage by all households is very low. Household space heating demand is more likely to occur at the same, or very similar times, i.e. when boilers come on in the morning at the coldest times of the year.

Peak heat demands have been estimated through the summation of the following:

- Space heating peak demand, based on benchmark figures (as detailed below in the following paragraph).
- DHW peak demands, diversified using DS 439 (as detailed below in a subsequent paragraph).

Peak Space Heating Demands

To calculate per-dwelling space heating demand, WSP have used the following benchmark figures:

- For new dwellings which are of standard construction, a fixed peak space-heating benchmark of 25 W/m^2 (based on previous WSP project experience on projects involving new-build residential tower blocks within Greater London)
- For dwellings which are targeting fabric performance to Passivhaus standard, a fixed space-heating benchmark of 15 W/m^2.

Peak Hot Water Demands

For hot water, the peak demand has been estimated using the calculation in the Danish DS439 standard, which determines both the load (based on an assumed peak of 37.5kW per dwelling), and a diversity factor (as a percentage of the total demand) according to the number of connected dwellings.

An illustration of the effect of diversification on the per-dwelling DHW heat demand as more dwellings are connected to a heat network is presented in the chart below (Danish standard DS 439:2009). This shows that as the number of dwellings reaches approximately 600, the diversified per-dwelling DHW heat demand reduces to below 2kW.

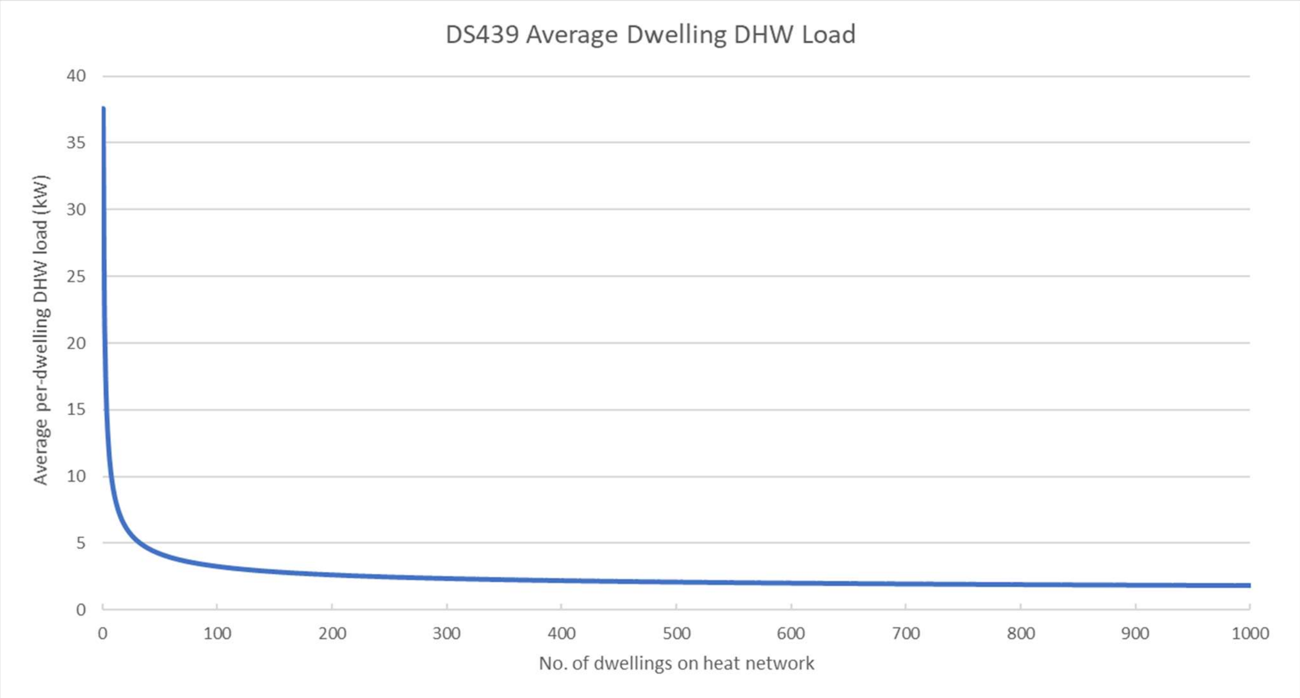


Figure 3-1 - Diversified per-dwelling heat demand by network size using DS 439.

Over-sizing of heat networks is detrimental to their performance. Larger pipes mean higher heat losses, while pumps and other plant that are larger than required can result in a significant increase in capital costs. It also results in poorer energy and heat efficiency of the system over its service life. Conversely, slightly under-sizing is only a factor for a very small proportion of the time when heat demand is at its absolute peak, whereas heat losses are continuous throughout the year.

Internal site heat losses

Each development will experience site-internal heat losses relating to the distribution of heat from a central facility. Losses in risers and lateral pipework runs are the primary sources of these losses. At this stage of the project, the assumption is that heat will be provided to the base-of-block / site centralised plant, for onward distribution and sale to residents / end-users. On this basis, as the heat residential demands have been based on the calculation of demands at individual dwellings, an allowance for site-internal heat losses has also been made.

The magnitude of these losses has been based upon the figure suggested within the CIBSE CP1 (Heat Networks: Code of Practice for the UK) document, as follows:

Table 3-5 – Internal site heat loss assumption

	Internal site heat loss
CP1 best practice – applied to new residential developments	10%

The losses are not applied to the non-residential demand figures, as for these loads, it is assumed that the benchmarks already make allowance for a component of heat distribution loss.

Electrical Demands

Electrical demands from residential properties have not been estimated in this study due to the complexities and legal requirement to maintain competition in supply, when putting in connection by a private wire network to individual dwellings.

NON-RESIDENTIAL DEMAND ESTIMATE METHODOLOGIES

Annual Heating Demands

Unless stated, annual heating demands for the non-residential components of the new Croydon developments have been based on benchmarks (including both space heating and hot water) derived from a combination of previous WSP project experience and from CIBSE TM46: Energy Benchmarks (2008), updated for improvements in energy efficiency standards since the time of publishing.

TM46 Energy Benchmarks

The previous Section 3.2 describes the CIBSE document 'TM46: Energy Benchmarks (2008)', which is assumed to be representative of buildings that have been constructed to 2006 Building Regulations.

Since 2006, updates to Building Regulations have increased the carbon emissions reduction required from a new building relative to the 2006 baseline. These reductions are assumed to have been achieved as a result of more stringent maximum U-values (among other measures). WSP has therefore adjusted the TM46 energy benchmark figures for new developments in line with carbon savings required by each update of the Building Regulations.

Since 2013, the only update to the Building Regulations has been through a set of amendments issued in April 2016, none of which affect the maximum U-values. Nevertheless, it is reasonable to assume that, in keeping with a general move towards low carbon, building materials have continued to evolve and the actual U-values achieved in building fabric have reduced. A 5% improvement has therefore been applied compared to the 2013 Regulations in both 2016 and 2019.

Table 3-6 - Fabric improvements since the publishing of TM46 energy benchmarks

Building Regulations Release Date	Fabric Improvement (cumulative)
2010	25%
2013	34%
2016	39%
2019	44%

A notional boiler efficiency of 85% has been modelled to reflect the lifecycle efficiency of a newly-installed boiler. Note that, in modifying the benchmark figures, WSP has applied the carbon reduction only to the portion of the overall heat demand that is for space heating as the DHW demand would not be affected by changes in fabric energy efficiency. The split between SH and DHW has been derived from industry benchmarks, and WSP estimates based on previous project experience.

The benchmark figures used by WSP in this study for non-residential floor space are summarised below in Table 3-7.

Peak Heating Demands

Peak heat demands for the non-residential loads has been estimated using benchmarks taken from the BSRIA Blue Book (2017) and from previous WSP project experience. These are summarised below in Table 3-7.

Electrical Demands

Annual electrical demands for the non-residential components within each development have been estimated using benchmarks determined from previous WSP project experience and unmodified benchmark figures from TM46 (2008).

Peak electrical demands have been estimated using benchmarks determined from previous WSP project experience and benchmarks (see Table 3-7).

Summary of Non-Residential Benchmarks Used in the Assessment

The benchmarks used for non-residential heat demands are listed in the table below.

Table 3-7 – Summary of non-residential benchmark figures used in this study.

Usage Type	Annual Heat Demand (kWh/m²/year)	Peak Heat Demand (kWh/m²/year)	Annual Electrical Demand (kWh/m²/year)	Peak Electrical Demand (kWh/m²/year)	Source of Data
Office	40	75	72	87	Mix of sources (TM46, WSP projects, BSRIA, load factor calculation, ESCo advice)
Retail	50	70	93	160	Mix of sources (TM46, WSP projects, BSRIA, load factor calculation, ESCo advice)
Restaurant	159	140	90	160	Mix of sources (TM46, WSP projects, BSRIA, load factor calculation, ESCo advice)
Club rooms / community space	43	70	20	87	Mix of sources (TM46, WSP projects, BSRIA, load factor calculation, ESCo advice)
Entertainment Halls	219	250	150	160	Mix of sources (TM46, WSP projects, BSRIA, load factor calculation, ESCo advice)
Dry sports and leisure facility	157	100	95	160	Mix of sources (TM46, WSP projects, BSRIA, load factor calculation, ESCo advice)

SUMMARY – ALL DEVELOPMENTS

A summary of the total energy demands, by development, is provided in the table below. Refer to Appendix A for a more detailed breakdown of energy demands for each development.

Table 3-8 – Total energy demands by development

Category	Floor Area - Residential (m²)	Floor Area - Non-Residential (m²)	Total Floor Area (m²)	Annual Heat Demand – Residential (kWh)	Annual Heat Demand – Non-Residential (kWh)	Annual Heat Demand – Total (excl internal site losses) (kWh)	Peak Heat Demand - Residential (kW)	Peak Heat Demand – Non-Residential (kW)	Peak Heat Demand – Total (kW)	Annual Non-Domestic Electrical Demand (kWh)	Peak Non-Domestic Electrical Demand (kW)
Addiscombe Grove	7,104	0	7,104	387,752	0	387,752	610	0	610	0	0
Addiscombe Square	15,039	1,760	16,799	705,343	88,000	793,343	899	123	1,023	163,680	282
Barclay Road Annexe	3,489	750	4,238	176,817	47,240	224,057	317	59	376	34,683	65
Cambridge House	6,503	0	6,503	340,006	0	340,006	485	0	485	48,709	30
Carolyn House	10,086	443	10,529	492,400	70,437	562,837	710	62	772	39,870	71
Fairfield Halls	25,803	4,287	30,090	1,300,275	406,559	1,706,834	1,549	518	2,068	282,835	504
Former Essex House (101 George Street)	34,097	1,244	35,340	1,449,040	34,206	1,483,246	1,959	118	2,077	80,929	144
Former Job Centre Plus	11,118	800	11,918	642,613	83,600	726,213	764	84	848	73,200	128
Leon House	23,133	1,222	24,355	1,344,467	61,100	1,405,567	1,379	86	1,465	113,646	196
Mondial House	17,932	2,006	19,938	829,663	84,470	914,133	1,007	148	1,155	153,315	205
Morello Tower (Cherry Orchard Rd and Gardens)	29,972	1,746	31,718	1,476,065	78,570	1,554,635	1,693	127	1,820	144,045	216
Ruskin Square	42,520	126,271	168,791	2,085,369	5,243,095	7,328,465	2,294	9,505	11,799	13,697,300	11,765
St George's House (Nestle / Queen's Square)	18,367	572	18,939	910,409	38,044	948,453	1,139	48	1,186	46,805	83
Taberner House	35,111	1,159	36,270	1,713,867	57,950	1,771,817	1,933	81	2,014	107,787	185
Wandle Road	8,176	781	8,957	407,536	32,040	439,576	587	58	645	57,912	74
Total	**288,450**	**143,041**	**431,489**	**14,261,622**	**6,325,311**	**20,586,934**	**17,325**[3]	**11,017**	**28,343**[4]	**15,044,716**	**13,948**

[3] Not including diversity between sites
[4] Not including diversity between sites, nor diversity between domestic and non-domestic uses

4 ENERGY DEMAND PROFILES

The annual energy demand estimates presented in Section 3 were used in developing overall hourly heat and electricity demand profiles for the scheme. These hourly profiles form the basis for the energy balance modelling that then leads to the techno-economic modelling results that are presented in later work packages that form part of this project (WP

In-house load profiling software was used to develop hourly heat demand profiles using a database of normalised daily HW and SH profiles for different building usage types, to distribute annual energy consumption over the year on an hourly basis. A degree day series based on a 15.5°C base temperature has been used to distribute the SH load according to ambient temperature. The result of this process is a load profile for each connection based on the total annual heat consumption. The SH and HW split for the annual heat demands have also been applied to the in-house profiling software to derive an annual heat demand profile.

4.1 DAILY PROFILES FOR EXISTING BUILDINGS

This section provides an illustration of the different heat and power demand profiles assumed for the existing buildings and used for building up demand profiles for the total network schemes. Half-hourly metered electrical data were available for Davis House, Town Hall / Central Library and Bernard Wetherill House. However, for heat no hourly metered profiles were available for any of the existing stock, and hence the need to develop synthesized profiles:

METERED ELECTRICAL DATA

The following shows the Davis House electrical demand profile for 2018 (the most recent full calendar year for which data was available).

Figure 4-1 - Davis House Metered Electrical Data

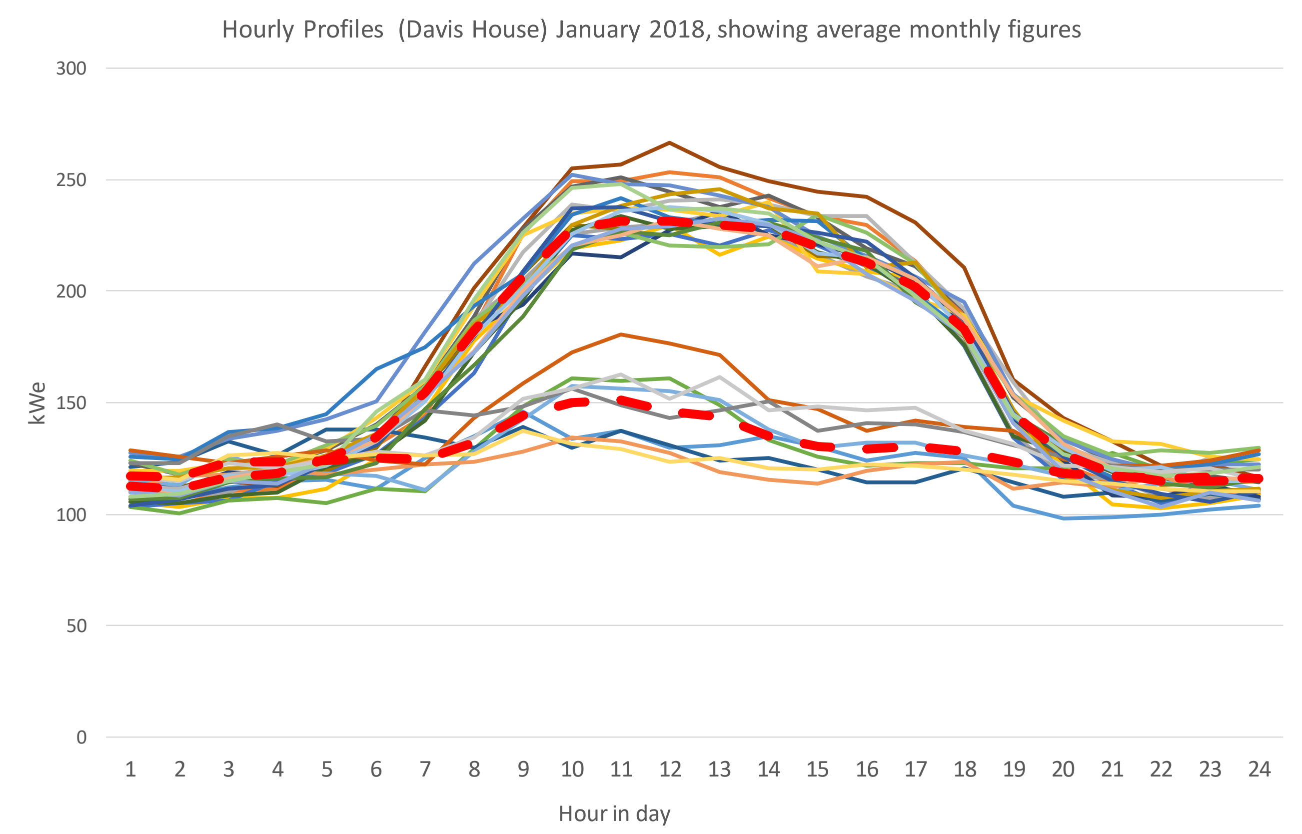


Figure 4-2 - Davis House electrical monthly average demands

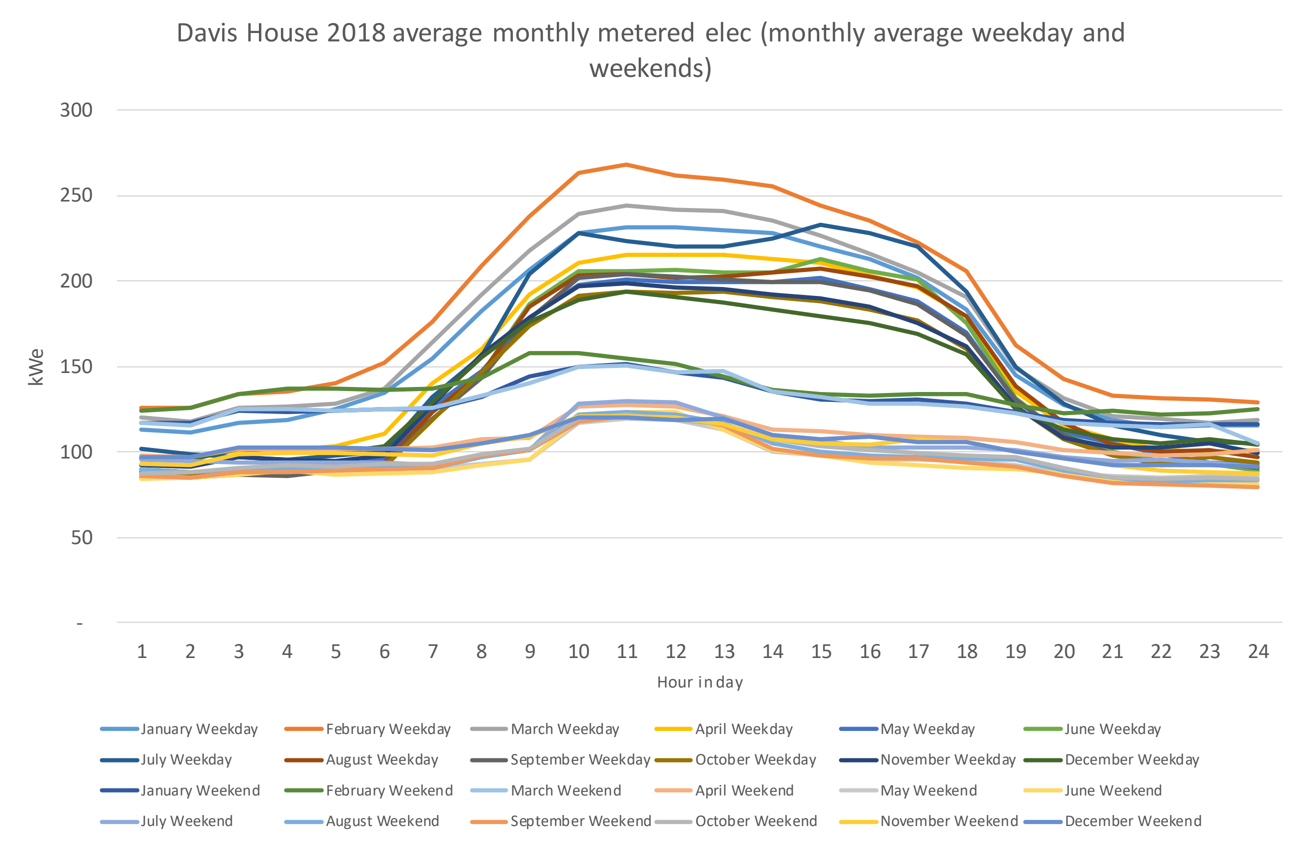
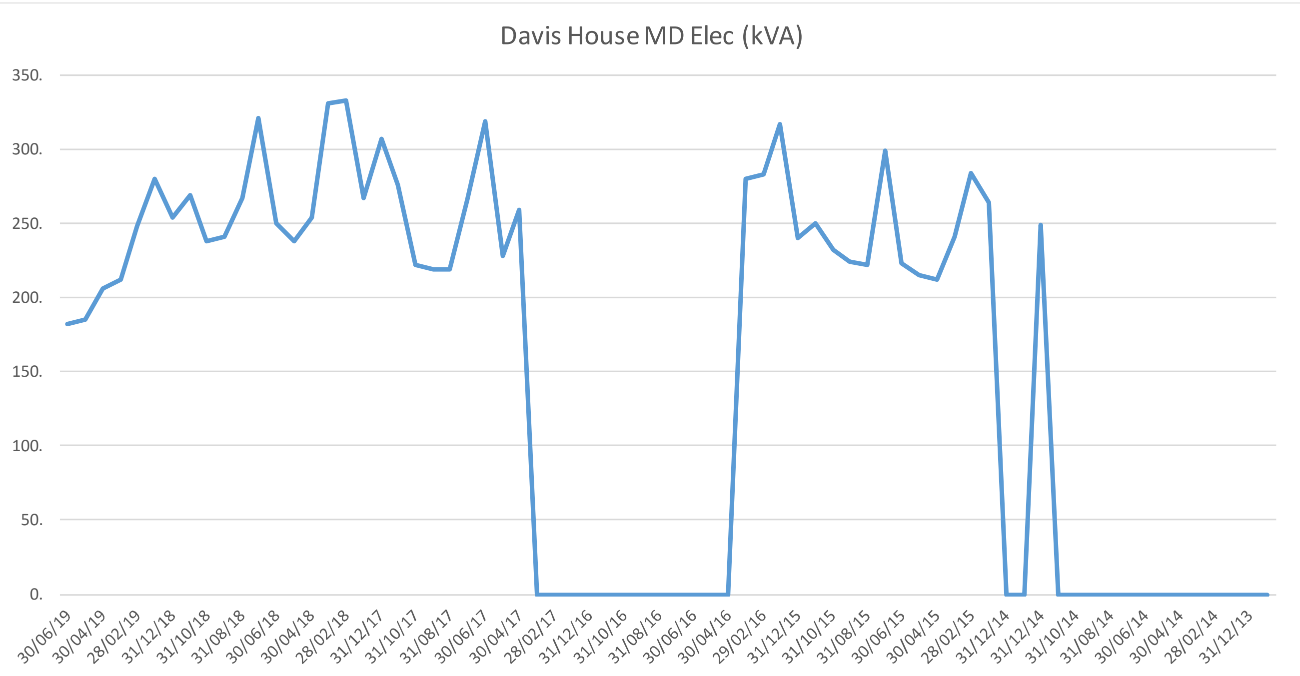


Figure 4-3 - Davis House maximum demand



The metered data for the electrical consumption of the ‘Civic Buildings’ (comprising the Town Hall and Central Library) have been analysed as shown below:

Figure 4-4 - Town Hall / Central Library (combined) electrical demand

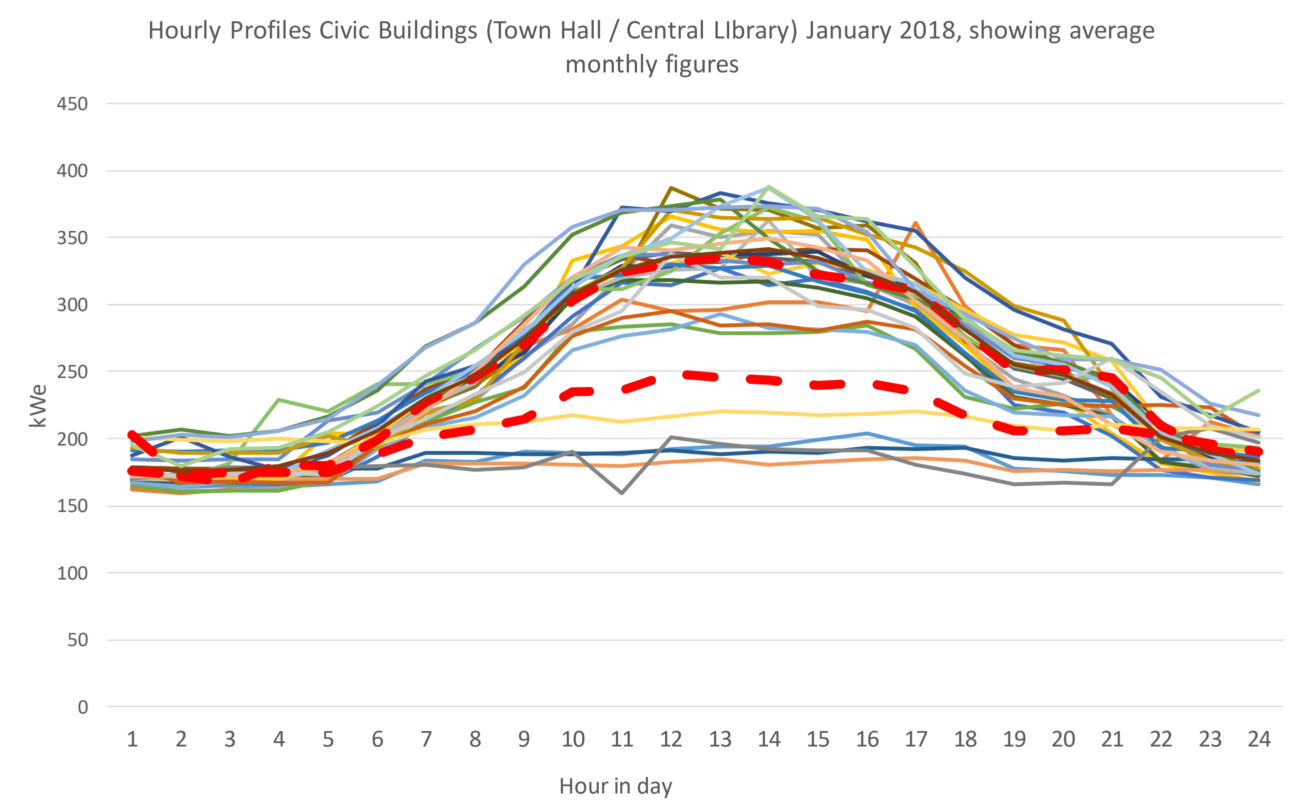


Figure 4-5 - Town Hall / Central Library (combined) monthly average elec demand

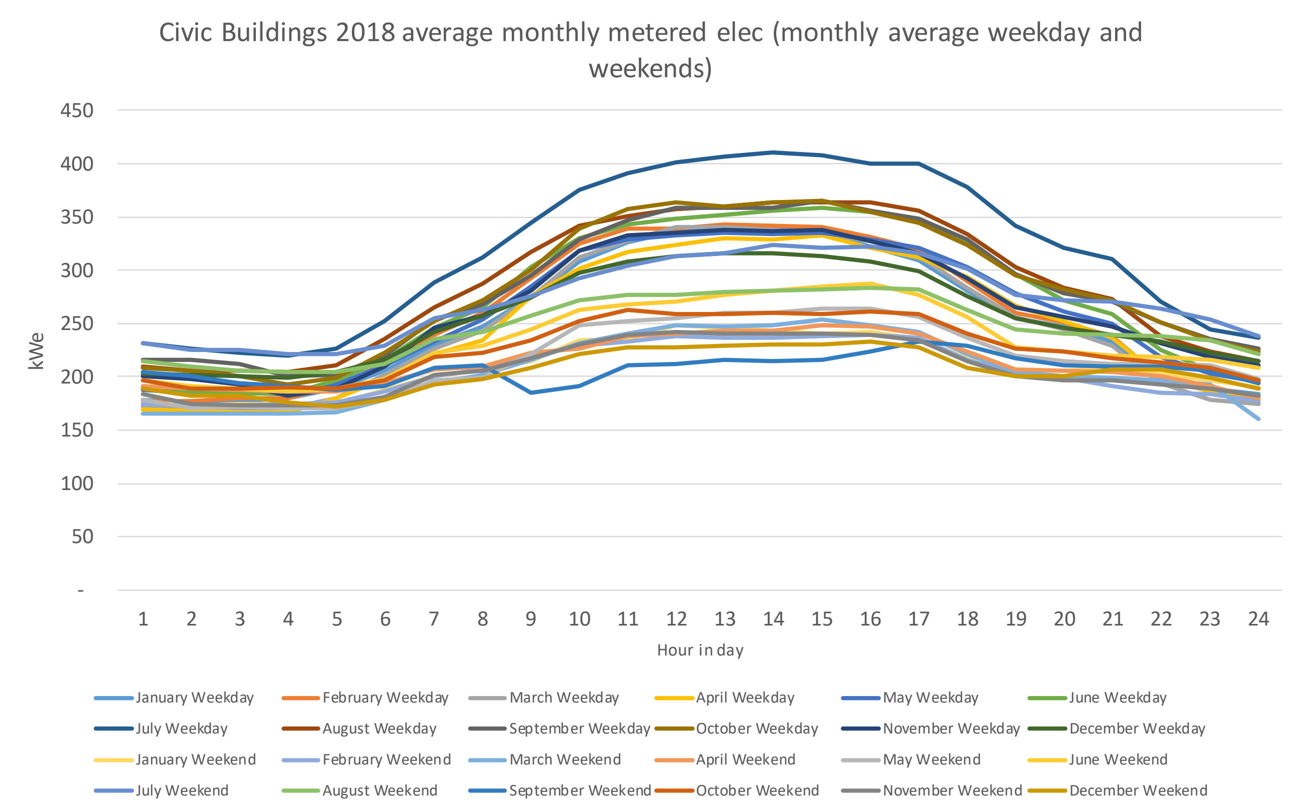
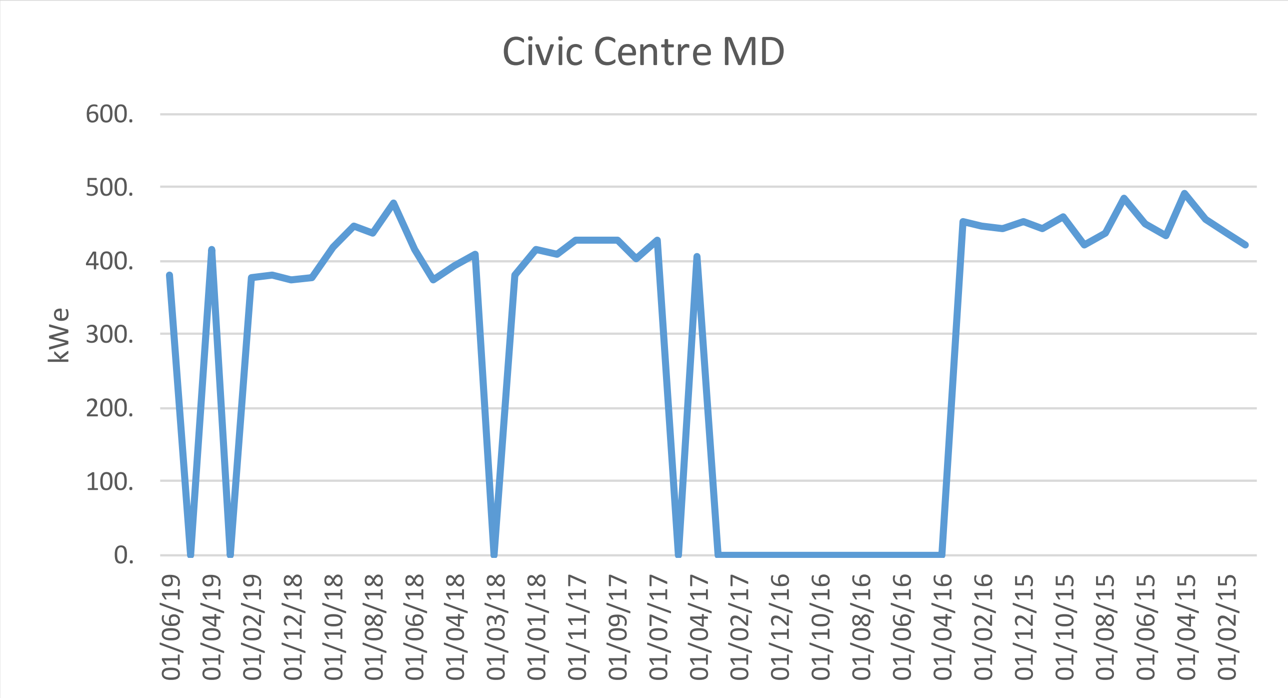


Figure 4-6 - Town Hall / Central library (combined) maximum demand



BWH

The following graphs illustrate the combined demands from the two existing supplies at BWH.

Figure 4-7 - BWH hourly demands (January 2018)

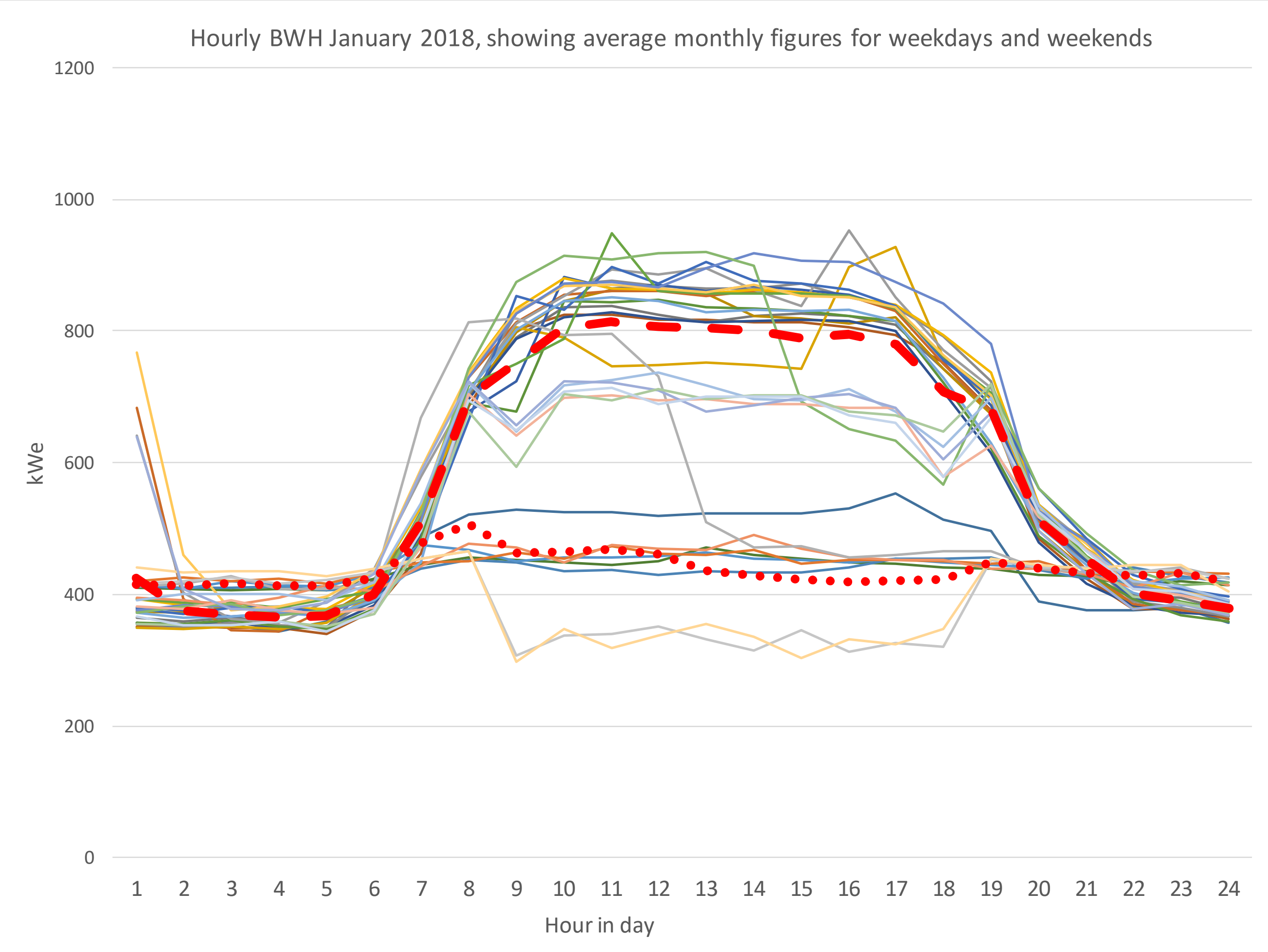
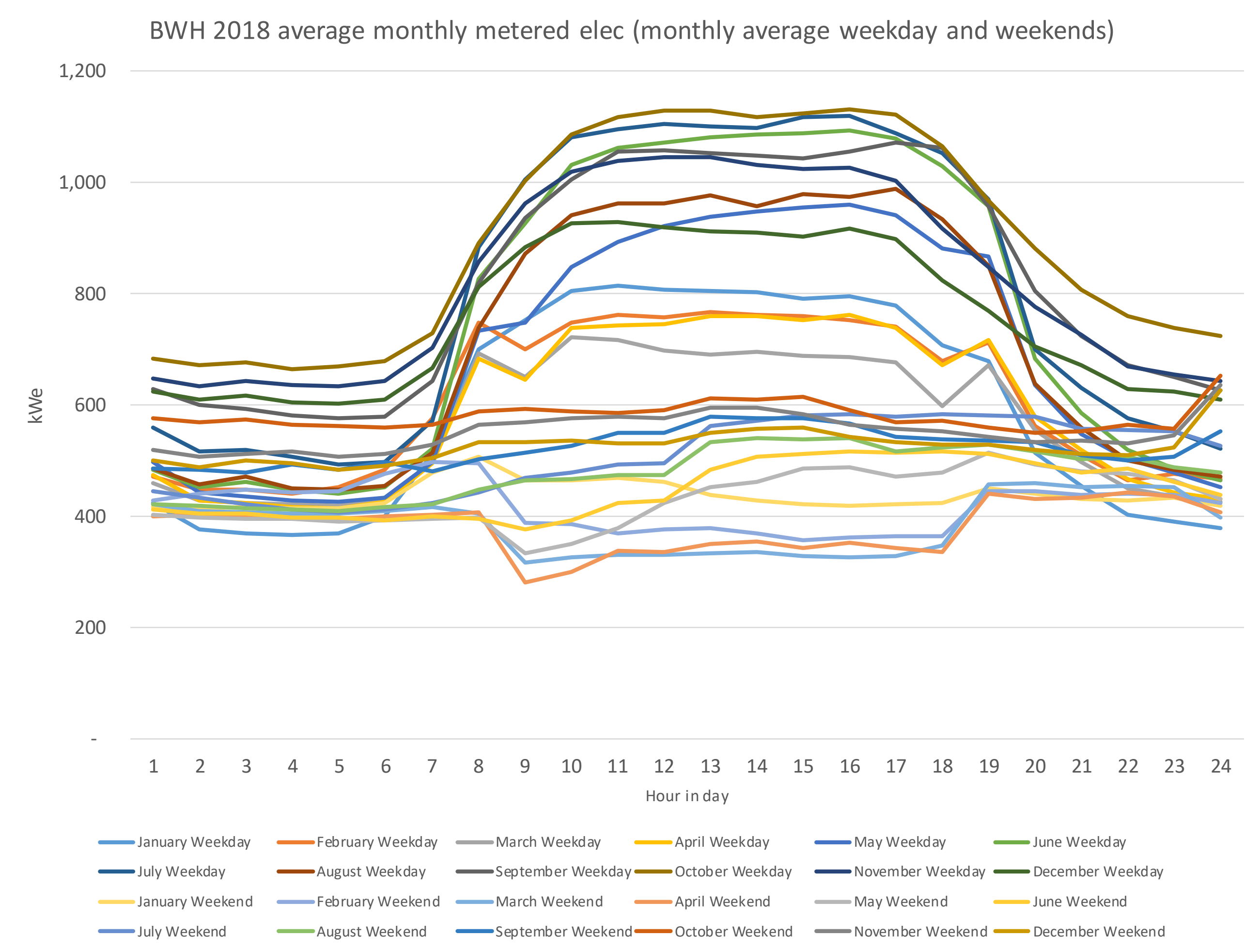
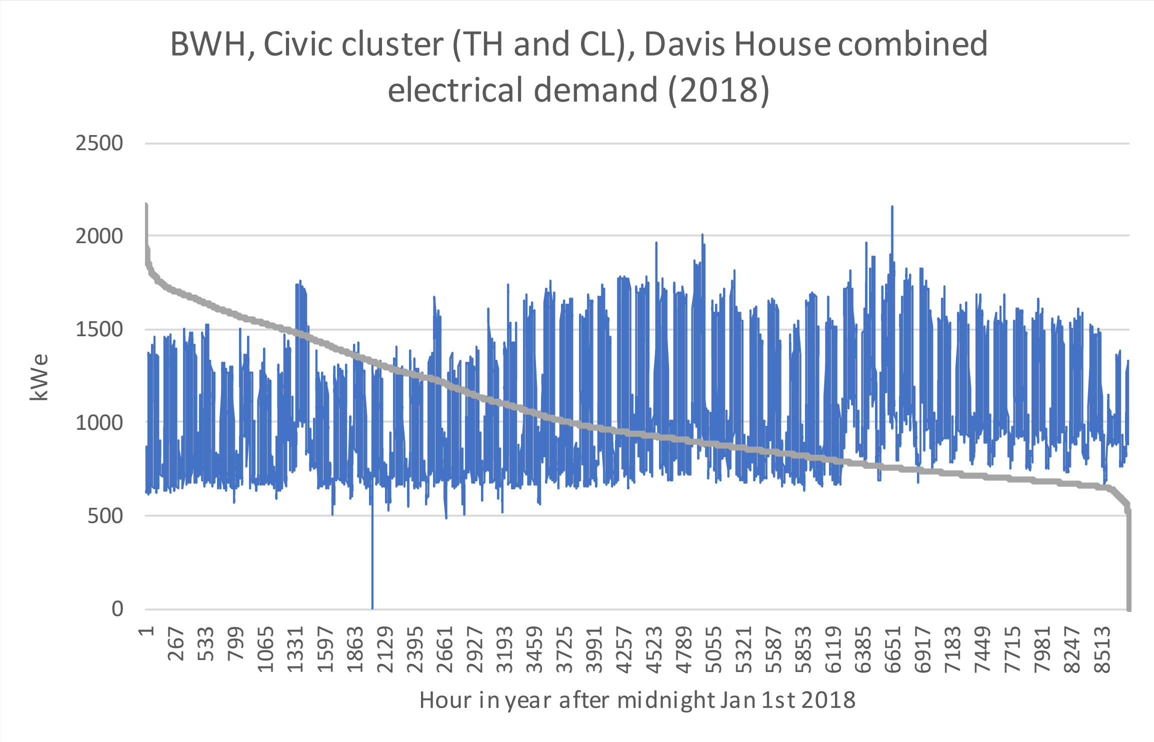


Figure 4-8 - BWH monthly average demands (elec)



The combined civic cluster demands are shown below, in chronological and load duration curve format for 2018:

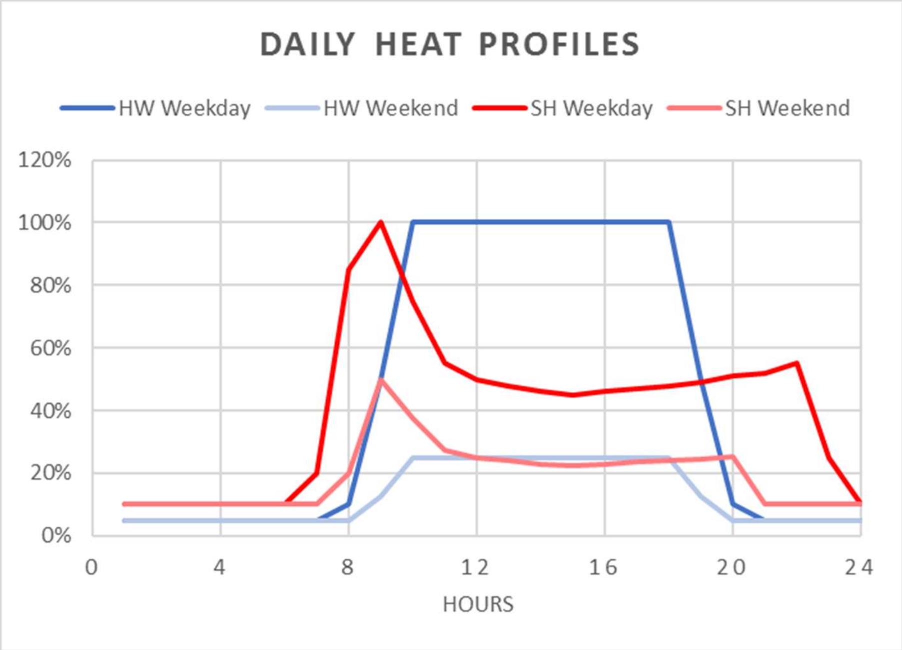
Figure 4-9 - Combined BWH, Town Hall, Library, Davis House elec demand



OFFICE/LIBRARY (EXISTING)

Daily heat demand profiles used in this assessment for existing offices/library are illustrated below.

Figure 4-10 - Daily heat demand profiles - existing office/library.



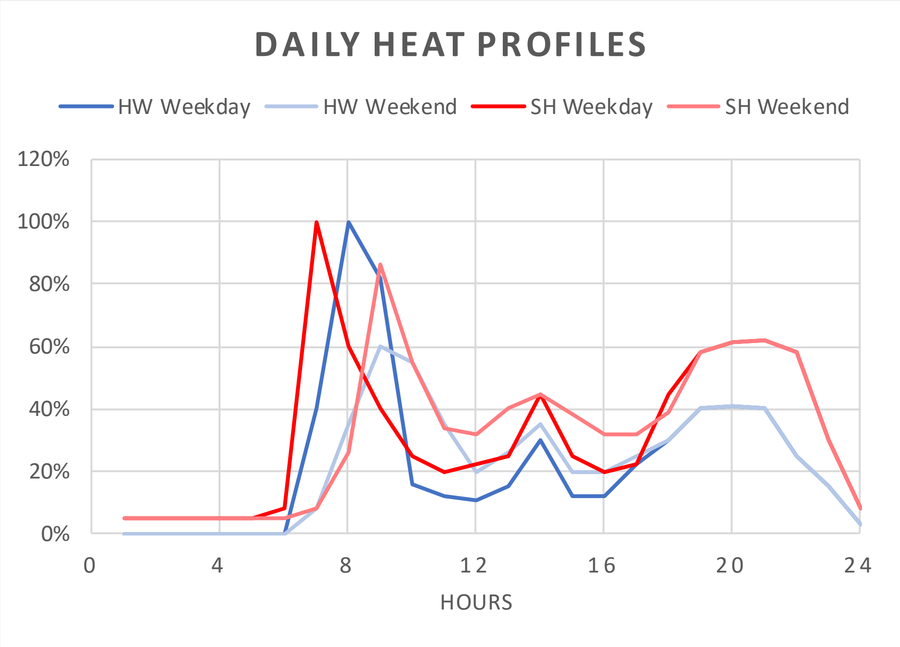
4.2 DAILY PROFILES FOR NEW DEVELOPMENTS

This section provides an illustration of the different heat and power demand profiles assumed for the new developments and used for building up demand profiles for the total network schemes.

RESIDENTIAL (NEW)

Daily heat demand profiles used in this assessment for new residential are illustrated below.

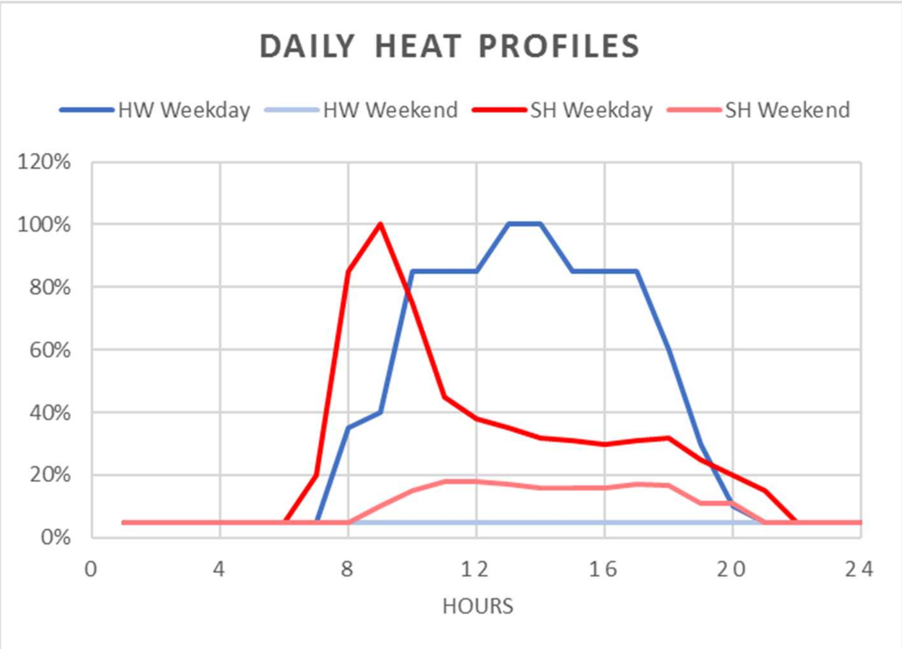
Figure 4-11 - Daily heat demand profiles – new residential.

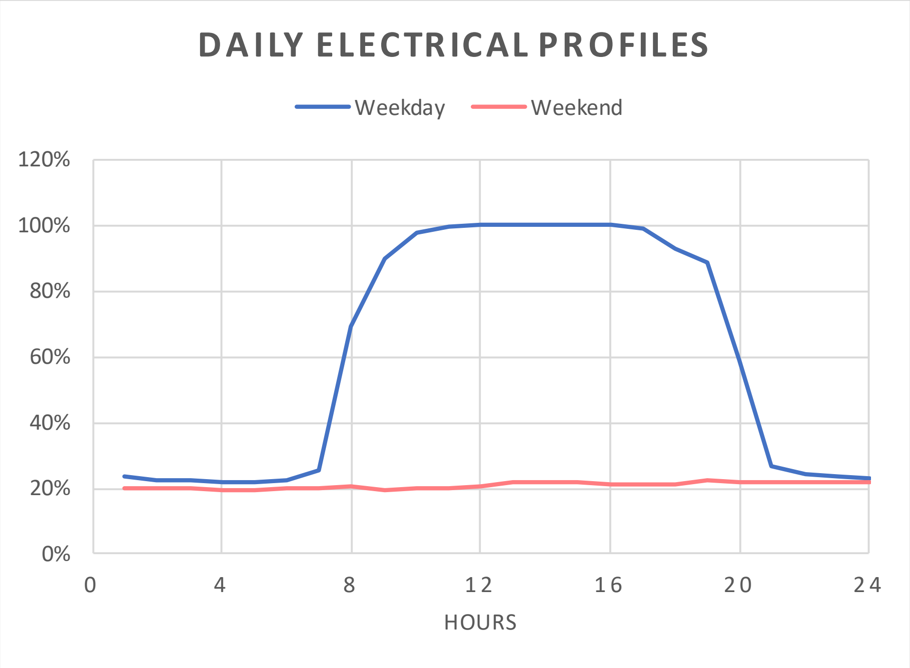


OFFICE (NEW)

Daily heat and power demand profiles used in this assessment for new offices are illustrated below.

Figure 4-12 - Daily heat and power demand profiles - new office.

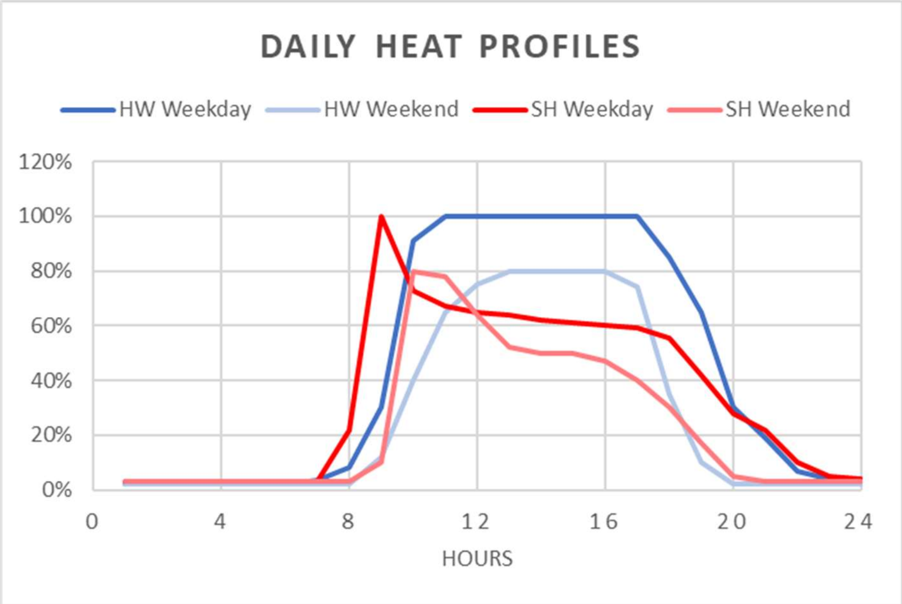


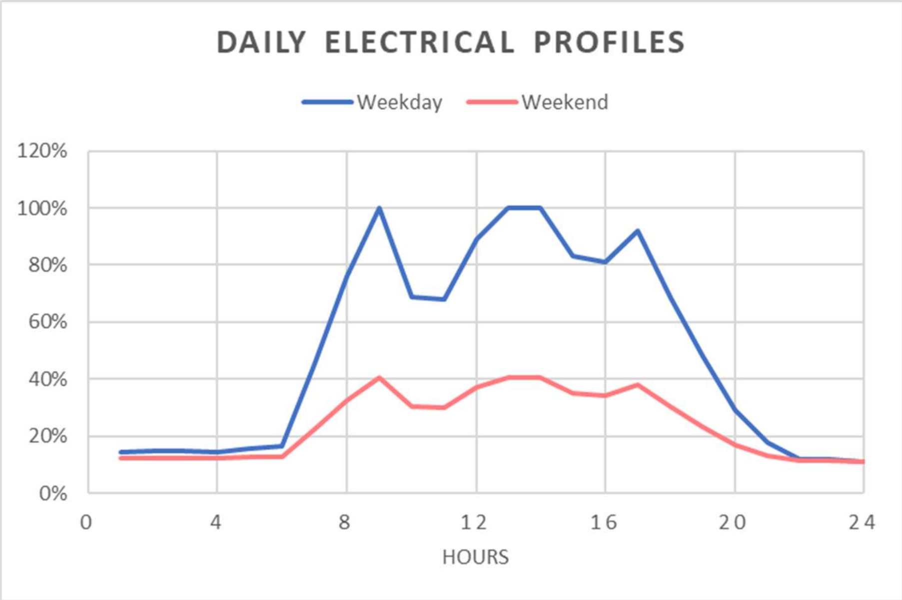


RETAIL (NEW)

Daily heat and power demand profiles used in this assessment for new retail are illustrated below.

Figure 4-13 - Daily heat and power demand profiles - new retail.

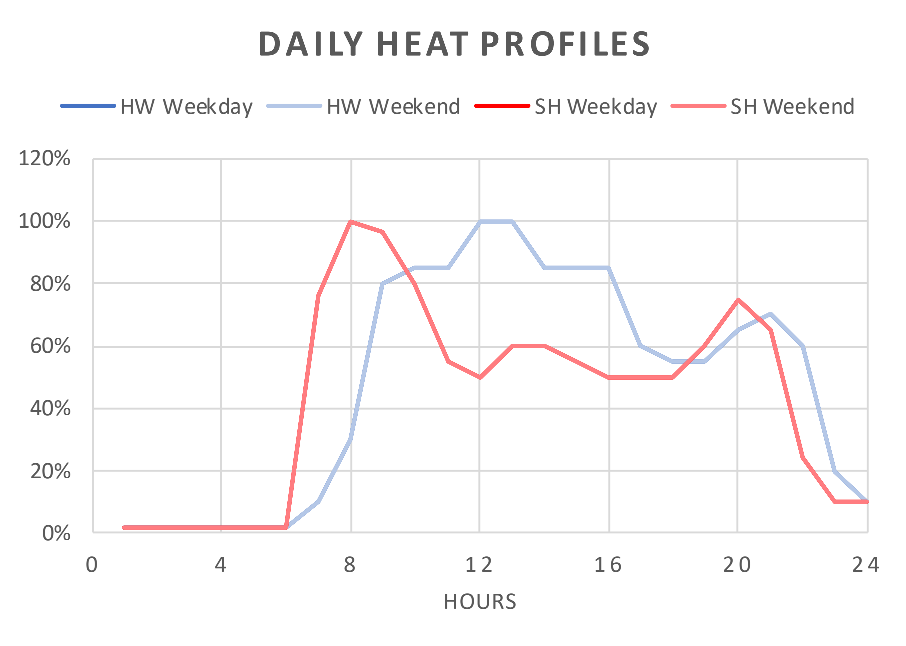


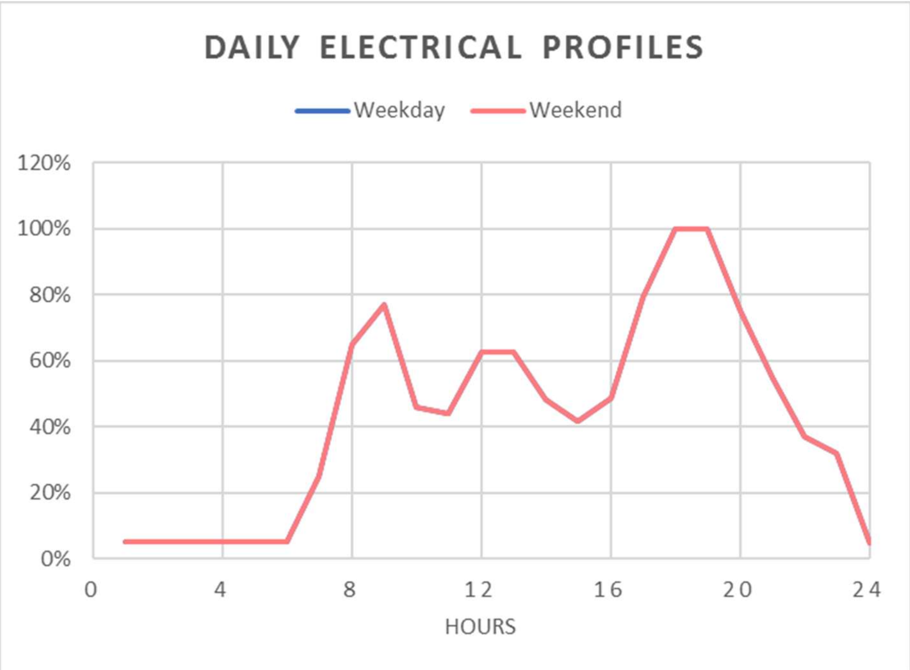

DAILY ELECTRICAL PROFILES
Weekday
Weekend
120%
100%
80%
60%
40%
20%
0%
0
4
8
12
16
20
24
HOURS

RESTAURANT (NEW)

Daily heat and power demand profiles used in this assessment for new restaurants are illustrated below.

Figure 4-14 - Daily heat and power demand profiles - new restaurant.





5 SUMMARY OF DEMANDS

The following summarises the demands of both the new and existing buildings considered for the project, split into areas as delineated by the following diagram:

Figure 5-1 - Notional demand zones

Table 5-1 – Summary of demands by notional demand zones

	CORE – council loads	CORE plus EXT 1	CORE, EXT1, and EXT2	CORE, EXT1, EXT2 and EXT3
Annual heat[5] (MWh p.a.)	5,586	16,984	26,305	32,113
Peak heat (kW)	6,027	13,618	24,206	28,121
Annual elec (MWh p.a.)	9,138	11,105	24,843	27,214
Peak elec (kW)	2,162	2,409	5,668	6,235

The table above shows that as the scheme extends from the Core to Core plus Ext 1, that there is relatively little increase in electrical demand, but three-fold increase in heat demand. This reflects the

[5] Including site internal heat losses

mix of non-domestic loads in the Core scheme, and the residential-dominated loads of the Extension 1 area.

The following graphs represent the annual chronological demands developed, and the load duration curves for each of the areas identified.

5.1 CORE AREA DEMAND GRAPHS

Figure 5-2 - Core area demands

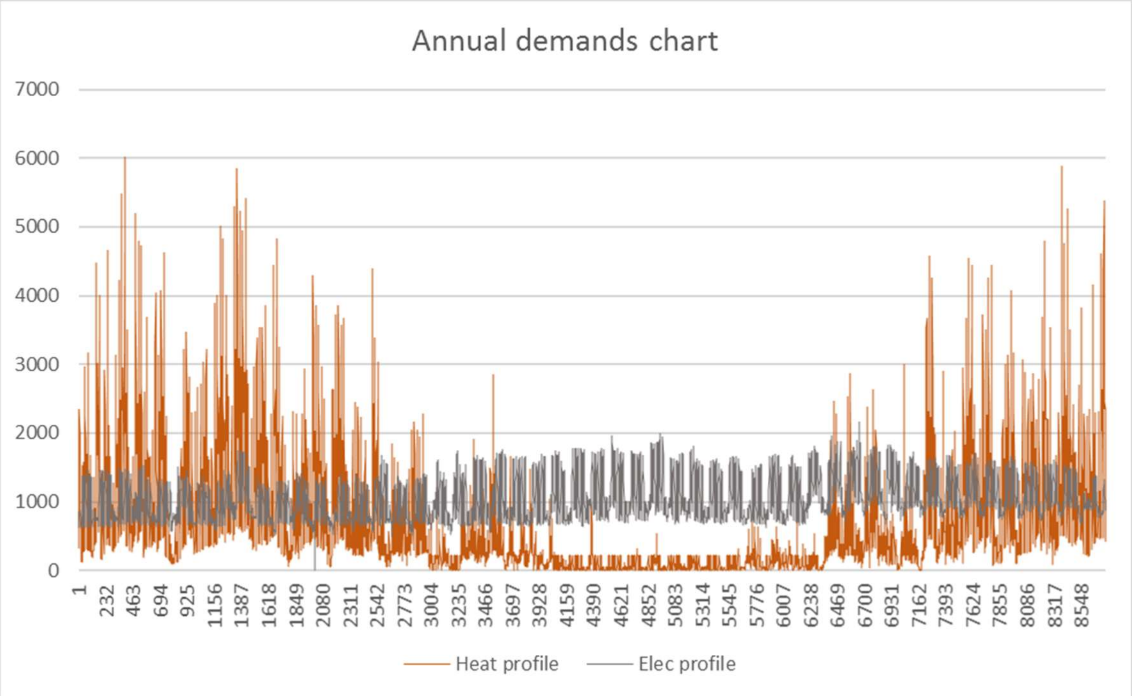
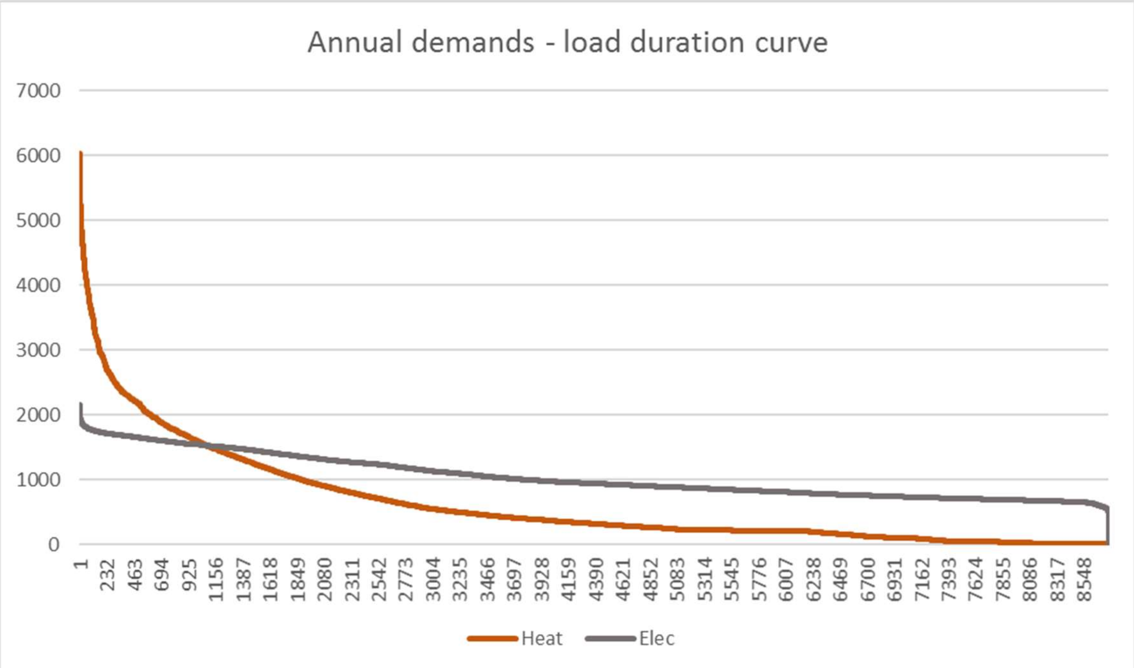


Figure 5-3 - Core area load duration curves



5.2 CORE AND EXT 1 AREAS DEMAND GRAPHS

Figure 5-4 – Core and Ext1 areas demands

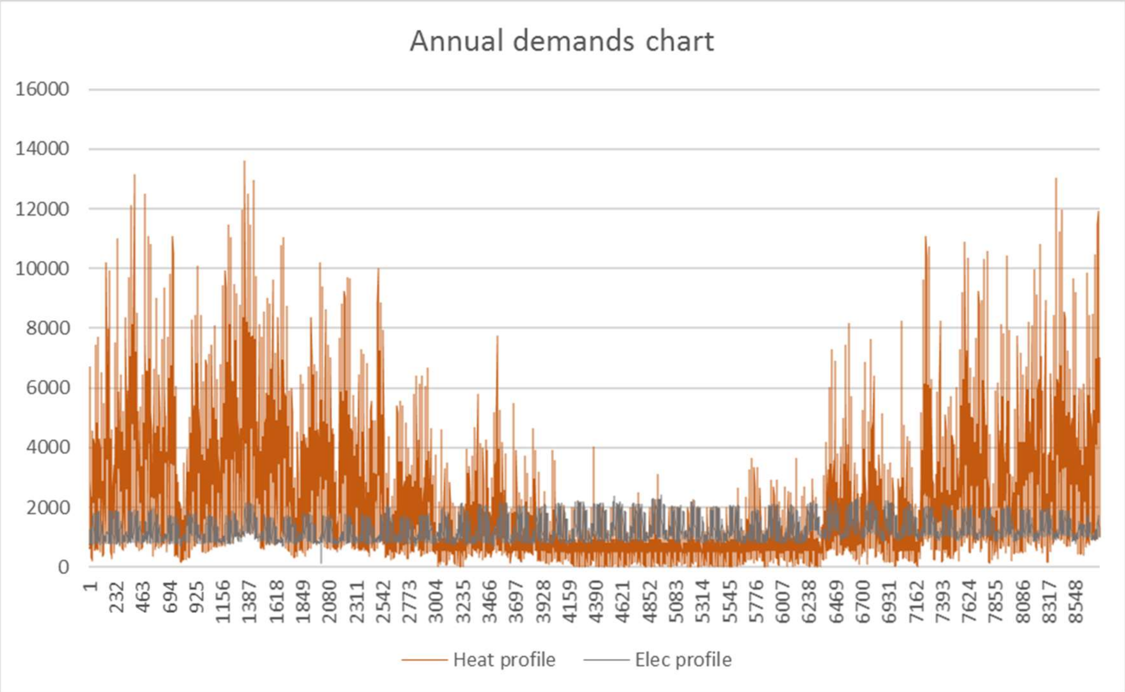
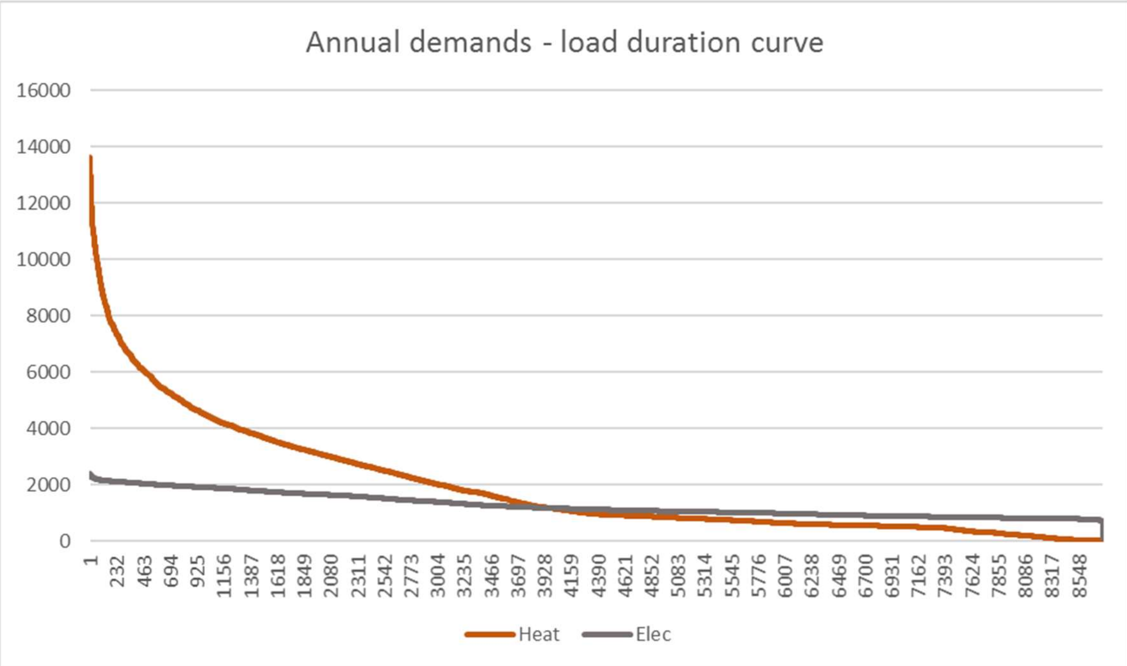


Figure 5-5 - Core and Ext1 areas load duration curves



5.3 CORE, EXT1 AND EXT2 AREA DEMAND GRAPHS

Figure 5-6 – Core, Ext1 and Ext2 areas demands

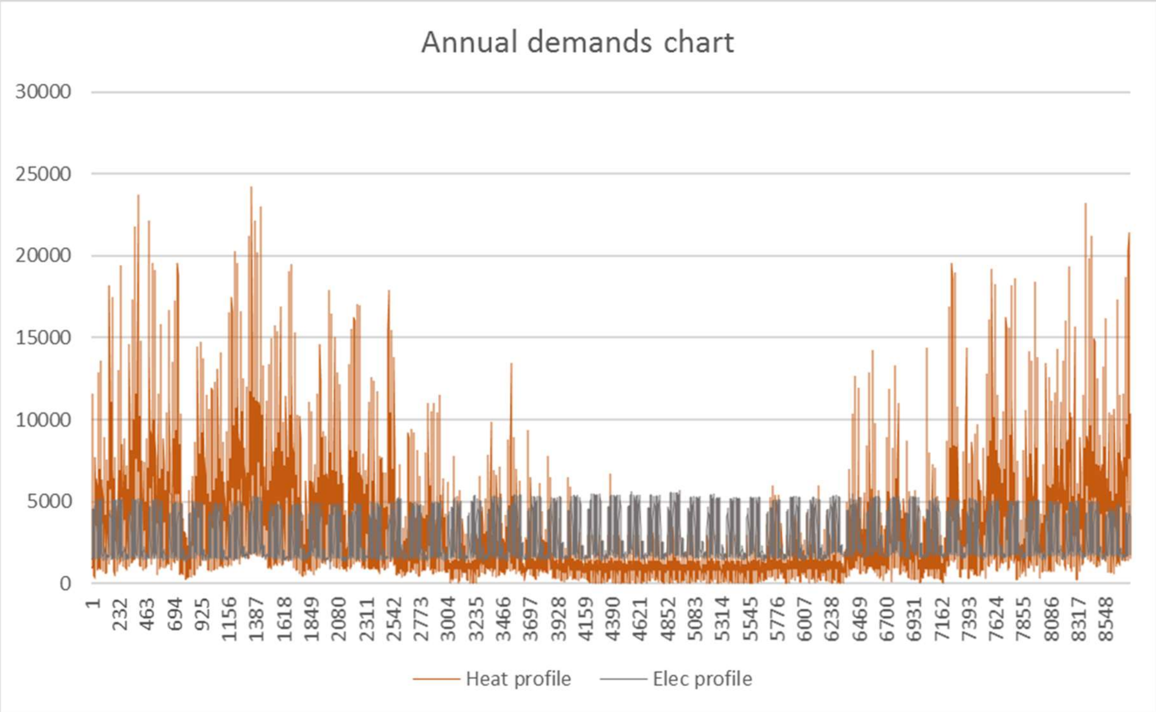
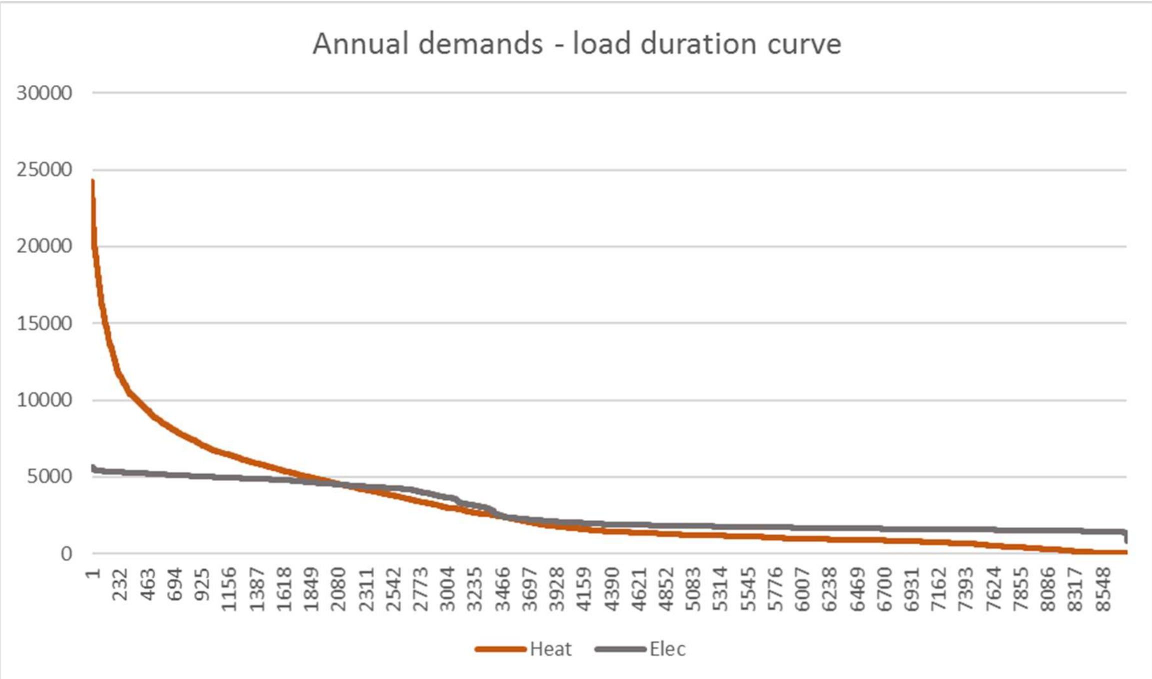


Figure 5-7 – Core, Ext1 and Ext2 areas load duration curves



5.4 CORE, EXT1, EXT 2, AND EXT3 AREA DEMAND GRAPHS

Figure 5-8 – Core, Ext1, Ext2 and Ext3 areas demands

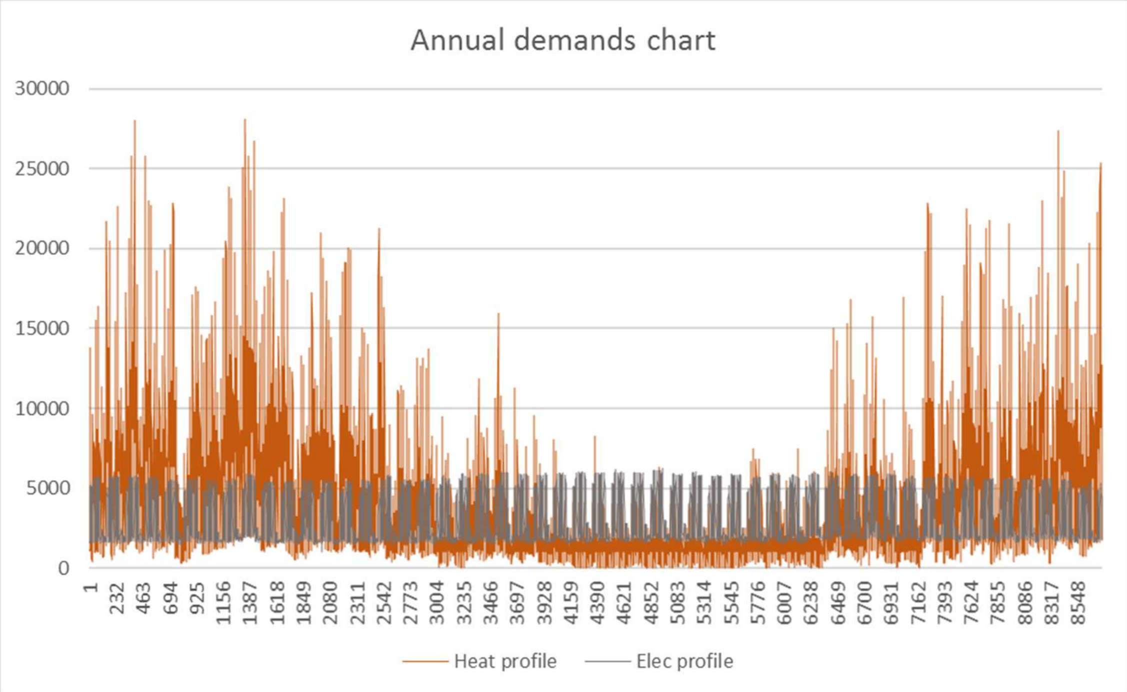
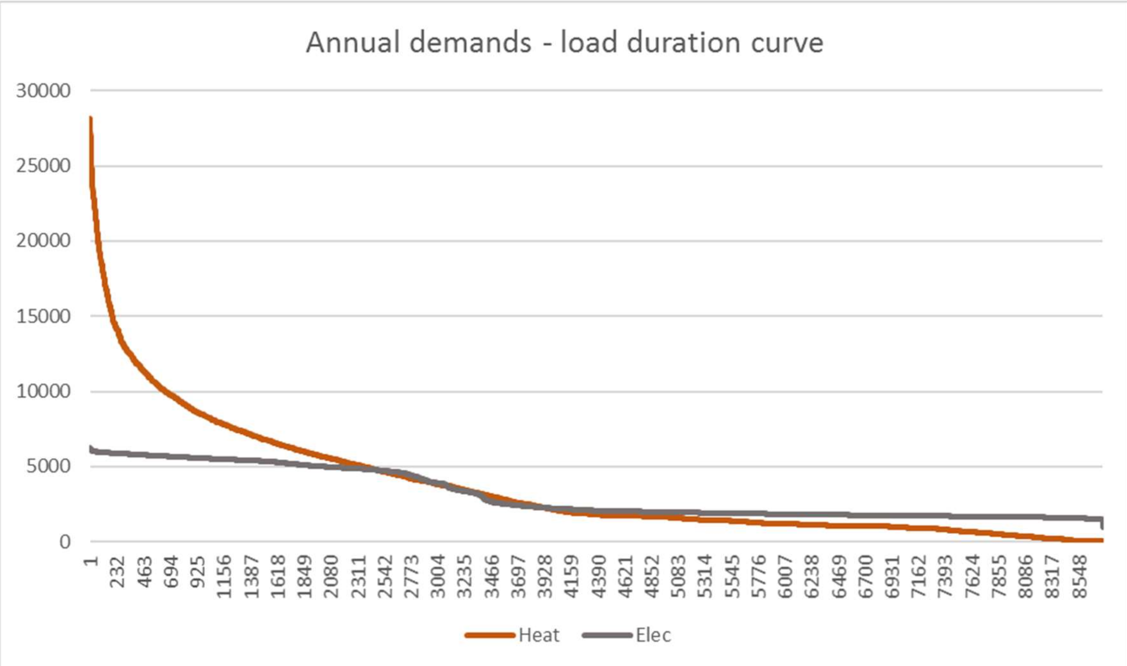


Figure 5-9 - Core, Ext1, Ext2 and Ext3 areas load duration curves



Appendix A

ENERGY DEMANDS BY DEVELOPMENT

APPENDIX A – ENERGY DEMAND ESTIMATES BY DEVELOPMENT SITE

This section presents the development sites that have been assessed for connection to the Croydon District Energy Scheme along with their estimated energy demands. NB that all of the demands presented here exclude estimates of the site-internal heat losses that are incorporated in overall calculations of viability taken forward under WP1D and WP1E

28 - 30 Addiscombe Grove

Residential Heat Demands

28-30 Addiscombe Grove is a residential only development. According to planning consent, the developer is required to engage with the operator of the Croydon District Heating Scheme, but no further stipulations about connecting to the scheme have been imposed. The development energy strategy states that a communal heating system will be used, with provision for a future DH connection.

Floor areas for each type have been based on an average from the accommodation schedule.

A summary of the energy demand estimates for this development, established using WSP benchmarks, are given in the table below.

Table 5-2 – Total energy demand summary: 28-30 Addiscombe Grove

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
153	7,104	387,752	610	-	-

Addiscombe Square (former Post Office site)

According to planning consent, there is no requirement for this development to connect to the Croydon District Heating Scheme, only that space should be reserved for equipment for linking to a future District Heating System.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-3 – Residential heat demand summary: Addiscombe Square

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
201	15,039	705,343	899

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-4 – Non-residential energy demand summary: Addiscombe Square

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Retail	1,760	88,000	123	163,680	282
Totals	**1,760**	**88,000**	**123**	**163,680**	**282**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-5 – Total energy demand summary: Addiscombe Square

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	15,039	705,343	899	-	-
Non-Residential	1,760	88,000	123	163,680	282
Totals	16,799	793,343	1,023	163,680	282

Barclay Road Annexe

This development is for the conversion of a former Croydon College building to a mixed-use development. According to planning consent, there is no requirement for this development to connect to the Croydon District Heating Scheme; however, the present design is understood to include provision for a future DH connection.

Residential Heat Demands

Heat demand data was provided in the development's Energy Statement for the residential properties; however, following a brief analysis, WSP felt that these figures were excessive and benchmark figures were used instead.

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-6 – Residential heat demand summary: Barclay Road Annexe

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
58	3,489	176,817	317

Non-Residential Energy Demands

The following energy intensity figures were inferred from the Energy Statement and used in the non-residential energy demand estimates in lieu of the benchmark figures stated in Table 3-7 above.

Table 5-7 – Non-residential heating benchmark figures for Barclay Road Annexe.

	Non-Residential Heat Demand ($kWh/m^2/year$)
Space Heating	43
Hot Water	20
Total Heat	63

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-8 – Non-residential energy demand summary: Barclay Road Annexe

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Offices (incl. mezzanine)	228	14,388	9	16,438	20
Commercial / Cultural Enterprise Units	521	32,852	42	18,246	45
Totals	**750**	**47,240**	**51**	**34,683**	**65**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-9 – Total energy demand summary: Barclay Road Annexe

Category	Total Floor Area (m^2)	Annual Heat	Peak Heat Demand (kW)	Annual Electrical	Peak Electrical

		Demand (kWh)		Demand (kWh)	Demand (kW)
Residential	3,489	176,817	317	-	-
Non-Residential	750	47,240	59	34,683	65
Totals	**4,239**	**224,057**	**376**	**34,683**	**65**

Carolyn House

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

This development consists of 183 dwellings; 53 of these are part of a rooftop extension which is stated within an Energy Strategy document to target Passivhaus standard for fabric performance.

Information on the number of units has been taken from planning documents and also online resources[6].

A summary of the residential heat demand estimates for this development, established using WSP benchmarks, are given in the table below.

Table 5-10 – Residential heat demand summary: Carolyn House

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
183	10,086	492,400	710

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-11 – Non-residential energy demand summary: Carolyn House

Commercial Usage	Total Floor Area (m^2)	Annual Heat	Peak Heat Demand (kW)	Annual Electrical	Peak Electrical

[6] Noel Lawler Consulting Engineers: Carolyn House, Croydon https://www.nlce.uk.com/carolyn-house (accessed: July 2019).

		Demand (kWh)		Demand (kWh)	Demand (kW)
Restaurant	443	70,437	62	39,870	71

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-12 – Total energy demand summary: Carolyn House

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	10,086	492,400	710	-	-
Non-Residential	443	70,437	62	39,870	71
Totals	**10,529**	**562,837**	**772**	**39,870**	**71**

Fairfield Development

The original planning application for the Fairfield development took the form of a hybrid application:

- Detailed planning application for Phase 1A
- Outline planning application for Phases 1B, 2 and 3.

Based on correspondence with Croydon Council, the buildings which make up the outline planning application are now understood to either be part of other developments or are no longer being developed.

The image below shows the area covered by the Fairfield Halls detailed planning application (Phase 1A) in yellow. The areas in green are those that are now understood to be part of other developments (101 George St site in the north-east corner alongside the Mondial site, and the Barclay Rd Annexe and the retained Magistrates Court in the south-east corner) and the Croydon College and College Green area (initially included as Phase 1B) which is now no longer being developed.

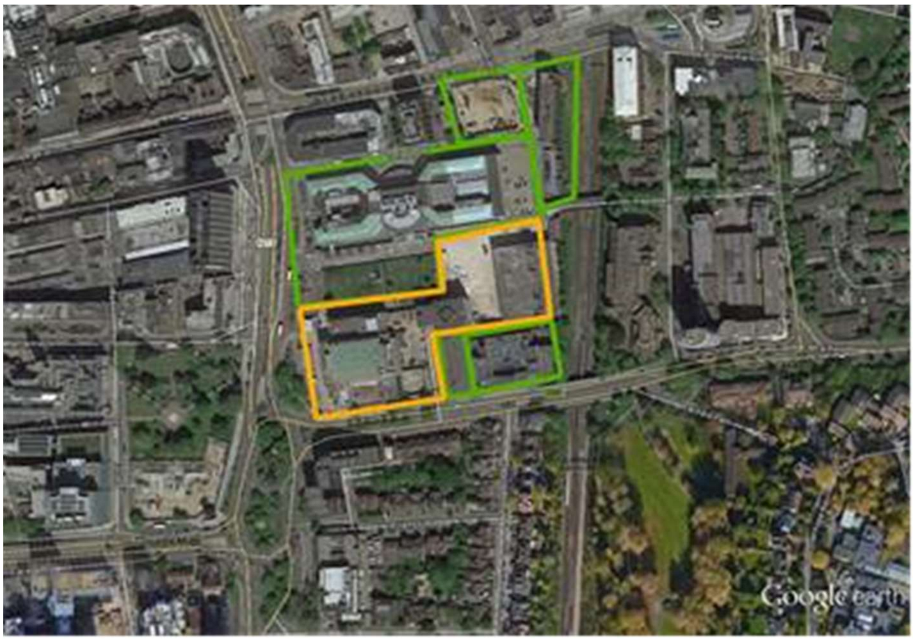


Figure 5-10 - Fairfield Halls development boundaries for outline and detailed planning applications.

This energy demand assessment has therefore focussed solely on the loads which lie within the yellow boundary, which represent Phase 1A only of the development.

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-13 – Residential heat demand summary: Fairfield Halls Phase 1A

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
421	25,803	1,300,275	1,549

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-14 – Non-residential energy demand summary: Fairfield Halls Phase 1A

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)

Retail	505	25,250	35	46,965	81
Restaurants/Cafes	131	20,829	18	11,790	21
Community Space	2,489	106,002	174	49,780	217
Entertainment Halls	1,162	254,478	291	174,300	186
Totals	**4,287**	**406,559**	**518**	**282,835**	**504**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-15 – Total energy demand summary: Fairfield Halls Phase 1A

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	25,803	1,300,275	1,549	-	-
Non-Residential	4,287	406,559	518	282,835	504
Totals	**30,090**	**1,706,834**	**2,068**	**282,835**	**504**

Former Essex House, 101 George Street

According to planning consent, there is no requirement for this development to connect to the Croydon District Heating Scheme, only for the developer to engage with the operator of the scheme. However, the present design is understood to include provision for a future DH connection.

Energy Statement Data

Annual heat demand data was provided in the development's Energy Statement for the residential properties and non-residential properties and converted into heat density values (kWh/m^2/year) using floor areas from the planning documents. Although WSP felt that the non-residential figures were toward the lower end of the scale for likely heat demand, these inferred Energy Statement benchmarks were used for all of this development's non-residential annual heat demand estimates in lieu of the WSP benchmark figures stated in Table 3-7. The inferred heat demand figures are listed in the table below.

Table 5-16 – Annual heating benchmark figures for Former Essex House, inferred from Energy Statement.

Usage Type	Annual Heat Demand (kWh/m2/year)
Residential Hot Water	26.3
Residential Space Heating	16.2
Non-Residential Hot Water	9
Non-Residential Space Heating	19

Residential Heat Demands

Annual heat demand estimates for the residential properties in the development were carried out using the inferred values in **Table 5-16**. Peak heat demand estimates are based on WSP benchmarks.

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-17 – Residential heat demand summary: Former Essex House

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
546	34,097	1,449,040	1,959

Non-Residential Energy Demands

Annual heat demand estimates for the non-residential floorspace in the development were carried out using the inferred values in **Table 5-16**. Peak heat demand estimates are based on WSP benchmarks.

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-18 – Non-residential energy demand summary: Former Essex House

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Offices	406	7,526	30	29,239	35

Gyms	131	3,606	13	12,455	21
Restaurant	359	9,867	36	32,283	57
Community Space (incl. club rooms and delivery space)	348	9,562	24	6,952	30
Totals	**1,244**	**34,206**	**118**	**80,929**	**144**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-19 – Total energy demand summary: Former Essex House

Category	Total Floor Area (m²)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	34,097	1,449,040	1,959	-	-
Non-Residential	1,244	34,206	118	80,929	144
Totals	**35,340**	**1,483,246**	**2,077**	**80,929**	**144**

Former Job Centre Plus site, 17 -21 Dingwall Road

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

Space heating demands have been estimated using figures taken from the Energy Statement. Hot water demand estimates are based on SAP methodology.

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-20 – Residential heat demand summary: Former Job Centre Plus

No. Dwellings	Total Floor Area (m²)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
181	11,118	642,613	764

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below. A 50-50 split of retail and restaurant usages has been assumed, based on information gathered from the Energy Statement.

Table 5-21 – Non-residential energy demand summary: Former Job Centre Plus

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Retail	400	20,000	28	37,200	64
Restaurants/Cafes	400	63,600	56	36,000	64
Totals	**800**	**83,600**	**84**	**73,200**	**128**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-22 – Total energy demand summary: Former Job Centre Plus

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	11,118	642,613	764	-	-
Non-Residential	800	83,600	84	73,200	128
Totals	**11,918**	**726,213**	**848**	**73,200**	**128**

Leon House

According to planning consent, there is no requirement for this development to connect to the Croydon District Heating Scheme; however, the present design is understood to include provision for a future DH connection.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-23 – Residential heat demand summary: Leon House 2

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
359	23,133	1,344,467	1,379

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below. Retail usage has been assumed due to the ground-floor location of the non-residential area.

Table 5-24 – Non-residential energy demand summary: Leon House

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Restaurants/Cafes	1,222	61,100	86	113,646	196
Totals	**1,222**	**61,100**	**86**	**113,646**	**196**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-25 – Total energy demand summary: Leon House

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	23,133	1,344,467	1,379	-	-
Non-Residential	1,222	61,100	86	113,646	196
Totals	**24,355**	**1,405,567**	**1,465**	**113,646**	**196**

Mondial House

According to planning consent, there is no requirement for this mixed-use development to connect to the Croydon District Heating Scheme, only that a DH connection strategy is approved which shows how the development might connect to the scheme in future.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-26 – Residential heat demand summary: Mondial House

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
220	17,932	829,663	1,007

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-27 – Non-residential energy demand summary: Mondial House

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Office	1,583	63,320	119	113,976	138
Retail Units (3No.)	423	21,150	30	39,339	68
Totals	**2,006**	**84,470**	**148**	**153,315**	**205**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-28 – Total energy demand summary: Mondial House

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	17,932	829,663	1,007	-	-
Non-Residential	2,006	84,470	148	153,315	205
Totals	**19,938**	**914,133**	**1,155**	**153,315**	**205**

Morello Tower

The Morello Tower development consists of two separate tower blocks on opposite sides of Cherry Orchard Road. The buildings have been named as follows:

- Cherry Orchard Road Tower
- Cherry Orchard Gardens Tower

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-29 – Residential heat demand summary: Morello Tower

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
445	29,972	1,476,065	1,693

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below. A 50-50 split of retail and restaurant usages has been assumed, based on information gathered from the Energy Statement.

Table 5-30 – Non-residential energy demand summary: Morello Tower

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Office	873	34,920	65	62,856	76
Retail	873	43,650	61	81,189	140
Totals	**1,746**	**98,649**	**127**	**144,045**	**216**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-31 – Total energy demand summary: Morello Tower

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	29,972	1,476,065	1,693	-	-
Non-Residential	1,746	78,570	127	144,045	216
Totals	**31,718**	**1,554,635**	**1,820**	**144,045**	**216**

Ruskin Square

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

In the absence of an accommodation schedule, residential numbers for the development were built up using an online marketing website[7] and a mix of unit types based on another development in Croydon.

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-32 – Residential heat demand summary: Ruskin Square

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
625	42,520	2,085,369	2,294

Non-Residential Energy Demands

Commercial floor areas for the development have been built up using information taken from planning documents and the online marketing website[7]. Floor area for the theatre has been estimated through comparison with a theatre with similar seating capacity.

[7] Ruskin Square: http://www.ruskinsquare.com/live/ (Accessed: July 2019).

Heating and electrical benchmark figures were given in the Energy Statement. The electrical figures (see table below) have been used for this assessment, but on review of the heating figures, it was felt that WSP's benchmarks were more appropriate.

Table 5-33 – Annual electrical benchmark figures for Ruskin Square, from Energy Statement.

Usage Type	Annual Electrical Demand ($kWh/m^2/year$)
Office	100
Retail	200
Theatre	270
Community Areas	20

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-34 – Non-residential energy demand summary: Ruskin Square

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Office	115,199	4,607,960	8,640	11,519,900	10,022
Retail	10,172	508,600	712	2,034,400	1,628
Community Space	400	17,035	28	8,000	35
Theatre	500	109,500	125	135,000	80
Totals	**126,271**	**5,243,095**	**9,505**	**13,697,300**	**11,765**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-35 – Total energy demand summary: Ruskin Square

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)

Residential	42,520	2,085,369	2,294	-	-
Non-Residential	126,271	5,243,095	9,505	13,697,300	11,765
Totals	**168,791**	**7,328,465**	**11,799**	**13,697,300**	**11,765**

St George's House, Queens Square

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-36 – Residential heat demand summary: St George's House

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
288	18,367	910,409	1,139

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-37 – Non-residential energy demand summary: St George's House

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Office Space	37	1,480	3	2,664	3
Retail Units	367	18,350	26	34,131	59
Restaurant	95	15,105	13	8,550	15
Residents Amenity Space	73	3,109	6	1,460	6
Totals	**572**	**38,044**	**48**	**46,805**	**83**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-38 – Total energy demand summary: St George's House

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	18,367	910,409	1,139	-	-
Non-Residential	572	38,044	48	46,805	83
Totals	**18,939**	**948,453**	**1,186**	**46,805**	**83**

Taberner House

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-39 – Residential heat demand summary: Taberner House

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
514	35,111	1,713,867	1,933

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-40 – Non-residential energy demand summary: Taberner House

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Retail	1,159	57,950	81	107,787	185
Totals	**1,159**	**57,950**	**81**	**107,787**	**185**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-41 – Total energy demand summary: Taberner House

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	35,111	1,713,867	1,933	-	-
Non-Residential	1,159	57,950	81	107,787	185
Totals	**36,270**	**1,771,817**	**2,014**	**107,787**	**185**

Wandle Road

According to planning consent, this mixed-use development is required to develop a Communal Heating Scheme that connects to the wider Croydon District Heating Scheme where possible or otherwise makes provision for future connection.

Residential Heat Demands

A summary of the residential heat demand estimates for this development are given in the table below.

Table 5-42 – Residential heat demand summary: Wandle Road

No. Dwellings	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (diversified) (kW)
128	8,176	407,536	587

Non-Residential Energy Demands

A summary of the non-residential energy demand estimates for this development are given in the table below.

Table 5-43 – Non-residential energy demand summary: Wandle Road

Commercial Usage	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Office	701	28,040	53	50,472	61

Retail	80	4,000	6	7,440	13
Totals	**781**	**32,040**	**58**	**57,912**	**74**

Total Energy Demands

The total energy demand estimated for the development, including both residential and non-residential, is summarised in the table below.

Table 5-44 – Total energy demand summary: Wandle Road

Category	Total Floor Area (m^2)	Annual Heat Demand (kWh)	Peak Heat Demand (kW)	Annual Electrical Demand (kWh)	Peak Electrical Demand (kW)
Residential	8,176	407,536	587	-	-
Non-Residential	781	32,040	58	57,912	74
Totals	**8,957**	**439,576**	**645**	**57,912**	**74**

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London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1B)

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CONFIDENTIAL

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EXECUTIVE SUMMARY

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. This second report in a wider suite of documents represents a summary of survey findings, design approaches, and cost assumptions for the building interface elements of the proposed Croydon DEN. This constitutes WP1B under the wider Croydon District Energy Scheme technical workstream.

A number of existing buildings were surveyed to help inform the technical viability of connecting these to the DH network and assess the proposed connection details. Some buildings were not surveyed due to the lack of response from stakeholders, and in these cases assumptions were made.

For the development sites, information was gathered from planning documents and engagement with developers to help inform the proposed connection details.

This information was used to establish connection capacities for each of the buildings/development sites.

Existing Buildings Customer Site	Substation Serves	Connection Capacity	Location
	Building communal heating system / Heating system only / Hot Water system only	kW	Area designation
Bernard Weatherill House	Heating system only	2,700	Core
	Hot Water system only	300	
Town Hall	Building communal heating system	1,000	Core
Central Library	Building communal heating system	1,500	Core
Davis House	Heating system only	250	Core
	Hot Water system only	150	
Croydon Combined Court	Building communal heating system	1,200	Ext3
Magistrates Court	Building communal heating system	900	Ext1
Croydon College	Building communal heating system	3,000	Ext1
Croydon Park Hotel	Heating system only	2,000	Ext3
	Hot Water system only	2 x 150	

Development Sites Customer Site	Substation Serves	Connection Capacity	Location
	Development communal heating system / Heating system only / Hot Water system only	kW	Area designation
101 George Street	Development communal heating system	2,100	Ext1
Barclay Annexe	Development communal heating system	400	Ext1
Fairfield Halls 01	Development communal heating system	1,700	Ext1
Fairfield Halls 02	Development communal heating system	1,600	Ext1
Leon House	Development communal heating system	1,500	Ext1
Mondial House	Development communal heating system	1,200	Ext1
Nestle	Development communal heating system	1,300	Ext1
Taberner House	Development communal heating system	2,100	Ext1
Wandle Road	Development communal heating system	700	Ext1
Ruskin Square B01	Development communal heating system	1,400	Ext2
Ruskin Square B02	Development communal heating system	1,500	Ext2
Ruskin Square B03	Development communal heating system	2,400	Ext2

Ruskin Square B04	Development communal heating system	2,000	Ext2
Ruskin Square B05	Development communal heating system	2,400	Ext2
Cambridge House	Development communal heating system	500	Ext2
Carolyn House	Development communal heating system	900	Ext2
Job Centre	Development communal heating system	900	Ext2
Ruskin Square R01	Development communal heating system	2,400	Ext2
Addiscombe Grove	Development communal heating system	700	Ext3
Addiscombe Square	Development communal heating system	1,100	Ext3
Morrello Tower Cherry Orchard Gardens	Development communal heating system	600	Ext3
Morrello Tower Cheerry Orchard Road	Building communal heating system	1,500	Ext3

Connection costs have been established for each building/development site based on the works expected. These costs are based on tender prices obtained from previous projects where the works are of similar type and magnitude. The substation costs have also been checked with previous project quotes from suppliers.

Existing Buildings Customer Site	Proposed Substation		
	Type	Heat Rating	CAPEX
	Heating / Hot Water	kW	£
Bernard Weatherill House	Heating	2,700	£53,000
	Hot Water	300	£43,000

Town Hall	Heating	1,000	£56,500
Central Library	Heating	1,500	£129,500
Davis House	Heating	250	£79,500
	Hot Water	150	£39,500
Croydon Combined Court	Heating	1,200	£92,000
Magistrates Court	Heating	900	£87,000
Croydon College	Heating	3,000	£117,000
Croydon Park Hotel	Heating	2,000	£127,500
	Hot Water	2 x 150	£68,500

Development Sites	**Proposed Substation**		
Customer Site	**Type**	**Heat Rating**	**CAPEX**
	Heating / Hot Water	**kW**	**£**
101 George Street	Heating	2,100	£84,000
Barclay Annexe	Heating	400	£48,500
Fairfield Halls 01	Heating	1,700	£80,000
Fairfield Halls 02	Heating	1,600	£80,000
Leon House	Heating	1,500	£80,000
Mondial House	Heating	1,200	£71,000
Nestle	Heating	1,300	£71,000
Taberner House	Heating	2,100	£84,000
Wandle Road	Heating	700	£68,500
Ruskin Square B01	Heating	1,400	£71,000

Ruskin Square B02	Heating	1,500	£80,000
Ruskin Square B03	Heating	2,400	£84,000
Ruskin Square B04	Heating	2,000	£84,000
Ruskin Square B05	Heating	2,400	£84,000
Cambridge House	Heating	500	£48,500
Carolyn House	Heating	900	£54,500
Job Centre	Heating	900	£54,500
Ruskin Square R01	Heating	2,400	£84,000
Addiscombe Grove	Heating	700	£53,500
Addiscombe Square	Heating	1,100	£71,000
Morrello Tower Cherry Orchard Gardens	Heating	600	£68,500
Morrello Tower Cheerry Orchard Road	Heating	1,500	£80,000

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1 INTRODUCTION AND SCOPE

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. One element of this is the potential development of a district heating network, where the aspiration would be to provide new and existing buildings a cost-efficient means of moving from natural gas as the dominant fuel, to a lower carbon and renewable fuel mix

A feasibility study was completed in 2017 which indicated that an initial scheme based on new development and existing public-sector buildings was economically viable. The council has allocated a site for the scheme energy centre. With new developments having to meet the London Plan Zero Carbon target, the best longer term low carbon heat supply option would be to connect to the Beddington Energy Recovery Facility (ERF). This commission aims to provide greater confidence in the viability of this supply option, and an alternative based on gas-fired CHP in the identified energy centre.

The objective of the work is to develop a viable scheme that can proceed to procurement.

The scope of the overall commission therefore comprises:

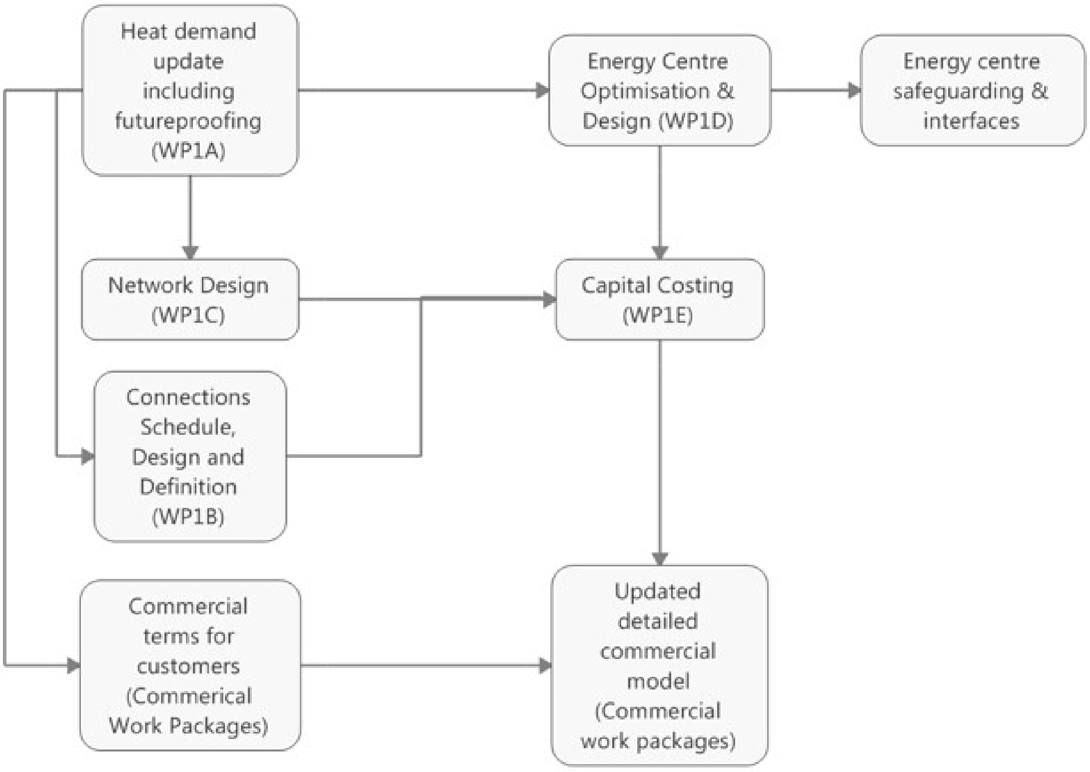
- A review of the 2017 feasibility study
- Updating the heat demands and techno-economics (according to the current phasing of new development)
- Establishing a preliminary system design, along with the capex and opex to a good degree of certainty – including the option of connection to the Beddington ERF plant
- Carrying out a commercial evaluation and identify the business models options that could be taken forward by the Council.

The scope of work is split into five work packages:

- **Work Package 1A:** Heat demands and consumptions. Power demand and consumption for potential 'private wire' supply to civic centre buildings.
- **Work Package 1B:** Distribution and supply to end users
- **Work Package 1C:** Heat network infrastructure
- **Work Package 1D:** Energy Centre
- **Work Package 1E:** Cost schedule for energy centre plant and pipe network

The workflow of the work packages and their relation to the commercial modelling work packages is summarised in Figure 1-1.

Figure 1-1 - Flowchart summarising key outputs of Technical work pages and their relationship to Commercial work packages



This report represents the deliverable **Work Package 1B** of the project. The information from this work package will be used to safeguard future connectivity of buildings identified in the base and extended schemes for DHN connection and provide detailed design requirements for building connections to the network. The scope of this work package is:

- Future connections – 'future proofing' of plant, space provisions, network access point etc.
- Connection at build – design of secondary systems, interim plant solutions (e.g. temporary HOB)
- Determine the detailed suitability of connection of existing buildings and their connection needs as well as the requirements of future development to enable connection to any potential district energy network.

The required outputs of this element of the study are:

- Determining the peak capacity and age of existing boiler plant
- Cost of replacement of existing boilers on a like-for-like basis
- Identifying flow and return temperatures of existing systems
- Estimating installed connection costs for the different buildings (existing and proposed), taking into account their specific circumstances and the required equipment, including:
  - Heat exchangers
  - Heat metering

- Controls
- LTHW pipework
- Other related equipment

- Cost data for input into Work Package 1E
- Report outlining the methodology, data sources, key findings
- Plant life cycle and replacement assumptions adopted
- Schematic design drawings in CAD of building connections to DHN, to include substation and plant room connections.

2 EXISTING BUILDINGS

Under the Work Package 1B scope of the works for the development of a business case for the Croydon District Energy (DE) Scheme, plant room surveys were undertaken of the existing buildings to assess the technical viability of connection each building to district heating (DH) network. These included the following buildings:

- Bernard Weatherill House
- Town Hall
- Central Library
- Davis House
- Croydon College

The following buildings were not surveyed due to lack of response from these stakeholders.

- Croydon Combined Court
- Croydon Magistrates Court
- Croydon Park Hotel

The surveys sought to identify the following:

- Confirm the existing heating system design and its compatibility with a DH supply
- Identify space for the DH heat substation
- Assess the practicality of connection (i.e. DH route into the plant room, etc.)
- Identify secondary system modifications required to make them compatible with a DH supply
- The type and condition of existing heating plant

The following sections summarise the findings of this process for each of the customer connections.

2.1 BERNARD WEATHERILL HOUSE (BWH)

Building Type	Office
Plant Room Location	Basement -2 plant room
Heating Plant Details	Building is heated via four floor-standing Ygnis gas-boilers. The boiler output, as labelled on each boiler plate is 1,300kW. The boilers installed in 2011 are in good condition. Heat is also provided by a 238kWe (359kWth) gas-fired Cogenco CHP unit which is connected to thermal store. CHP unit has not been operational for a good number of months.
Heating Systems Supplied	A set of four pumps circulate LTHW around the primary circuit. The boilers each have their own duty/standby pumpset which circulates LTHW onto this primary circuit. The CHP also has its own duty/standby pumpset. Three secondary LTHW CT circuits are fed from the primary circuit: LTHW to the BWH building for heating, LTHW to the BWH building for hot water and LTHW to the Town Hall for heating. Both secondary heating circuits are hydraulically separated via plate heat exchangers. The BWH plate heat exchangers serve air handling plant, chilled beams, fan coil units and underfloor heating. Most of the heating equipment has 2-port valves. The equipment at the end of each branches appear to have 3-port valves or 4-port valves. The LTHW circuit serving the hot water cylinders have 3-port valves.
Heating System Operating Conditions	The BMS showed that the boiler heating return set-point temperature was 81°C.

	The BMS showed that the thermal store set-point temperature was 83°C.
Recommended Modifications to Heating Systems	Controls modifications are recommended to weather compensate the heating circuits. This can be achieved via a sliding scale relationship between the heating circuits and the external ambient temperature. It is envisaged that the boilers, CHP and thermal stores are mothballed. It is proposed that the DH network will be connected directly to the existing BWH heating plate heat exchangers where connections have been allowed for. The hot water cylinders are proposed to be disconnected to the existing heating system and provided with heat directly from the DH network via new plate heat exchangers. Connections points have been allowed for this; however, it is not recommended to use these connection points due to the design temperatures. New temperature probes are proposed along with modification of the existing heating controls philosophy to suit the new DH connection. It is proposed that the existing equipment for the Town Hall will be re-located to the basement area within the Town Hall.
DH substation sizing and control philosophy	The existing plate heating exchangers for the heating of BWH is proposed to be re-utilised. These plates appear to be rated for approximately 2,500kW each based on info from the schematic and configured in a duty/standby arrangement. A new 300kW plate heat exchanger is proposed to serve both hot water cylinders. It is proposed to connect these directly into the hot and cold water pipework rather than the valved off connection on the LTHW pipework. This is because of the heating coils within the cylinder has been sized on specific design temperatures which is expected to be higher than that proposed for the DH network, i.e. the heating coils within the cylinder would not be rated high enough.
Plant to be removed	As it is proposed that the existing plate heat exchangers serving the Town Hall is re-located, this would create space for the new metering arrangement and plates serving the existing hot water cylinders.
Proposed DH substation location	The DH substation is proposed to be located in the space vacated by the removal of the existing equipment.

Proposed routing to DH substation	It is proposed to utilise the existing pipework from the Town Hall basement to the BWH boiler plant room. DH pipework would be routed directly into the Town Hall basement area from Mint Walk where it would connect into the existing pipework. The rating of this pipework would need to be checked to ensure that it is suitably rated for the DH network.

2.2 TOWN HALL

Building Type	Office
Plant Room Location	Basement plant room
Heating Plant Details	Heat is provided from the heating plant within the BWH plant room. There is dedicated plate heat exchangers and pump located within the BWH plant room serving the Town Hall heating system. The pipework is routed via Mint Walk to the basement area of the Town Hall.
Heating Systems Supplied	LTHW is pumped from the dedicated plate heat exchangers to the Town Hall low loss header, where there are three CT circuits and one VT circuit providing heating to the building. Each circuit serves a different zone where fan coil units and radiators provide heat to spaces. The heating system is a closed system with the pressurisation and expansion equipment located in the BWH plant room.
Heating System Operating Conditions	No BMS readings were available for this building; however, the schematic shows the system operating on 82/71°C flow/return temperatures.
Recommended Modifications to Heating Systems	Controls modifications are recommended for the primary heating circuit to weather compensate this. This can be achieved via a sliding scale relationship between the circuit flow temperature and the external ambient temperature. It is proposed that the existing plate heat exchangers and pressurisation and expansion equipment is re-located to the Town Hall basement area.

DH substation sizing and control philosophy	It is proposed to re-use the existing plate heat exchangers. These plates appear to be rated for 1,100 kW each based on info from the schematics and operated in duty/assist arrangement, both at 50% of design demand.
Plant to be removed	It is not envisaged that any plant will need to be removed to create space for the new DH substation
Proposed DH substation location	It is proposed that the DH substation is located within the basement area under Mint Walk where it's currently used for storing furniture and equipment.
Proposed routing to DH substation	Similarly to BWH, the DH pipework would be routed into the basement area where it would connect to the existing pipework. Modifications would be required to break the existing pipework from BWH so that the DH pipework serves the new substation with the secondary pipework connected directly into the Town Hall heating system.

2.3 CENTRAL LIBRARY

Building Type	Library
Plant Room Location	Rooftop Plantroom
Heating Plant Details	The building is heated by six floor-standing Remeha gas-boilers. Each boiler is rated to 330kW. The boilers were installed in 2014 and in good condition.
Heating Systems Supplied	A set of primary pumps circulate LTHW from the boilers around the low loss header. Five CT circuits and one VT circuits are branched off the low loss headers. Each CT circuit serves different areas within the building where there are heater batteries are generally utilised to heat the space. The VT circuit serves the radiators within the building.
Heating System Operating Conditions	No BMS data was available for the building; it is assumed that the building operates on 82/71°C flow/return temperatures based on the age of the building.
Recommended Modifications to Heating Systems	Controls modifications are recommended for the primary heating circuit to weather compensate this. This can be achieved via a sliding scale relationship between the circuit flow temperature and the external ambient temperature.

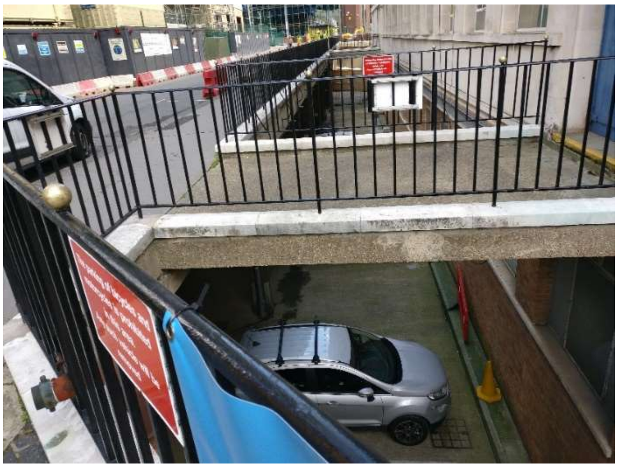
DH substation sizing and control philosophy	A dual plate heat exchanger PHX substation is proposed for the heating system rated for a peak heat load of approximately 1,500kW.
Plant to be removed	It is proposed that two of the boilers are removed to create space for the DH substation.
Proposed DH substation location	The DH substation is proposed to be located in the space vacated by the removal of the existing boilers.
Proposed routing to DH substation	DH pipework is proposed to be routed to the external loading bay area via Mint Walk. The pipework would then be routed up the building externally to the rooftop plant room. The pipework may need to be aesthetically treated to meet planning requirements.

2.4 DAVIS HOUSE

Building Type	Office
Plant Room Location	Basement Plant room
Heating Plant Details	The building is heated by two floor-standing Viessmann gas-boilers. Each boiler is rated at 630kW. The boilers were installed in 1996 and in ok condition.
Heating Systems Supplied	A set of pumps circulate LTHW from the boilers to the building heating system consisting of radiators. The building was retrofitted recently where the upper floors are heated and cooled via a VRF system. Only the lower floors (ground and level 1) and the stair cores are heated by the communal boilers.
Heating System Operating Conditions	The boilers appear to have a flow set-point temperature of 70°C which was advised as not adjusted throughout the year.
Recommended Modifications to Heating Systems	No modifications are proposed as it appears that system operates at a low flow temperature where low return temperature is expected back from the building heating system. It is proposed to remove the existing gas-fired hot water heaters where it is proposed that they will be replaced with packaged hot water unit served from directly from the DH network.
DH substation sizing and control philosophy	A dual plate heat exchanger PHX substation is proposed for the heating system rated for a peak heat load of approximately 250kW. A single packaged substation is proposed for hot water system rated for a peak load of approximately 150kW.

Plant to be removed	It is proposed to remove the existing gas-fired hot water heaters to create space for the hot water package unit.
Proposed DH substation location	There is space adjacent to the boilers to locate the heating substation. The substation providing hot water will be located in the space vacated by the removal of the existing hot water heaters.
Proposed routing to DH substation	The DH pipework is proposed to be routed from Fell Road where it would be routed into the covered car park area and routed on the underside of the building to the plant room, following the gas pipework.

2.5 CROYDON COLLEGE



Building Type	Education – College
Plant Room Location	Basement, central to the building
Heating Plant Details	The building is heated by six floor-standing Hartley and Sugden gas-boilers. Each boiler is rated at approximately 1,100kW. The boilers were installed in 2006 and in ok condition.
Heating Systems Supplied	Each boiler has its own twin head pump which circulates LTHW to the secondary heating circuits. From the low loss header, there five CT and four VT circuits branches. It is planned to undertake upgrades to existing BMS and pumps.
Heating System Operating Conditions	During the peak winter time, only three boilers ever operate to provide the heating demand. The boilers have an 80°C set-point flow temperature. The primary pipework was showing 82/75°C flow/return temperatures during the survey.
Recommended Modifications to Heating Systems	Controls modifications are recommended for the primary heating circuit to weather compensate this. This can be achieved via a sliding scale relationship between the circuit flow temperature and the external ambient temperature.
DH substation sizing and control philosophy	A dual plate heat exchanger PHX substation is proposed for the heating system rated for a peak heat load of approximately 3,000kW.

Plant to be removed	It is proposed to remove at least two boilers to create space for the DH substation.
Proposed DH substation location	The substation is proposed to be located in the space vacated by the removal of the boilers
Proposed routing to DH substation	It is proposed that the DH pipework is routed into the basement car park area at high level along College Road. From there, the pipework would feed directly into the plant room at high level where it is proposed to be hidden under the existing walkway to the building.

2.6 CROYDON PARK HOTEL

Building Type	Hotel
Plant Room Location	Rooftop & basement plant room
Heating Plant Details	The building is heated by three floor-standing gas-boilers located within the rooftop plant room. The rating of the boilers is unknown. It is likely the boilers may be the original units installed when the building was built in 1984. The hot water cylinders serve the building which includes the ground floor kitchen and laundry room are located within a basement plant room. These cylinders are heated via the existing boilers in the rooftop plant room.
Heating Systems Supplied	The details of the heating system are unknown. It was advised that the system was not maintained well.
Heating System Operating Conditions	The operating conditions are unknown; however, it is envisaged that the system was designed to traditional 82/71°C flow/return temperatures, common to those systems installed during that era.
Recommended Modifications to Heating Systems	Controls modifications are recommended for the primary heating circuit to weather compensate this. This can be achieved via a sliding scale relationship between the circuit flow temperature and the external ambient temperature. It is proposed that the hot water is disconnected from the existing heating system and served directly from the DH network via a packaged hot water unit.
DH substation sizing and control philosophy	A dual plate heat exchanger PHX substation is proposed for the heating system.

	Hot water packages are proposed for providing hot water to the building which would be provided with heat directly from the DH network.
Plant to be removed	It is proposed to remove at least the redundant boilers to create space for the heating substation. It is proposed to remove the existing hot water cylinders to create space for the hot water package units.
Proposed DH substation location	The substations are proposed to be located in the space vacated by the removal of the existing plant.
Proposed routing to DH substation	It is proposed that the DH pipework is routed to the rooftop plant room via external pipework up the building from Altyre Road. The final appearance of the pipework will be subject to planning. The pipework to the basement plant room can be routed directly into the space via the car park area.

2.7 BUILDING IMPROVEMENTS

Where there are existing buildings earmarked for connection onto a DH network, it is typically the case that the operational temperatures of these buildings drive up the requirement for higher network flow temperature. It is also these buildings that influence the higher return temperatures back to the energy centre. It is therefore crucial to the scheme to improve the operational temperature of these buildings in advance of connecting onto a DH network.

Sometimes this can be achieved more easily by monitoring the heating system, in particular the installed 3-port valves to see if they bypass water from the LTHW flow into the return during a cold winters day. This will determine whether the heating system has been oversized, which is common practice of older buildings. If the system is oversized, then the heating system set-point temperature can be lowered which will then in turn lower the return temperature back from the heating system. When the existing 3-port valves are due for replacement, it is highly recommended that these are replaced with 2-port valves with differential pressure control, i.e. a PICV which incorporates both functions in one valve.

Weather compensating the heating system set-point temperature to correspond with the external ambient temperature can also be readily achieved via BMS modification works. Care will need to be taken if the heating system serves hot water calorifiers as the temperature may only be lowered to a certain temperature to prevent water storage temperatures being too low.

It is highly recommended that when the heating system within the building is life-expired that these systems are replaced with systems that operate with low flow and return temperatures in accordance with CIBSE Heat Networks: Code of Practice for the UK (CP1). Variable speed pump should also be implemented to improve the overall efficiency of the building system along with greater levels of pipework insulation to minimise heat losses.

3 DEVELOPMENT SITES

For the development sites, WSP has reviewed the available drawings / planning documents for each connection, and has adjusted the proposals for network connection accordingly, resulting in the network design proposals that are outlined in report WP1C.

For the development sites that could potentially connect to the Croydon DEN, the majority of the sites have already obtained planning consent, and the designs of the buildings have been developed to planning submission stage. In the vast majority of cases, a planning condition has been imposed on the developments to ensure compatibility with the DEN concept. A summary of the planning conditions imposed in include below:

Table 3-1 – Planning Conditions

Site	Planning application number	Condition text (if text could be copied – see appendices where applicable)	Web link to conditions notice
Barclay Road Annexe	19/01025/FUL	WSP has not identified planning conditions for site.	https://publicaccess3.croydon.gov.uk/online-applications/simpleSearchResults.do?action=firstPage
Phase 1A (Fairfield - College Green) : Resi **Phase 1A (Fairfield - College Green) : Non-resi** **Phase 1B (Fairfield - College Green) : Non-resi** **Phase 2 (Fairfield - College Green) : Resi** **Phase 2 (Fairfield - College Green) : Non-resi** **Phase 3 (Fairfield - College Green) : Resi**	16/00944/P	A19. Communal Heating Network (a) No development (other than Excluded Works) shall be commenced until a Communal Heating Scheme (CHS) for Phase 1A has been submitted to and approved in writing by the Local Planning Authority. The CHS shall as a minimum set out a plan identifying the location of the following : (i) Energy Centre within the Fairfield Halls existing boiler room; (ii) Communal heating pipes and any plant room serving Phase 1A Dwelling and non-residential units in Building C; (iii) Communal heating pipes and any plant room serving the Gallery; (iv) Communal heating pipes and valve connections to allow future connections to Blocks 4, 5, 6 and 7; and (v) A safeguarded route (or routes) that enable pipes to be extended to the back of footway of Park Lane. (b) The approved CHS shall be implemented such that: (i) It is operational and serves the hot water and heating needs of Buildings A, B and C before they are First Occupied. (ii) It is operational and serves the hot water and heating needs of Fairfield Halls before it is re-opened. (iii) It is operational and serves the hot water and heating needs of the Gallery before it is first brought in to use. (iv) It makes passive provision (in the form of capped valves and a safeguarded route (or routes) for future pipes) for connection to Blocks 1 to 7. (v) It connects to a wider Croydon District Heating Scheme where possible or otherwise makes passive provision (in the form of capped valves and a safeguarded route (or routes) for future pipes) for connection to such a scheme along the Park Lane frontage, the George Street frontage and Hazeldean Bridge. Reason: To ensure the efficient use of energy and reduce carbon emissions and facilitate decentralised energy in accordance with Policies 5.2, 5.5 5 and 5.6 of the London Plan (Consolidated with alterations since 2011) and Policy SP6.2 of the Croydon Local Plan: Strategic Policies 2013.	https://publicaccess3.croydon.gov.uk/online-applications/files/21EE3B64D15F3368F57710ED3D889A31/pdf/16_00944_P-DECISION_NOTICE_16_00944_P-2044200.pdf
Ruskin Square Block A **Ruskin Square Block B + C** **Ruskin Square Block D** **Ruskin Square Block E + F** **Ruskin Square Block B1**	11/00631/P	See pdf copy in Appendices	https://publicaccess3.croydon.gov.uk/online-applications/files/13215A1C64E8CF347A37489C8DD6E214/pdf/11_00631_P-106_Legal_agrrement-435200.pdf

Site	Planning application number	Condition text (if text could be copied – see appendices where applicable)	Web link to conditions notice
Ruskin Square Block B2 **Ruskin Square Block B3** **Ruskin Square Block B4** **Ruskin Square Block B5** **Ruskin Square Block L1**			
Morello Tower : Resi **Morello Tower : Non-Resi**	17/05046/FUL	17 Prior to the commencement of above ground works (and no later than RIBA stage 5) the approval of the Local Planning Authority shall be obtained with respect to the following matters: a) Means by which the buildings are enabled for connection to a District Energy Scheme for provision of all heating and hot water requirements, or b) The provision of pipework to the edge of the sites to enable connection to a District Heating Network. The approved details shall be provided before first occupation of a building. Reason: To ensure the development is able to reduce carbon emissions.	https://publicaccess3.croydon.gov.uk/online-applications/files/1201429FB359711A424BBE4BBFC62488/pdf/17_05046_FUL-GRANTED__106G__FULL_-_DEC_NOTICE-2556238.pdf
Wandle Road : Resi **Wandle Road : Non-Resi**	17/06318/FUL	4 Prior to the erection of above ground works, the approval of the Local Planning Authority shall be obtained with respect to the following matters: a) details of the means by which the buildings are enabled for connection to a District Energy Scheme for provision of all heating and hot water requirements, or b) details of the provision of pipework to the edge of the sites to enable connection to a District Heating Network. The approved details shall be provided before first occupation of a building. Reason: To ensure the development is able to reduce carbon emissions.	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?keyVal=PUQBO9JL0BK00&activeTab=summary
Former Essex House, 101 George Street	17/04201/FUL	See pdf copy in Appendices	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?keyVal=OUSAPNJLHF900&activeTab=summary

Site	Planning application number	Condition text (if text could be copied – see appendices where applicable)	Web link to conditions notice
28 - 30 Addiscombe Grove CR0 5LP	17/02680/FUL	See pdf copy in Appendices	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?keyVal=OQIBW4JL0M100&activeTab=summary
Carolyn House	16/02458/P	The residential units hereby approved will not be occupied until the applicant has provided to the Local Planning Authority for approval a District Energy Connection Strategy. This will show how the development has incorporated design features which facilitate future connection to a District Energy Network. The development shall only be implemented in accordance with the approved details. Reason: To enable future connection in accordance with Policy 5.6 of the London Plan (Consolidated with alterations since 2011).	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?keyVal=ZZZW0CJLXB078&activeTab=summary
Queens Square / St George's House : Resi **Queens Square / St George's House: Non-Resi**	12/03491/P ; No PP yet	See pdf copy in Appendices	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?activeTab=documents&keyVal=ZZZW0TJLXB175
Taberner House : Resi **Taberner House : Non-Resi**	14/00196/P	23. The means by which the development can be connected to a future District Energy Network shall be submitted to and approved by the local planning authority prior to commencement of development. The approved scheme shall be provided to each building prior to its occupation. Reason: To enable future connection in accordance with Policy 5.6 of the London Plan (2011).	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?activeTab=documents&keyVal=ZZZW0OJLXB040
Addiscombe Square (former Post Office site): Resi **Addiscombe Square (former post office site): Non-Resi**	No PP	n/a	n/a
Leon House	18/06140/FUL	See excerpt from Committee Report on this development in Appendices	https://publicaccess3.croydon.gov.uk/online-applications/simpleSearchResults.do?action=firstPage

Site	Planning application number	Condition text (if text could be copied – see appendices where applicable)	Web link to conditions notice
Job Centre Plus site, Dingwall Road -	17/06327/FUL	See pdf copy in Appendices	https://publicaccess3.croydon.gov.uk/online-applications/applicationDetails.do?keyVal=P1B9HWJLKFS00&activeTab=summary
Mondial House – Resi **Mondial House - Commercial**	16/00180/P	No above ground works shall take until the applicant has provided to the Local Planning Authority for approval a District Energy Connection Strategy. This will show how the development has incorporated design features which facilitate future connection to a District Energy Network. The development shall only be implemented in accordance with the approved details.	File titled “16_00180_P-GRANTED__106G__FULL_-_DEC_NOTICE-2297508” via planning portal

The conditions listed above illustrate that all of the developments are required to demonstrate compatibility with a District Heating connection.

On this basis, the general assumption adopted in modelling and costing of connections has been that:

- A route between the public highway and the plant room locations has been safeguarded for DH infrastructure
- Sufficient space is available within the development site to house the required plate heat exchanger(s) for the transfer of energy to the development from the DH pipework
- Adequate access is available to allow for installation of the requisite plant to enable DH heat supply
- Isolated points have been allowed within the heating system for connection of the heating substation
- Heating systems have been designed to low flow and return temperatures[1]

[1] CIBSE Heat Networks: Code of Practice for the UK (CP1) should be adhered to when designing heating systems and selecting design temperatures in connecting to DH networks; however, due to the timing of development sites being sufficiently progressed, a conservative approach has been taken with regards to design temperatures.

4 CONNECTION CAPACITIES

4.1 EXISTING BUILDINGS

Utilising data gathered from the site surveys and metered data provided, heat connection capacities for the existing buildings were established. Where no information was available, benchmarking and heat profiling was utilised to determine the proposed heat connection capacity.

The table below details the proposed connection capacity for each building along with information on the existing building heating system and the expected DH network return temperature back from each.

The heating substations are proposed to have two plate heat exchangers each with the exception of the hot water packaged units as these have resilience provided via the hot water storage capacity. These plates will be operated in duty/assist configuration where both will operate to provide the peak heating demand. The dual plate heat exchangers will allow the substation to operate well during low loads periods, typically during the summer, due to better turndown when compared to a single larger capacity plate heat exchanger.

This dual plate arrangement will provide resilience for the connection where a single plate heat exchanger can be serviced while the other is active. As each plate heat exchanger will be sized for 60% of the peak heating demand, this would typically be able to cover the heating demand for more than 80% of the year. Another benefit of the dual plate arrangement is the ability of the substation to operate well during low loads periods, typically during the summer.

It is recommended that prior to connecting any existing building to the DH network, the heating system is sampled to provide information on the condition of the water circulating the building. This will help inform if additional water treatment measures are required to prevent the plate heat exchangers from fouling in the near future.

Existing Buildings Customer Site	Proposed Substation					Existing Building Heating System Details		DH Network	Comments
	Serves	Connection Capacity	Proposed No. of Plate Heat Exchangers	Plate Configuration	Resilience Comments	**LTHW Flow Temp**	**LTHW Return Temp**	**Expected Return Temp**	
	Building communal heating system / Heating system only / Hot Water system only	kW				**°C**	**°C**	**°C**	
Bernard Weatherill House	Heating system only	2,700	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
	Hot Water system only	300	1 packaged unit without calorifier	Duty	Provided by existing re-utilised cylinders	N/A	N/A		New substation will be connected directly to the hot and cold water pipework
Town Hall	Building communal heating system	1,000	2	Duty / Assist	Plates sized at 60% of peak heat demand	82	71	73	
Central Library	Building communal heating system	1,500	2	Duty / Assist	Plates sized at 60% of peak heat demand	82	71	73	
Davis House	Heating system only	250	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	60	65	
	Hot Water system only	150	1 packaged unit with calorifier	Duty	Provided by new storage capacity	N/A	N/A		Hot water currently provided by gas-fired hot water heaters
Croydon Combined Court	Building communal heating system	1,200	2	Duty / Assist	Plates sized at 60% of peak heat demand	82	71	73	
Magistrates Court	Building communal heating system	900	2	Duty / Assist	Plates sized at 60% of peak heat demand	82	71	73	
Croydon College	Building communal heating system	3,000	2	Duty / Assist	Plates sized at 60% of peak heat demand	82	71	73	
Croydon Park Hotel	Heating system only	2,000	2	Duty / Assist	Plates sized at 60% of peak heat demand	82	71	73	
	Hot Water system only	2 x 150	2 packaged units with calorifier	Duty	Provided by new storage capacity	N/A	N/A		Hot water currently provided by gas-fired hot water heaters

Table 4-1 – Existing Buildings Connection Capacities

4.2 DEVELOPMENT SITES

The proposed connection capacities are based on information provided within the energy statements provided. Where no information was available, benchmarking and heat profiling was utilised to determine the proposed heat connection capacity.

The table below details the proposed connection capacity for each development along with information on the envisaged heating system design temperatures and the expected DH network return temperature back from each.

Similar to the substation proposed for the existing buildings, the substation will consist of dual plate heat exchangers to provide better turndown during low load periods and better resilience when compared with a single plate heat exchanger arrangement.

Where the It is expected that the DH substation serves a development area, it is envisaged that a communal heating system will be installed with a central plant room. The new DH substation would then be located within this plant room where it would connect into the heating system.

Development Sites Customer Site	Proposed Substation					Existing Building Heating System Details		DH Network	Comments
	Serves	Connection Capacity	Proposed No. of Plate Heat Exchangers	Plate Configuration	Resilience Comments	LTHW Flow Temp	LTHW Return Temp	Expected Return Temp	
	Development communal heating system / Heating system only / Hot Water system only	kW				°C	°C	°C	
101 George Street	Development communal heating system	2,100	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	It has been assumed that the majority of these system have been designed to low temperatures, prior to CIBSE Heat Networks: Code of Practice for the UK (CP1) being implemented
Barclay Annexe	Development communal heating system	400	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Fairfield Halls 01	Development communal heating system	1,700	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Fairfield Halls 02	Development communal heating system	1,600	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Leon House	Development communal heating system	1,500	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Mondial House	Development communal heating system	1,200	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Nestle	Development communal heating system	1,300	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Taberner House	Development communal heating system	2,100	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Wandle Road	Development communal heating system	700	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	
Ruskin Square B01	Development communal heating system	1,400	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55	

Ruskin Square B02	Development communal heating system	1,500	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Ruskin Square B03	Development communal heating system	2,400	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Ruskin Square B04	Development communal heating system	2,000	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Ruskin Square B05	Development communal heating system	2,400	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Cambridge House	Development communal heating system	500	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Carolyn House	Development communal heating system	900	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Job Centre	Development communal heating system	900	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Ruskin Square R01	Development communal heating system	2,400	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Addiscombe Grove	Development communal heating system	700	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Addiscombe Square	Development communal heating system	1,100	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Morrello Tower Cherry Orchard Gardens	Development communal heating system	600	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55
Morrello Tower Cheerry Orchard Road	Building communal heating system	1,500	2	Duty / Assist	Plates sized at 60% of peak heat demand	70	50	55

Table 4-2 – Development Sites Connection Capacities

5 FUTURE PROOFING

One key element of design for this project is to ensure that the development of the scheme is carried out in such a way as to allow for future flexibility in terms of scope / extent / primary energy sources.

The future proofing of DH substation interfaces is understood to imply consideration of the following issues:

- Ensuring that the DH substations are designed with sufficient heat transfer capacity to accommodate changes in operational temperatures of the network within agreed limits
- Ensuring that the scale of DH substations initially installed is of sufficient capacity at each load to accommodate changes of use / build-out of sites. However, when load growth is anticipated to be phased, WSP would stress the need to consider the controllability of DH substations during low-load conditions and ensuring that plate heat exchanger selections reflect this.
- Ensuring that the physical locations of the DH substations will remain suitably accessible to allow maintenance and replacement operations to be carried out without incurring unreasonable cost

The parameters that have been adopted in DH substations costing / selection to respond to the points above are:

Table 5-1 – DH Substation future proofing

Parameter	Design approach / limit	Notes
District heating flow temperature	95 °C	Two variants of the scheme are currently proposed – a CHP-based approach, and supply based on low-carbon heat from the Beddington ERF. Neither of these technologies requires low temperature supplies, and hence the primary rationale for the reduction of operating temperatures would be based on reducing heat losses. Preliminary analysis of a comparison of heat losses indicates that a higher temperature network (95°C) with series 3 insulation performs better than an 80°C network[2]. On this basis, the proposal is to maintain a 95°C flow temperature in the town centre network.

[2] Assuming that return temperatures are fixed – i.e. so that the higher flow temperature allows for a wider temperature differential in energy transfer.

		During the summer period where there is no heating demand, it is proposed that the temperature of the network can be lowered to, say 80°C, to provide the hot water demands.
Development return temperature	Variable, depending on the operation of the secondary heating circuits	The design and operation of the heating circuits will directly impact the return temperature back to the DH network. New developments/buildings are expected to have return temperature of 50°C and below. As more and more new developments/buildings are connected to the network, it is expected that the DH network return temperature will improve as it mixes with return temperatures from existing buildings.
Plate heat exchanger sizing	Allowing for good controllability at 10% of peak demands through means of multiple plates or specification of performance at low load conditions	Where multiple plates are proposed, these will operated in duty/assist arrangement

6 HEAT SUBSTATION REQUIREMENTS

This section provides general requirement for the specification of DH network heat substation.

The heat substations shall be a fully packaged unit, rated for operation in line with the operating temperatures and pressure of the system.

The substation is expected to be rated for operation at a continuous 95°C flow temperature and a minimum of 10 bar.

The substations shall be rated for a minimum of 25 years design life.

It is envisaged that any existing boilers will be not operational where the heating substation shall provide the sole heating for the building. As mentioned above, the package shall typically consist of a dual plate arrangement rated to the peak demand of the building/development.

All components shall be mounted on a galvanised steel base frame at the factory and delivered as a complete unit. Where installation as a single unit is not possible, the Contractor may be permitted to break down the unit for installation in parts as required to suit the specific spatial constraints of the site. This shall be carried out by simple bolting together base frame sections and pipework flange connections.

The packaged substation shall be mounted on single steel base frame where it is pre-fabricated off-site where possible. The substation shall consist of the following main components:

- Plate heat exchangers
- Pumps
- Isolation valves
- Regulating & balancing valves
- Safety relief valves
- Strainers
- Sensors (temperature and pressure)
- Gauges
- Two-port modulating control valves
- Two-port on / off control valves
- Self-acting differential pressure control valves
- Self-acting dead leg control valve
- Energy metering
- Control panel

All plate heat exchangers shall be 316L stainless steel.

Each heat exchanger shall be provided with a bespoke insulation jacket, which is suitable to be removed and refixed during maintenance tasks being affixed with a hook, an eye or similar as approved by the Supervisor. The insulation thickness shall be sufficient to limit the heat loss.

The use of permanent flushing bypass for flushing the pipework connections onto the heat substation shall not be permitted. Flushing of the connecting pipework shall be carried by looping out the flow and return connections with a temporary spool piece or hose, which shall be removed prior to the final connection of the heat substation.

It is envisaged that all control valves, actuators and energy meters will form part of the off-site fabricated package, with final instrumentation (excluding energy meter), wiring and control panel being carried out by a specialist controls supplier to ensure standardisation across the sites and compatibility with the wider scheme monitoring and control requirements. The secondary side pump(s) associated with the packaged substation shall be provided with a separately metered power supply from the existing building LV supplies to the power supply for the substation panel.

7 COST DATA FOR INPUT INTO WORK PACKAGE 1E

Based on the considerations listed above, and the survey work carried out for the existing building connections, the following table summarises the anticipated capital costs required for the installation of DH substations for the Croydon DEN.

The table below details the expected CAPEX for connecting the existing buildings.

Table 7-1 – Existing Buildings Connection CAPEX

Customer Site	Proposed Substation		
	Type	Heat Rating	CAPEX
	Heating / Hot Water	kW	£
Bernard Weatherill House	Heating	2,700	£53,000
	Hot Water	300	£43,000
Town Hall	Heating	1,000	£56,500
Central Library	Heating	1,500	£129,500
Davis House	Heating	250	£79,500
	Hot Water	150	£39,500
Croydon Combined Court	Heating	1,200	£92,000
Magistrates Court	Heating	900	£87,000
Croydon College	Heating	3,000	£117,000
Croydon Park Hotel	Heating	2,000	£127,500
	Hot Water	2 x 150	£68,500

The table below details the expected CAPEX for connecting the development sites.

Table 7-2 – Development Sites Connection CAPEX

Customer Site	Proposed Substation		
	Type	Heat Rating	CAPEX
	Heating / Hot Water	kW	£
101 George Street	Heating	2,100	£84,000
Barclay Annexe	Heating	400	£48,500
Fairfield Halls 01	Heating	1,700	£80,000
Fairfield Halls 02	Heating	1,600	£80,000
Leon House	Heating	1,500	£80,000
Mondial House	Heating	1,200	£71,000
Nestle	Heating	1,300	£71,000
Taberner House	Heating	2,100	£84,000
Wandle Road	Heating	700	£68,500
Ruskin Square B01	Heating	1,400	£71,000
Ruskin Square B02	Heating	1,500	£80,000
Ruskin Square B03	Heating	2,400	£84,000
Ruskin Square B04	Heating	2,000	£84,000
Ruskin Square B05	Heating	2,400	£84,000
Cambridge House	Heating	500	£48,500
Carolyn House	Heating	900	£54,500
Job Centre	Heating	900	£54,500

Ruskin Square R01	Heating	2,400	£84,000
Addiscombe Grove	Heating	700	£53,500
Addiscombe Square	Heating	1,100	£71,000
Morrello Tower Cherry Orchard Gardens	Heating	600	£68,500
Morrello Tower Cheerry Orchard Road	Heating	1,500	£80,000

These costs are based on tender prices obtained from previous projects where the works are of similar type and magnitude. The substation costs have also been checked with previous project quotes from suppliers.

The costs have been built up using the following components.

- General:
  - Site investigation and survey
  - Water sampling and reporting for customer systems
  - Validation and condition report of customer systems
  - Builders work in connection with works
  - Record documentation
- Removal works:
  - Any works involving removal of existing boilers or hot water heaters
- District heating substation for heating:
  - Supply of DH substation
  - Delivery and offloading of DH substation
  - DH substation installation
  - DH substation commissioning works
  - DH substation insulation
- Customer plant room works:
  - DH pipework and fittings from above ground demarcation point to DH substation and secondary system modifications
  - Pipework supply and installation of insulation
  - Pipework pressure test
  - System commissioning works
- BMS works:

- Supply and install of BMS outstations, field devices and associated equipment
  - BMS system commissioning works
  - BMS site acceptance testing
- Electrical services works:
  - Supply of DH substation breaker/consumer unit & energy meter
  - Install DH substation electrical supply and earthing
  - Install fibre optic panel electrical supply and earthing
  - Modification/expansion of existing fire and gas alarm system
  - Modification/expansion of existing general and emergency lighting system
  - Electrical testing and commissioning
- Building system BMS:
  - Modification of existing building BMS to improve heating system operation
  - Modification of existing building BMS to improve return temperatures back to the DH network

A more detailed cost breakdown can be found in Appendix B.

8 SCHEMATIC DRAWINGS OF BUILDING CONNECTIONS

The drawing below (also issued in pdf format) illustrates the preferred design of DH interfaces that are recommended for the Croydon DEN.

Figure 8-1 – DH Substation Schematic Interfaces Drawing

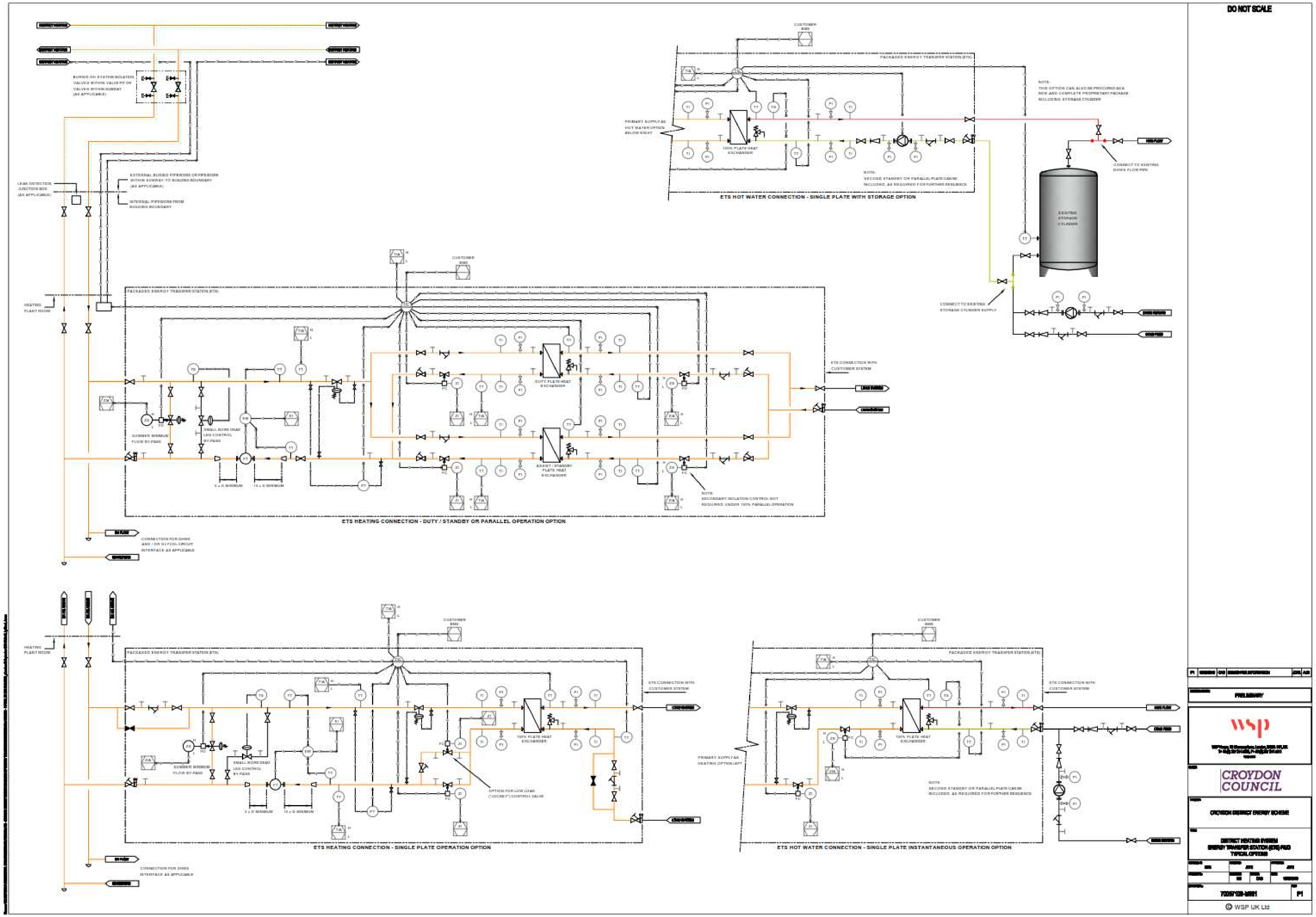
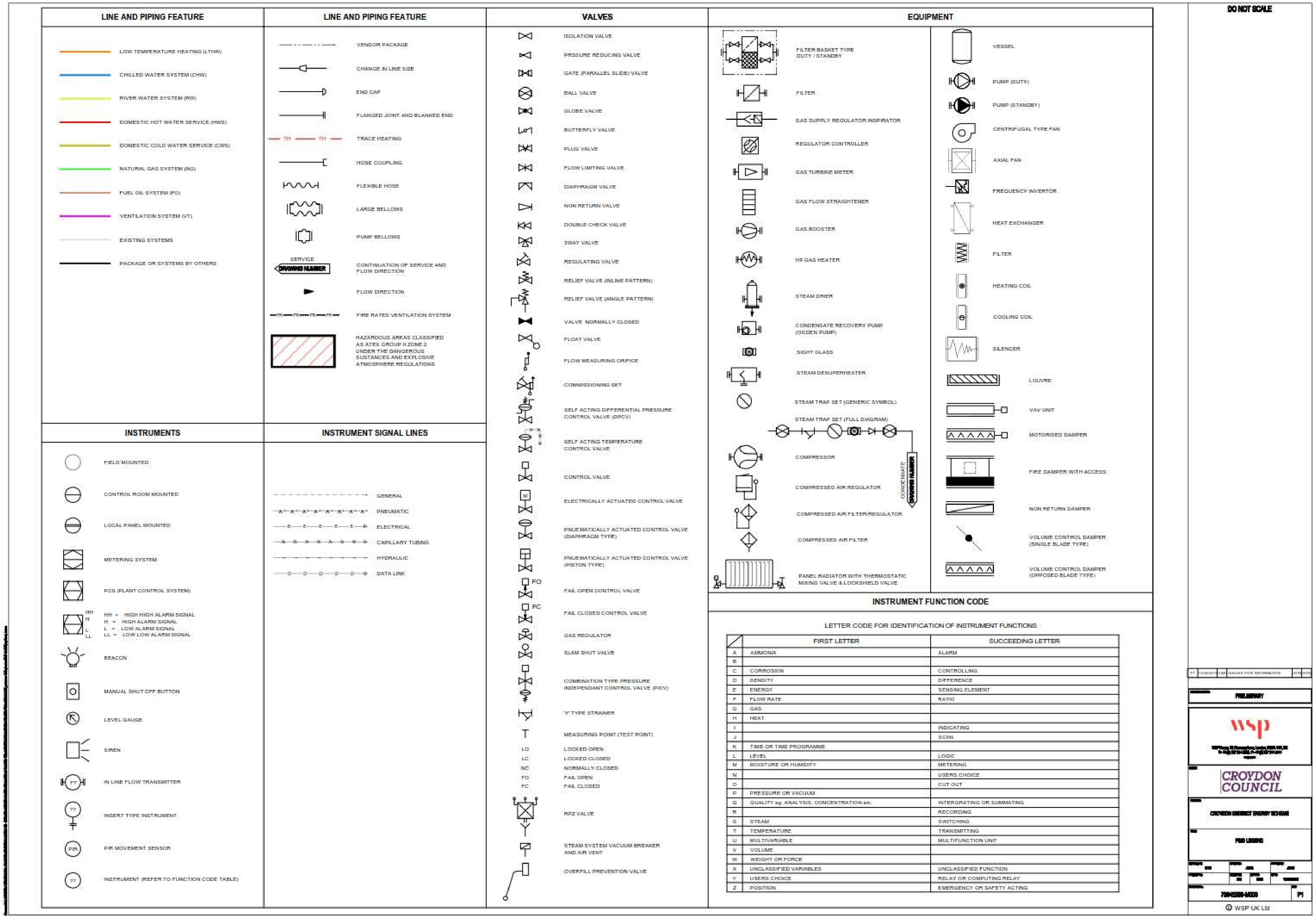


Figure 8-2 - Schematic DH Substation drawing legend



	FIRST LETTER	SUCCEEDING LETTER
A	AMMONIA	ALARM
B		
C	CORROSION	CONTROLLING
D	DENSITY	DIFFERENCE
E	ENERGY	SENSING ELEMENT
F	FLOW RATE	RATIO
G	GAS	
H	HEAT	
I		INDICATING
J		SCAN
K	TIME OR TIME PROGRAMME	
L	LEVEL	LOGIC
M	MOISTURE OR HUMIDITY	METERING
N		USERS CHOICE
O		CUT OUT
P	PRESSURE OR VACUUM	
Q	QUALITY eg. ANALYSIS, CONCENTRATION etc.	INTERGRATING OR SUMMATING
R		RECORDING
S	STEAM	SWITCHING
T	TEMPERATURE	TRANSMITTING
U	MULTIVARIABLE	MULTIFUNCTION UNIT
V	VOLUME	
W	WEIGHT OR FORCE	
X	UNCLASSIFIED VARIABLES	UNCLASSIFIED FUNCTION
Y	USERS CHOICE	RELAY OR COMPUTING RELAY
Z	POSITION	EMERGENCY OR SAFETY ACTING

Appendix A

PLANNING CONDITIONS

This Appendix contains a copy of the text of planning conditions as identified for the potential connections identified as part of this commission. NB only those conditions that could not be presented in Table 3-1 are replicated here:

RUSKIN SQUARE

As contained within document 11_00631_P-106_Legal_agrrement-435200, Condition 24.

24. PARTICIPATION IN THE DISTRICT HEATING SYSTEM

24.1 The Owner Covenants with the Council that:

24.1.1 In the event that a District Heating System is established, the Council may serve notice on the Owner that it requires the District Heating System to be connected to the Development to enable the District Heating System to supply the heating and hot water requirements of the Development and on receipt of such notice the Owner shall SUBJECT ALWAYS to paragraph 24.1.2 permit the District Heating System to be connected to the Development and shall install the heat exchanger and infrastructure in accordance with the specification referred to in 24.1.2.

24.1.2 The requirement for the District Heating System to be connected to the Development shall be subject to the following conditions being satisfied:

(a) a connection point(s) being at the boundary of the Site to which the Development can practicably be connected on a Phase by Phase basis;

(b) the total cost for heat and hot water (or any other service) to be supplied by the District Heating System being no greater than the cost of obtaining those services from elsewhere or by other means (having regard inter alia to tariffs, unit consumption charges, standing charges, management fees, plant replacement funds improved fabric costs) whilst still meeting the overall carbon performance standards as set out in the relevant planning policies;

(c) the connection charges to the District Heating System being reasonable and economically viable for the Owner;

(d) the provider of the District Heating System entering into a legally binding service level agreement with the Owner and with such tenants of the Development that the Owner shall notify to the Council and the Owner is satisfied that that agreement will provide adequate security of supply of services from the District Heating System; and

(e) the Owner being given full written details of the specifications of the heat exchanger and associated infrastructure required to enable the Development to be connected to the District Heating System.

24.1.3 The requirement for the Owner to connect the Development to the District Heating System shall also be subject to any regulatory changes governing the communal supply of energy.

24.1.4 The Owner shall use reasonable endeavours to agree the tariffs, charges, service level agreement and all other commercial terms necessary to enable it to connect to the District Heating System.

24.1.5 In the event that the Owner is unable to connect to the Croydon District Energy Scheme then it shall notify the Council and at the same time provide:

(a) the results of the detailed investigations which clearly demonstrate the reasons for the Owner's inability to connect to the Croydon District Energy Scheme including details of full financial comparison between connection and equivalent onsite energy provision

(b) the copies of all communications between the operator of the District Energy Scheme and the Owner

DISTRICT ENERGY SCHEME

1.3. Prior to the Practical Completion of the Development the Council may serve written notice on the Owner (the "Notification Letter") that it requires the Owner to engage with the District Energy Scheme's Operator and undertake a detailed investigation of the matters listed in paragraph 1.4 in accordance with the Notification Letter.

1.4. The process of engagement with the District Energy Scheme's Operator by the Owner will be set out in the Notification Letter and must involve the detailed investigation of the following by the Owner:-

1.4.1. the arrangements for connection to and ongoing receipt of heat from the District Energy Scheme for the Development; and

1.4.2. the feasibility and financial viability of such connection and ongoing operation for the Development.

1.5. The results of the engagement with the District Energy Scheme's Operator and detailed investigation must be submitted to the Council within 30 Working Days of the Notification Letter (or such longer period as agreed with the Council in writing).

1.6. In the event that the results of the engagement with the District Energy Scheme's Operator and detailed investigation show that the Owner cannot reasonably connect to the District Energy Scheme (including if it is not financially viable to do so or equivalent on-site energy provision has already been provided) then the Owner shall notify the Council in writing of this conclusion and at the same time provide the results of the detailed investigations which clearly demonstrate the reasons that the Owner is unable to reasonably connect to the District Energy Scheme (or equivalent on-site energy provision has been provided) including details of full financial comparison between connection and actual or proposed equivalent on-Site energy provision;

1.7. In the event that the results of the engagement with the District Energy Scheme's Operator and detailed investigations are agreed (or determined by an Expert to demonstrate) that the Owner can reasonably (in terms of feasibility and viability) connect to the District Energy Scheme then it shall as soon as reasonably possible:-

1.7.1. install the necessary heat exchanges and infrastructure at the Development prior to the Occupation of the Development to the Council's satisfaction; and

1.7.2. use reasonable endeavours to agree the tariffs, charges, service level agreement and all other commercial terms necessary to enable it to connect to the District Energy Scheme.

4.3 District Energy Scheme

4.3.1 In the event that the Council commences the process to establish a District Energy Scheme prior to first Occupation of the Residential Units constructed pursuant to the Development the Council may serve written

notice on the Owner (the "**Notification Letter**") that it requires the Owner to engage with the District Energy Scheme's Operator and undertake a detailed investigation in accordance with the Notification Letter.

4.3.2 The process of engagement with the District Energy Scheme's Operator by the Owner will be set out in the Notification Letter and must involve the detailed investigation of the following by the Owner:-

4.3.2.1 the arrangements for connection to and ongoing receipt of heat from the District Energy Scheme for the Development; and

4.3.2.2 the financial viability, practicality, feasibility and reasonableness of such connection and ongoing operation for the Development (including the commercial units).

4.3.3 The results of the engagement with the District Energy Scheme's Operator and detailed investigation must be submitted to the Council within 30 Working Days of the Notification Letter (or such longer period as agreed with the Council in writing).

4.3.4 In the event that the results of the engagement with the District Energy Scheme's Operator and detailed investigation show that the Owner cannot reasonably, viably, practicably or feasibly connect to the District Energy Scheme then the Owner shall notify the Council in writing of this conclusion and at the same time provide:-

4.3.4.1 the results of the detailed investigations which clearly demonstrate the reasons that the Owner is unable to reasonably, practicably or feasibly connect to the District Energy Scheme including details of full financial comparison between connection and equivalent on-Site energy provision; and

4.3.4.2 the copies of all material communications between the District Energy Scheme's Operator and the Owner.

4.3.5 In the event that the results of the engagement with the District Energy Scheme's Operator and detailed investigations show that the Owner can reasonably viably, practically and feasibly connect to the District Energy Scheme then it shall as soon as reasonably and practicably possible:-

4.3.5.1 install the necessary heat exchanges and infrastructure at the Development prior to the Occupation of the Development to the Council's reasonable satisfaction; and

4.3.5.2 use reasonable endeavours to agree the tariffs, charges, service level agreement and all other commercial terms necessary to enable it to connect to the District Energy Scheme

provided that the Owner shall not be required to connect to the District Energy Scheme if the process of engagement concludes after first Occupation of the Residential Units constructed pursuant to the Development in which case the obligations on the Owner in this paragraph 4.3 shall cease to apply.

QUEENS SQUARE / ST GEORGE'S HOUSE (NESTLE)

15. **Participation in the District Energy Scheme**

15.1 The Owners covenant with the Council that in the event that before Commencement of Development but not otherwise the Council commences the process to establish a District Energy Scheme and the Council serves notice, before Commencement of Development, on the Owners that it requires the District Energy Scheme with reasonable timescales stipulated by the Council to be connected to the Development to enable the District Energy Scheme to supply the heating and hot water requirements of the Development then the Owners shall instigate connection between the Development and the District Energy Scheme, and the ongoing receipt of hot water from the District Energy Scheme unless it can be demonstrated by the Owners to the Council that the connection would present additional cost to the provision of equivalent on Site energy provision.

15.2. In the event that the Owners do not instigate connection as required by paragraph 15.1, they shall notify the Council and at the same time provide:

(a) a full financial comparison between connection and equivalent on Site energy provision having regard to tariffs, unit consumption charges, standing charges, management fees and plant replacement funds and the capital cost of any plant already installed; and

(b) the copies of all communications between the operator of the District Energy Scheme and the Owners.

LEON HOUSE

WSP has not been able to identify the planning condition imposed upon the Leon House development, but below is an excerpt from the Officer's report of 18th July 2019 for the site.

9.185 Whilst no existing district heating networks currently exist, the site is within an area where one is planned. The use of a CHP (Combined Heat and Power) was discouraged by the GLA in favour of alternative low carbon heating methods, such as an air source heat pump. However, such a system would not be compatible with a District Heating System, and as the Council is currently undertaking the business case work on the heat network, the preference of officers is for the building to be able to connect to the planned network. Space has been allowed in the plant room for the incoming pipe services from a future District Heating System and the proposed use of plate heat exchangers would allow future connection. A s.106 obligation is also recommended requiring connection to the District Heating System if the council has appointed an operator before commencement on site, or a feasibility into connection to a future system on first replacement of the heating plant. On that basis, as the proposal complies with the above requirements regarding carbon reduction and a CO2 offset payment, subject to a condition requiring an updated energy strategy, the proposal is considered acceptable.

For this site it should also be noted that an addendum to the Energy Statement was published (dated 20th June 2019), which outlines the applicant's justification for reconsidering the energy supply options for the site. The addendum does not make a firm commitment to a particular technology solution, and hence there is still uncertainty as to what the counterfactual / base case approach is likely to be for this site.

JOB CENTRE PLUS SITE (DINGWALL ROAD)

20 Prior to the commencement of works (excluding demolition), the approval of the Local Planning Authority shall be obtained with respect to the following matters:
a) Means by which the building is enabled for connection to a District Energy Scheme for provision of all heating and hot water requirements, or
b) The provision of pipework to the edge of the site to enable connection to a District Heating Network.
c) Plans showing route of the heat network linking all buildings and uses on the site.
d)a revised energy strategy which includes all relevant information to the heating system design and a detailed analysis of the coefficient of performance (CoP) calculation;
e)a revised energy statement.

These matters shall be provided before first occupation of the building and thereafter the development shall accord with the approved details.

Reason: To ensure the development is able to reduce carbon emissions.

Appendix B

PRELIMINARY COST ESTIMATES

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wsp.com

London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1C)

SEPTEMBER 2019 CONFIDENTIAL

London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1C)

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70057109

DATE: SEPTEMBER 2019

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QUALITY CONTROL

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Signature				
Checked by	Bruce Geldard			
Signature				
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Signature				
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File reference	\\uk.wspgroup.com\central data\Projects\700571xx\70057109 - Croydon District Energy Scheme\02 WIP\Energy Solutions\06 Report\			

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FIGURES

APPENDICES

EXECUTIVE SUMMARY

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. This third report in a wider suite of documents represents a summary of the network investigations and route selections that have been carried out to date for the town centre area and ERF link.

The key risk areas for the project continue to be the railway crossing at Waddon Road on the ERF link, the tram crossings within the town centre, and the Brighton mainline crossing at Hazeldean Road bridge.

To date, WSP has not been able to reduce the critical risk associated with the Waddon Road railway crossing, and hence an alternative route is proposed for further consideration. This alternative route utilises the Purley Way bridge widening project as a vehicle through which new pipework could be integrated into the bridge design.

The following cost estimates have been compiled for the main and alternative routes, not including the cost of overcoming 'abnormal' obstacles such as the railway or tramlines, which will be documented as part of WP1D or WP1E.

	Estimated network cost (£m)
Town Centre network (all areas)	£5.1
ERF link (Waddon Road NR crossing)	£8.3
ERF link (Purley Way NR crossing)	£9.0
Total network cost (all town centre plus Waddon Rd NR crossing ERF route)	**£13.4**
Total network cost (all town centre plus Purley Way NR crossing ERF route)	**£14.1**

WSP is currently in the process of engaging with DH pipework suppliers to confirm the cost assumptions used in this report.

Contact name James Eland

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1 INTRODUCTION AND SCOPE

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. One element of this is the potential development of a district heating network, where the aspiration would be to provide new and existing buildings a cost-efficient means of moving from natural gas as the dominant fuel, to a lower carbon and renewable fuel mix

A feasibility study was completed in 2017 which indicated that an initial scheme based on new development and existing public-sector buildings was economically viable. The council has allocated a site for the scheme energy centre. With new developments having to meet the London Plan Zero Carbon target, the best longer term low carbon heat supply option would be to connect to the Beddington Energy Recovery Facility (ERF). This commission aims to provide greater confidence in the viability of this supply option, and an alternative based on gas-fired CHP in the identified energy centre.

The objective of the work is to develop a viable scheme that can proceed to procurement.

The scope of the overall commission therefore comprises:

- A review of the 2017 feasibility study
- Updating the heat demands and techno-economics (according to the current phasing of new development)
- Establishing a preliminary system design, along with the capex and opex to a good degree of certainty – including the option of connection to the Beddington ERF plant
- Carrying out a commercial evaluation and identify the business models options that could be taken forward by the Council.

The scope of work is split into five work packages:

- **Work Package 1A:** Heat demands and consumptions. Power demand and consumption for potential 'private wire' supply to civic centre buildings.
- **Work Package 1B:** Distribution and supply to end users
- **Work Package 1C:** Heat network infrastructure
- **Work Package 1D:** Energy Centre
- **Work Package 1E:** Cost schedule for energy centre plant and pipe network

The workflow of the work packages and their relation to the commercial modelling work packages is summarised in Figure 1.

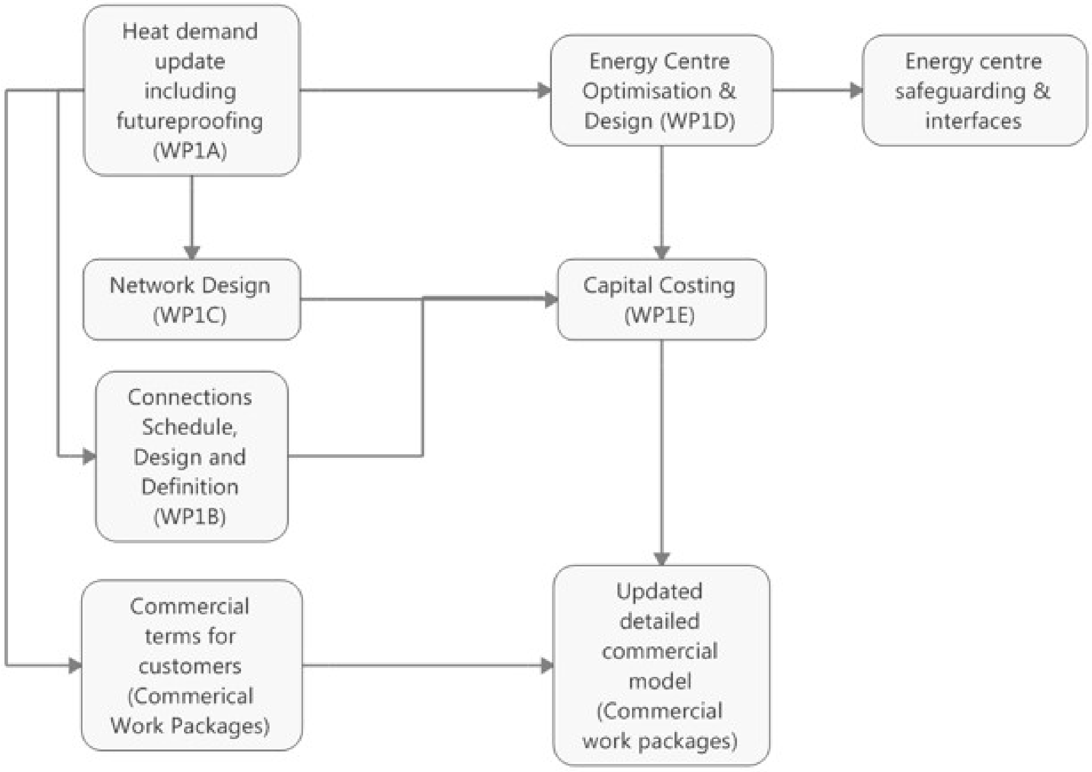


Figure 1: Flowchart summarising key outputs of Technical work pages and their relationship to Commercial work packages

This report represents the deliverable **Work Package 1C** of the project.

The aims of this work package are to:

- Assess the technical and financial viability of the proposed pipe route from Beddington ERF to the town centre energy centre. (NB that the financial viability of the proposal is addressed in WP1D and the techno-economic modelling associated with the project).
- Review the Stage 2 pipe routing and produce schematic design of the proposed town centre network route.
- Consider the potential to use '4th generation' DH pipework
- Identify suitable pipework routes given the existing infrastructure constraints and liaison with key stakeholders
- Identify suitable pipework technology for the routes (including an assessment of the use of twin pipe and insulation thickness
- Carry out hydraulic modelling of the network
- Develop cost estimates for the network routes (noting that the tender requires that budget cost estimates should also be obtained direct from heat network installation companies. This approach is required to increase the certainty and reduce the tolerance of the feasibility costings.

The outputs required from this element of the study are:

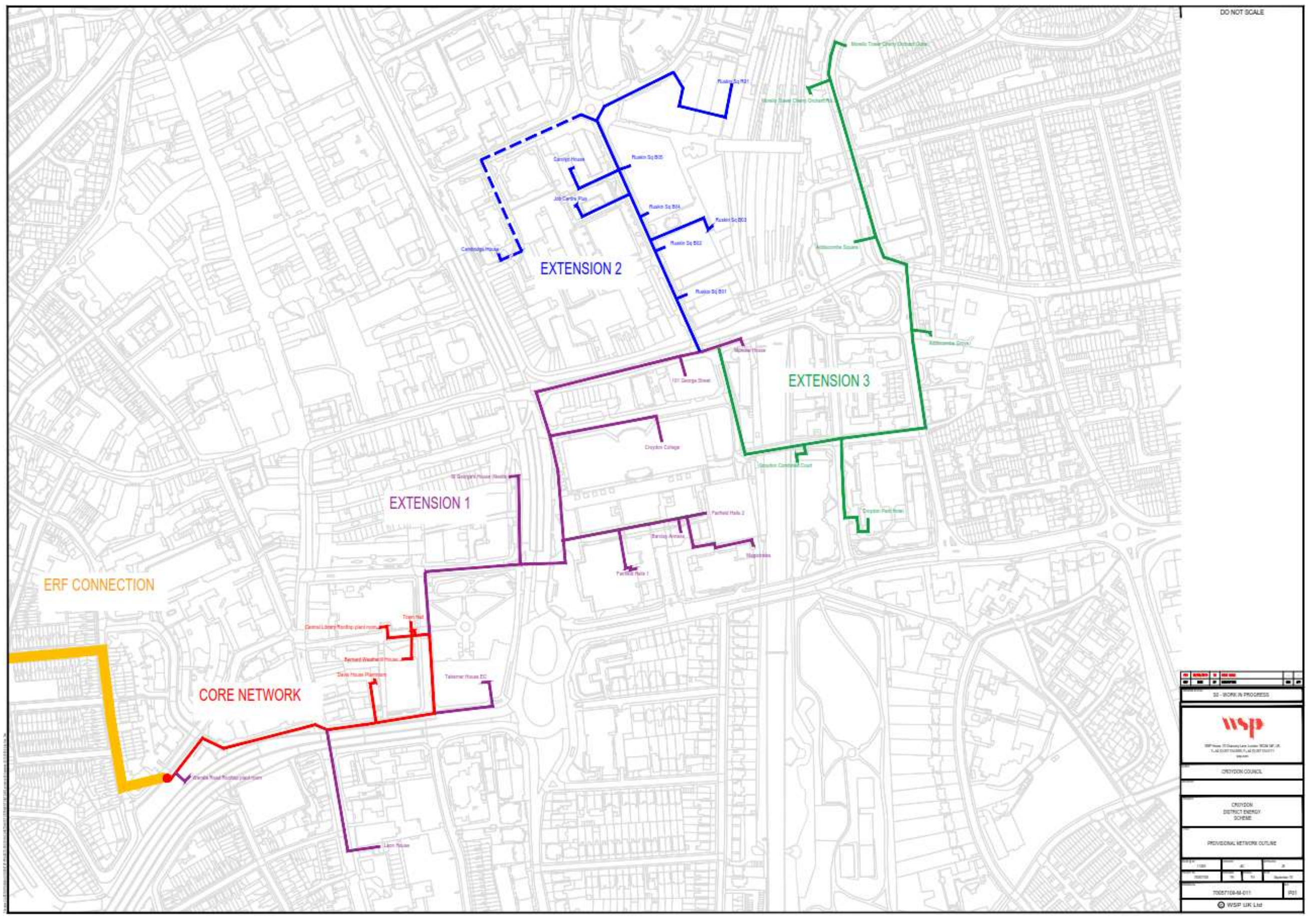
- A schematic drawing of town centre network in CAD. This drawing should show network development by phase and include the base and extended scheme building connections.
- A schematic drawing in CAD of the ERF to Wandle Road energy centre pipe route based on statutory utility drawings
- A schedule of technical and commercial risks shall be developed for the alternative DH pipe routes
- Hydraulic model to be passed to LBC for future usage.
- Cost data for input into Work Package 1E: Cost schedule for pipe network.
- A table giving the heat loss in W/m of pipe, split by diameter, should be provided and used to provide the instantaneous heat loss in kW and the annual heat loss e.g. MWh.
- Report to capture methodology, data sources, key findings, recommendations and conclusions.

2 PROPOSED PIPE ROUTING

2.1.1. Route

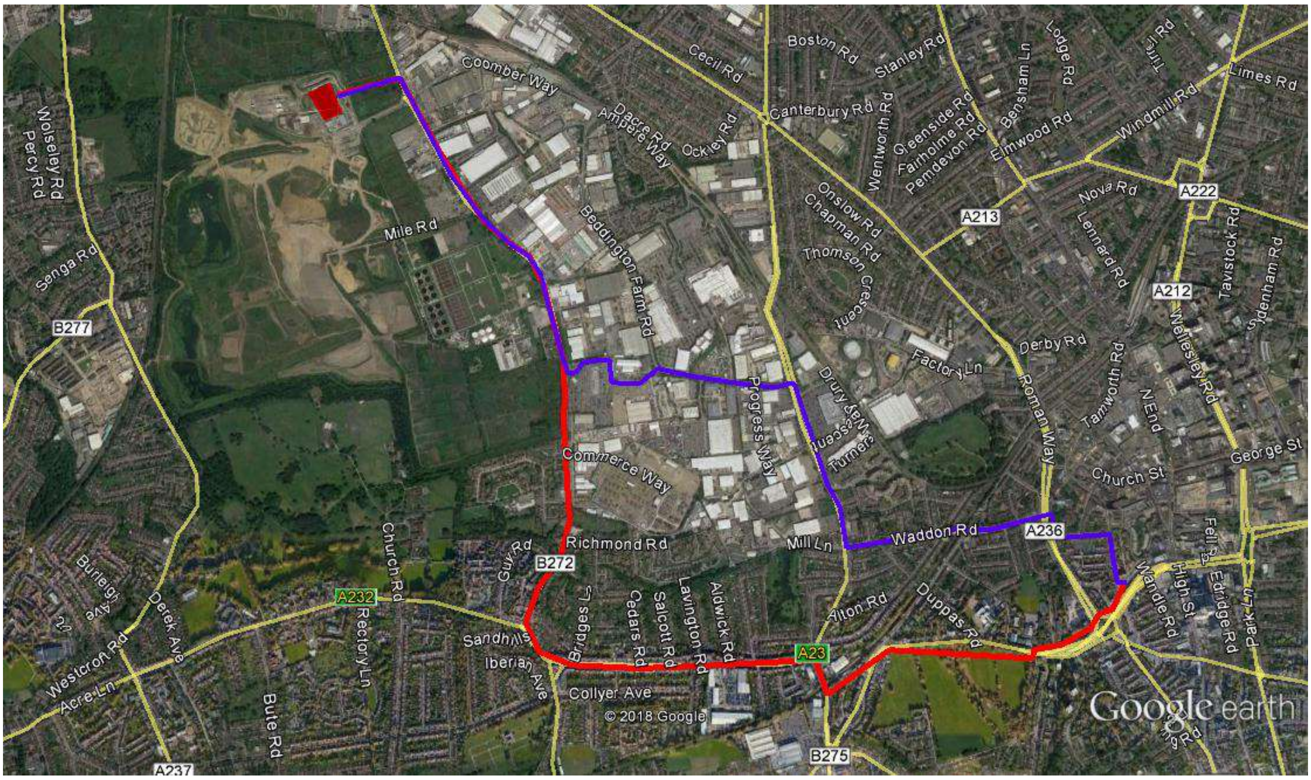
2.1.2. The following diagrams illustrate the overall routes proposed for the district heating network in both the town centre and ERF link areas.

Figure 2-1 - Town Centre network proposal



Two ERF connection routes are illustrated here – the more direct link that crosses the railway at Waddon Road (in this report referred to as the "Waddon Road crossing route", shown in blue below), and an alternative, longer route that crossing the railway at the A23 (Purley Way) (referred to as the "Purley Way crossing route", shown in red).

Figure 2-2 – ERF Connection network proposal



3 NETWORK

3.1 REVIEW OF STAGE 2 PIPE ROUTING

WSP has used the Stage 2 pipe routing as a basis for further developing the designs of the scheme, and as such this whole report represents a form of review of the Stage 2 designs.

3.2 UTILITIES ASSESSMENT

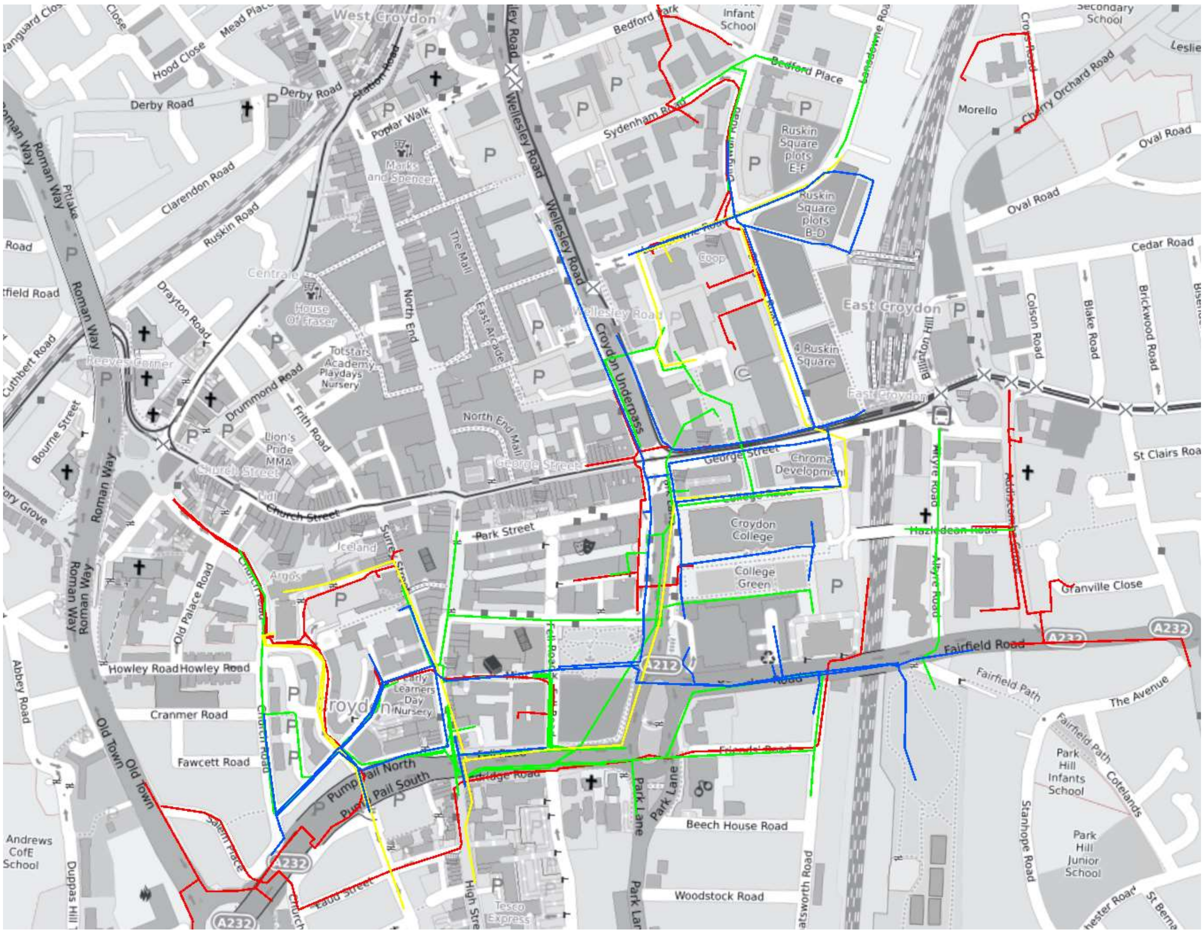
TOWN CENTRE

Historical utility mapping (December 2016) from a previous study was received from the council and studied. As expected, the town centre has a great deal of buried services mainly low voltage power, low pressure gas and small diameter water and sewer infrastructure along with telecommunications cables.

The below map shows a high-level overview of the location of the main utility constrains in the area:

- High voltage power cables (Red)
- Large diameter water mains (Blue)
- Large diameter sewers (Green)
- Large amounts of IT infrastructure (Yellow)

Figure 3-1 - Illustration of utilities as mapped



Please note there was no intermediate or high-pressure gas mains within the study area according to the 2016 utility maps although given the level of new developments constructed since, the gas grid in this area may have been subsequently reinforced.

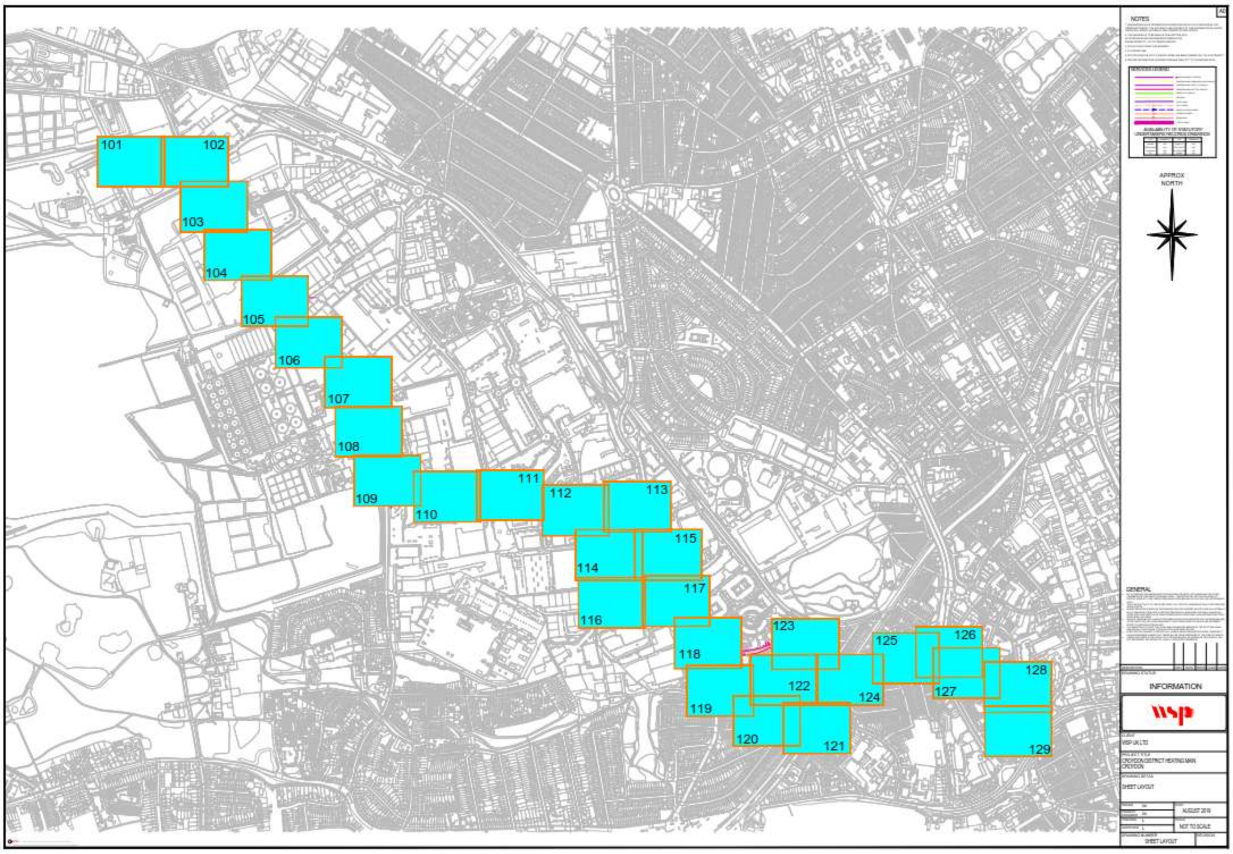
As a historic urban centre Croydon is inevitably home to large buried utilities, however, analysis of the 2016 Groundwise mapping has only flagged up one area of particular concern that being the area around the energy centre leading up to and including the junction of Whitgift St and High St.

There are numerous parts of the prospective network where there are a lot of existing services , but within the Town Centre they are in WSP's view in line with the normal conditions contractors would see in any dense urban centre in the UK.

ENERGY RECOVERY FACILITY CONNECTION

WSP has obtained and digitally mapped utilities information for the proposed route to the Beddington ERF plant from the Wandle Road Energy Centre location. The following illustrates the tiles that were produced to cover the area of this desktop survey.

Figure 3-2 - ERF link survey tiles



An example of one of these survey output tiles is shown below – the remainder of these data are included within the appendices of the report.

Figure 3-3 - Utilities sheet 129 (as per tiles numbering above)

These survey mapping outputs have informed the selections of pipework routes proposed for the DH link between the ERF facility and the Wandle Rd energy centre.

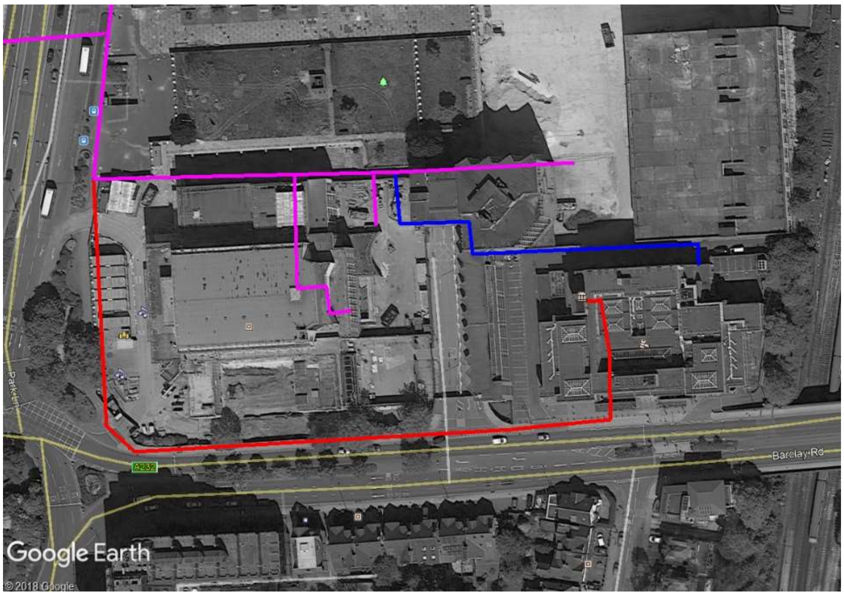
3.3 SITE SURVEY OUTCOMES

A route survey was undertaken on the 12th and 13th of August 2019, and this has informed some of the network routing decisions taken. A selection of these decisions and alternatives are described below:

ROUTE SELECTIONS AND ALTERNATIVES CONSIDERED

- The route proposed to serve the Magistrates Court now runs through the Fairfield development (blue), this avoids the need to run on Barclay Road (red) while also providing a more direct path to the Magistrate Courts' boiler room at the north-east corner of the building.

Figure 3-4 - Magistrates Court connection



- The route to serve a possible Cambridge House development is now proposed from a spur (shown in blue) off the Ruskin Square spine along Landsdowne and Walpole roads. This avoids a potentially disruptive and costly additional tram line crossing (shown in red) at the expense of a small amount of additional pipework.

Figure 3-5 - Cambridge House connection options

- The alternative route shown in purple below was considered as an alternative to the stretch of pipework route following Purley Way (A23). The alternative would have taken the pipework route down Commerce way and along Progress Way. However, this route was not preferred as there is also high density of services along the alternative route, and the narrow roadway has access to multiple small businesses, where the operation of pipework installation would have impeded access and given rise to potential negative impacts on deliveries etc.. The route that follows Purley Way, by contrast, is envisaged to require closure of a lane of traffic (which has its own detrimental impacts) but should generally not prevent access to any of the business or amenity facilities of the area.

Figure 3-6 - Alternative route considered around Purley Way

- The alternative route shown in mauve below was also considered as an alternative to a section of route following Purley Way (A23). The alternative would have taken the pipework along Whitestone Way, Connersville Way and Vicarage Road. However, this alternative route is also not proposed given the small section of installation work that would be required on private land on the junction between Vicarage Road and Connersville Way. There is inherent risk and potentially wayleave / easement costs linked to private land routes and the alternative route is of a similar overall length, and therefore estimated cost to the Waddon Road / Purley Way route.

Figure 3-7 - Waddon Rd and Purley Way alternative considered

ENERGY TRANSFER STATION / DH SUBSTATION LOCATIONS

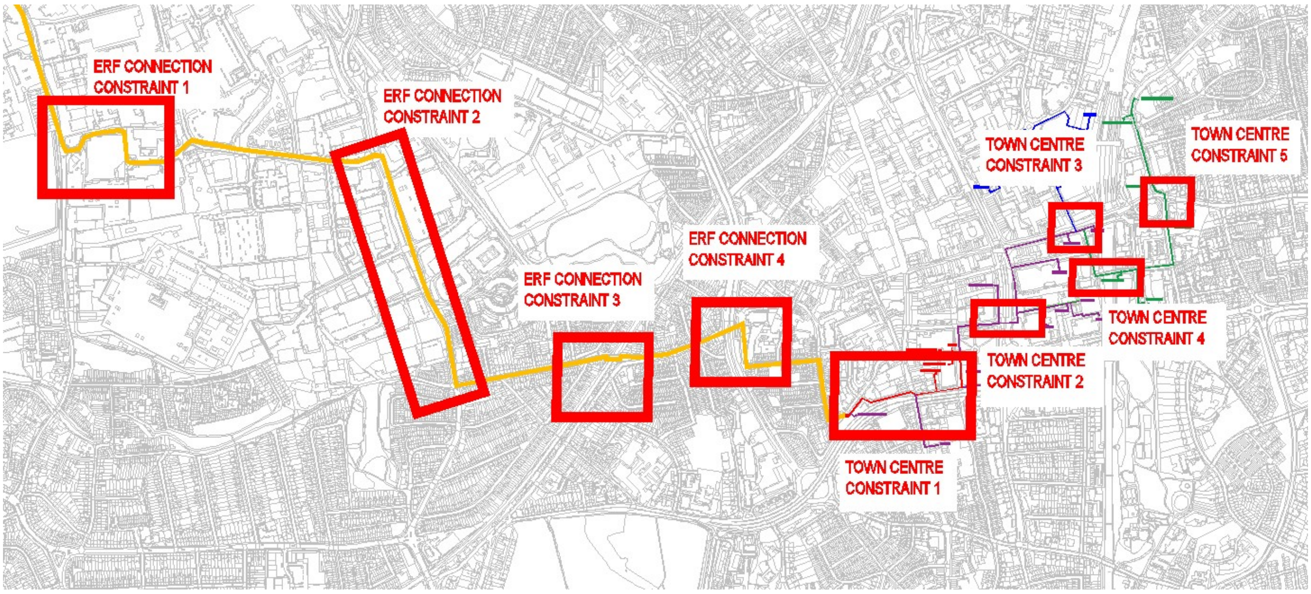
The location of the district heating interface plant required to serve each of the notional connections has been based either on site surveys (existing buildings) or the energy statement documents that were available for the majority of the other potential loads addressed as part of this study.

3.4 MAJOR CONSTRAINTS

The below represents a brief outline of the main constraints and pinch points WSP have identified for the Croydon DH network that are likely to add to costs beyond the typical for and Urban network.

A visual overview of the network and constraints is shown in drawing 70057109-M-010.

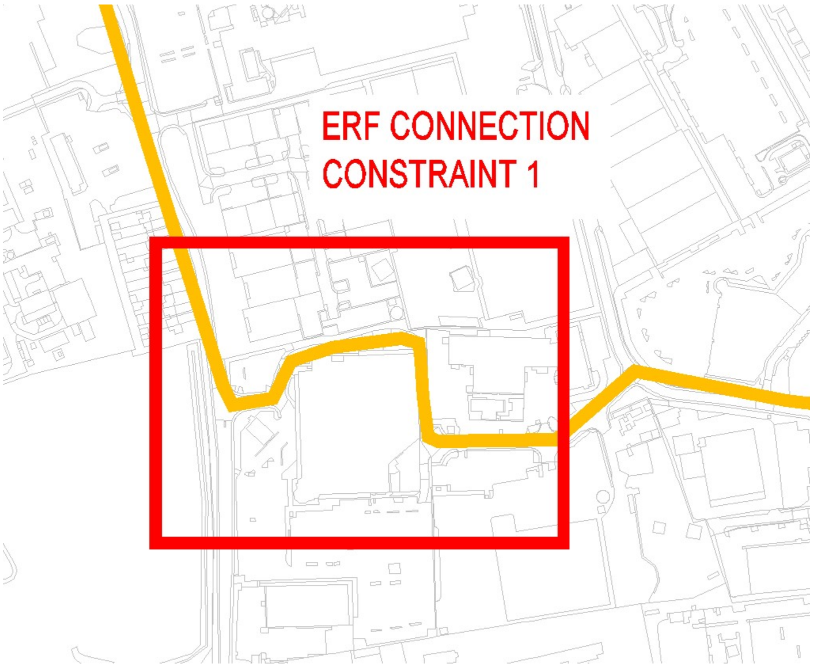
Figure 8 Croydon Constraint Overview



Utility maps referred to in the section below are from Groundwise Report 19170JS produced on 8th December 2016.

ERF CONNECTION CONSTRAINT 1

Figure 9 ERF Constraint 1 Map



Summary description

This constraint involves the section between Beddington Lane and Beddington Farm Road, the prime concern is ownership of the byway as there is a chance ASDA own a section of the road, additionally the road is relatively narrow for the size of pipe required and other utilities are also present.

Figure 3-10 – Marlowe Way at NW Corner of ASDA

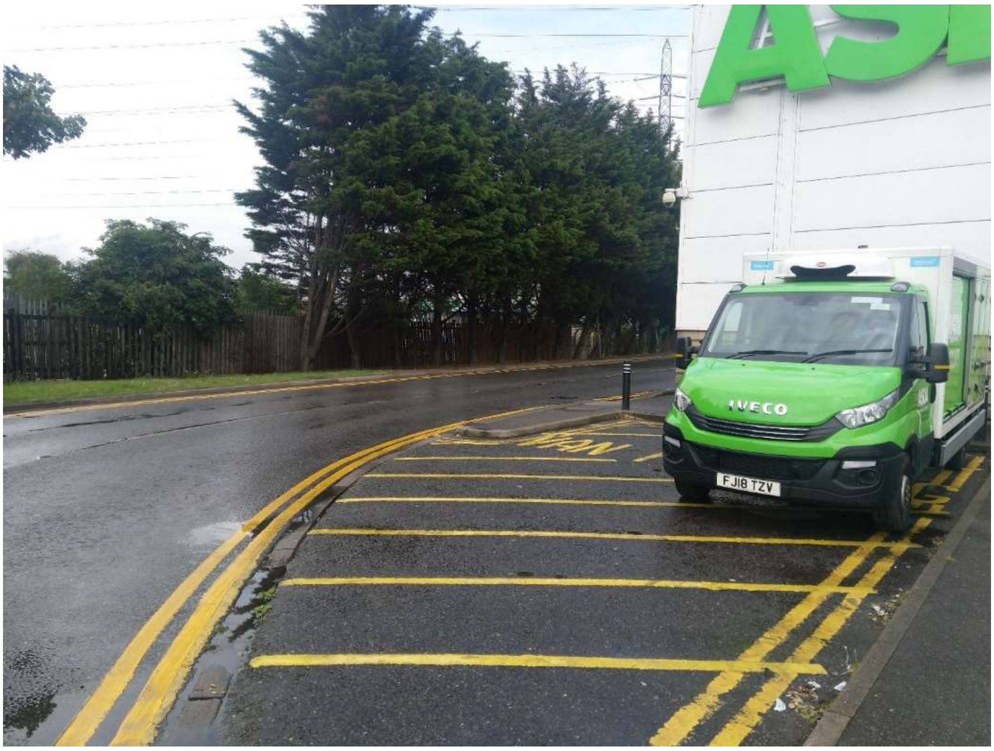
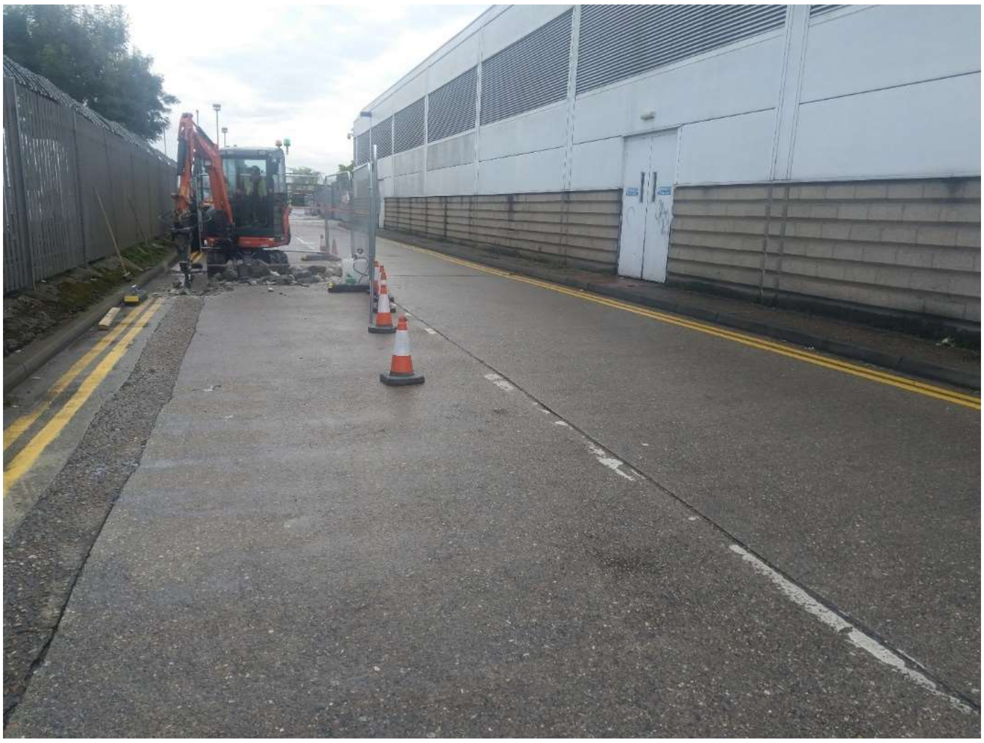
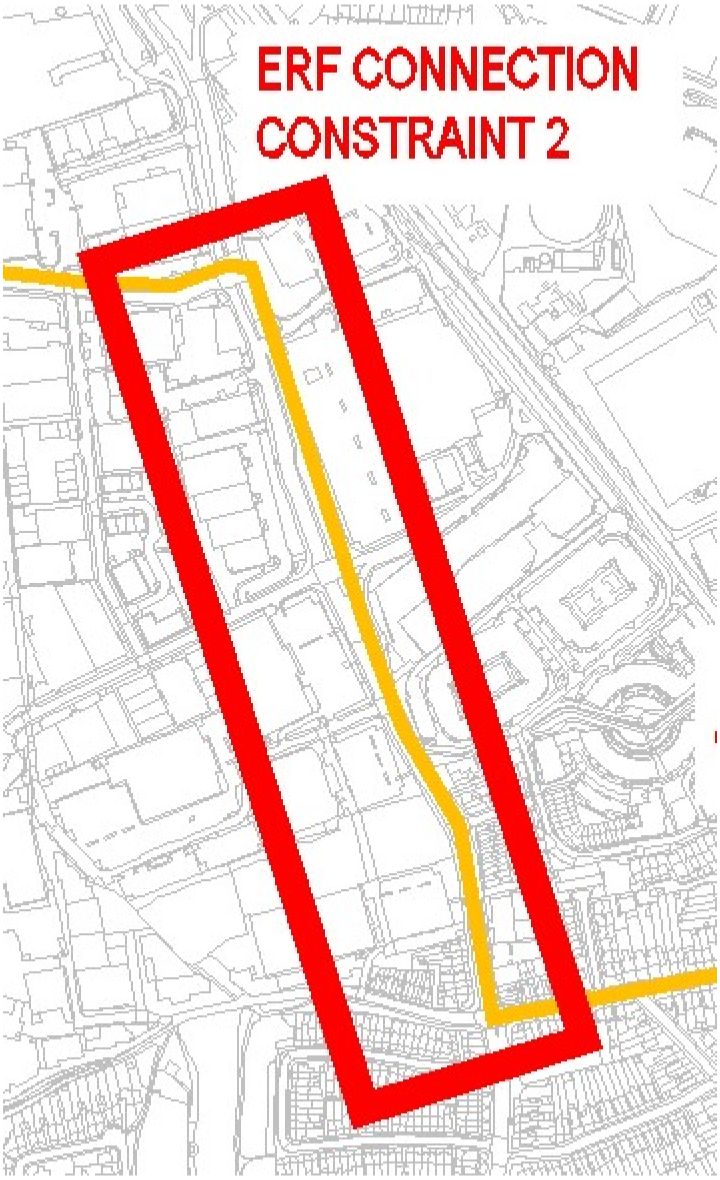


Figure 3-11 – Marlowe Way looking East behind ASDA



ERF CONNECTION CONSTRAINT 2

Figure 12 ERF Constraint 2 Map



Summary description

This section involves the main spine run down the A23, a major A-road in the area. Utilities are extremely dense in this section of road and impact to traffic during installation may be high. The road is relatively wide so only a partial closure may be possible for installation.

The most noteworthy Utilities present in the area are:

- A High Pressure Gas mains that runs from Commerce Way past Beddington Farm Rd where the DH pipe turns onto.
- A 132kV high voltage line that runs the entire length of the pipe route.

Figure 3-13 – Purley Way (A23) Looking North

Along with these two major utilities are lots of additional LP/LV gas & electricity plus telecoms and sewer and water pipes.

In particular two junctions are likely to require careful installation:

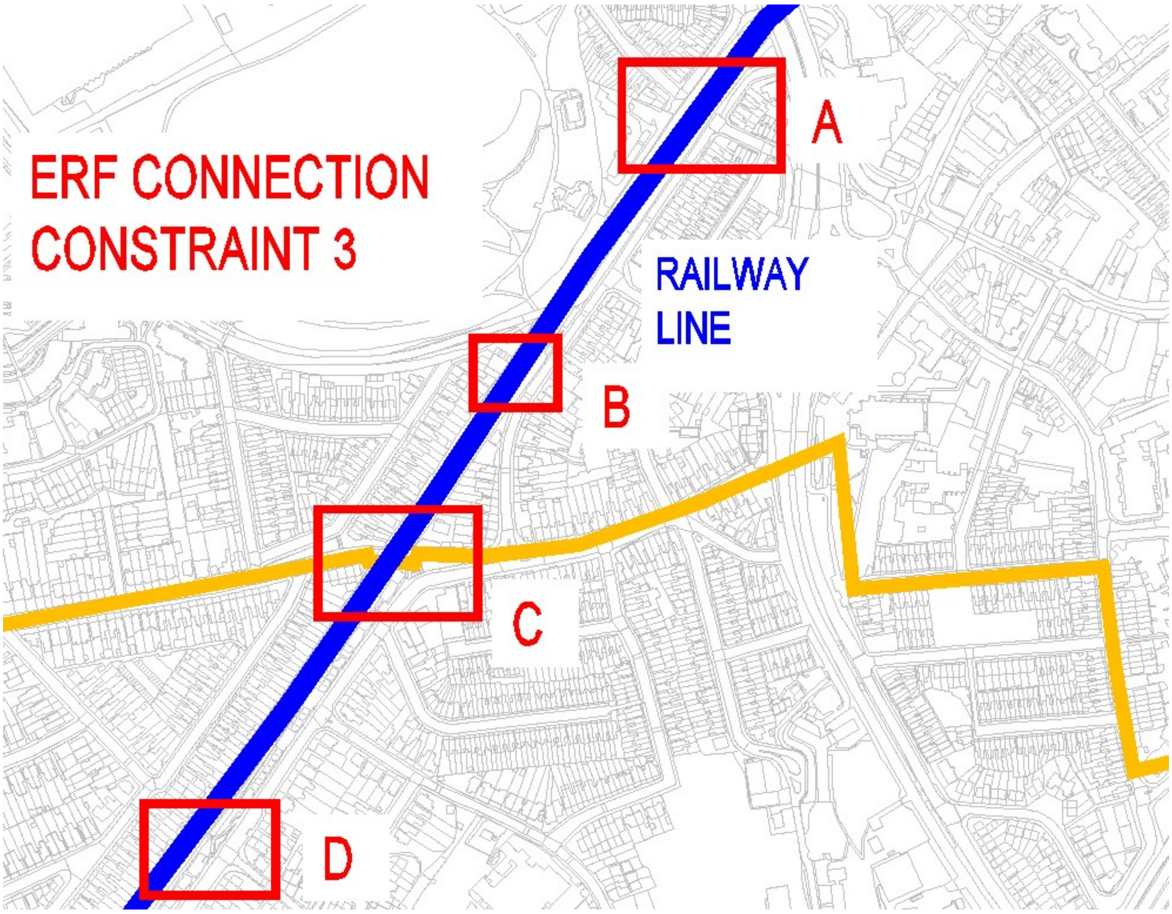
- The junction with commerce way
- The junction with Beddington Farm Rd

ERF CONNECTION CONSTRAINT 3

Summary description

This involves crossing the West Croydon to Waddon rail line, we have identified four options for crossing this rail line:

Figure 14 ERF Constraint 3 Map



A) Cut and Pull under the line between Cornwall Road and Lower Church Street

B) A new pipe bridge adjacent to the pedestrian crossing over the line at Waddon New Road/Ridges Yard

C) Utilise the existing pipe bridge on Waddon Road or replace with reinforced pipe bridge if not structurally sound.

D) Utilise the existing pedestrian crossing at Courtney Road/D uppas Road.

Site surveys have ruled out crossing D as there is insufficient space for a pipe bridge and space between properties insufficient for size of pipe required.

Option A would be expensive and likely require the closure of both roads adjacent to the rail line additionally the pipe would involve a tram crossing in the Industrial estate further increasing capital costs.

Option B is possible, there is hard standing available either side of the railway line however the land on the western side of the railway is private, adding a degree of risk to this option.

For these reasons Option C remains our preferred method for crossing the rail line.

The following image illustrates the UKPN infrastructure at the point of crossing of the railway. It is interesting to note that the live cables all appear to run in the road bridge, and not on the existing pipebridge on the southern side of the roadbridge. This suggests that this structure is no longer in use. However, to date, WSP has not been able to identify why this is the case.

Figure 3-15 - UKPN infrastructure around Waddon Rd railway bridge

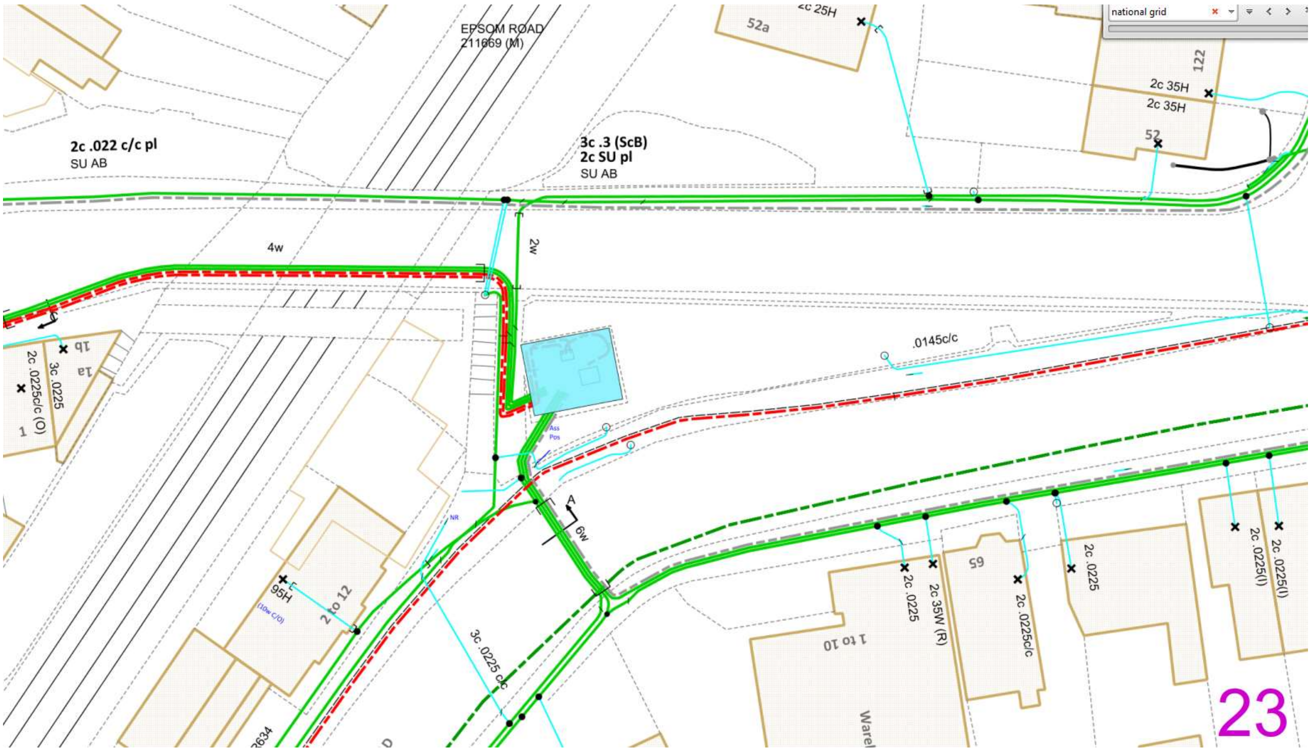


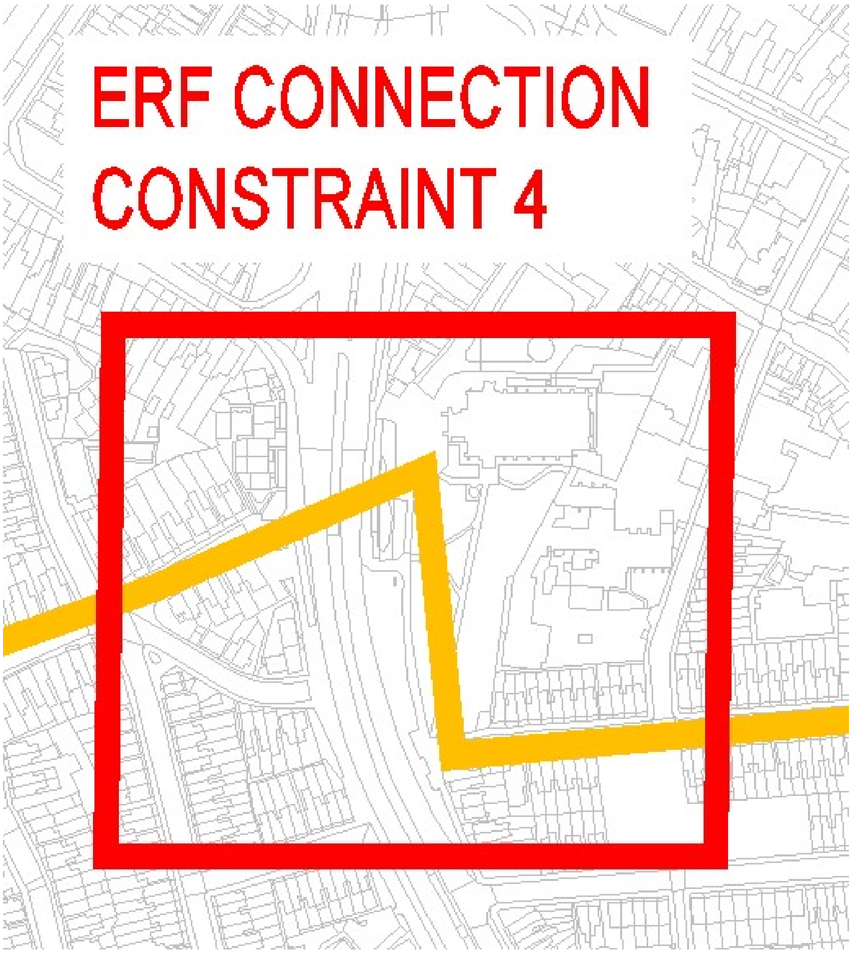
Figure 3-16 – Network Rail Ownership of Bridge

The above image shows the Network Rail ownership in the area around the Bridge, Network Rail own the actual bridge, ownership of the actual pipe bridge however is uncertain from the drawings as the asset is shown partially in green (network rail ownership) and partially white.

WSP has attempted to contact CADENT to ask about ownership and potential to utilise this structure. However, this dialogue has not resulted in concrete information surrounding ownership or the process that must be followed for pursuing potential works on the utilities bridge, and hence this option remains a critical risk at this stage. This railway crossing is the principal reason for pursuing an alternative route for the DH pipework.

ERF CONNECTION CONSTRAINT 4

Figure 17 ERF Constraint 4 Map



Summary description

The main constrain in this area is crossing the A213, a major A-road in the area.

Some key issues are:

- Underpass present but mapping shows no utilities through it, a site survey showed a possible conduit however pipe entry and exit would be problematic.
- Large amounts of electrical utilities run along the pavement.
- Access to St Johns Rd may prove a constraint due to pedestrian access to & around the underpass (pictured below).

Figure 3-18 – Roman Way Underpass Entrance

Other options may include crossing further south and running up Hanover Street to avoid the pedestrian underpass.

A summary of the main utilities present at this pinch point is presented below:

Figure 19 ERF Constrain 4 Utility maps Gas (Left) Electricity (Right)

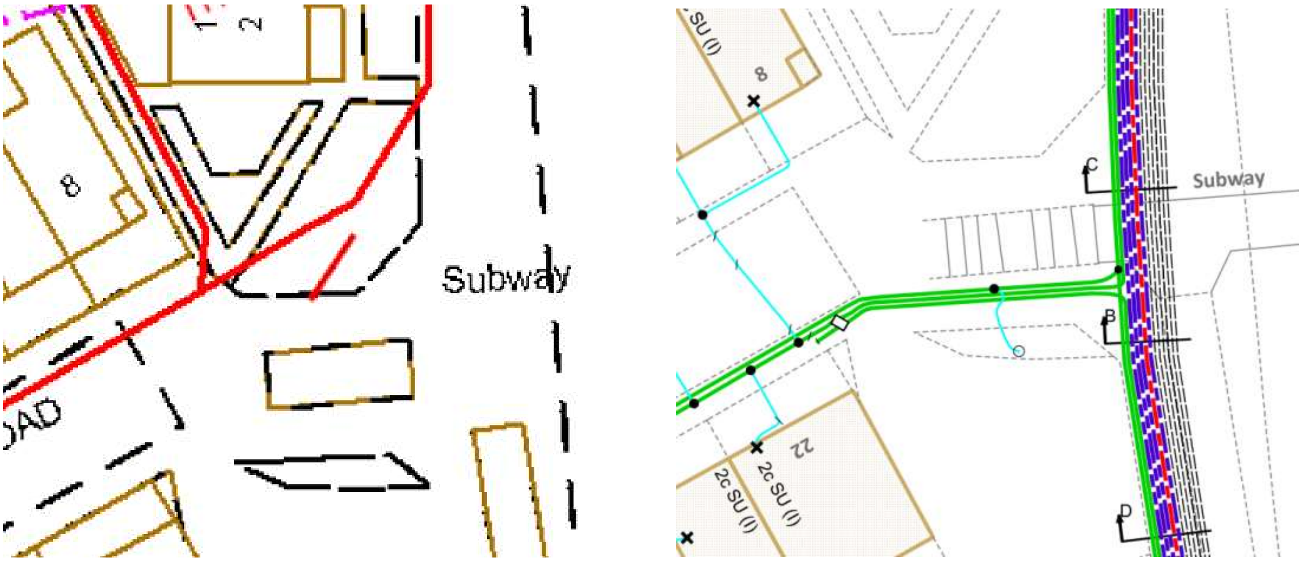
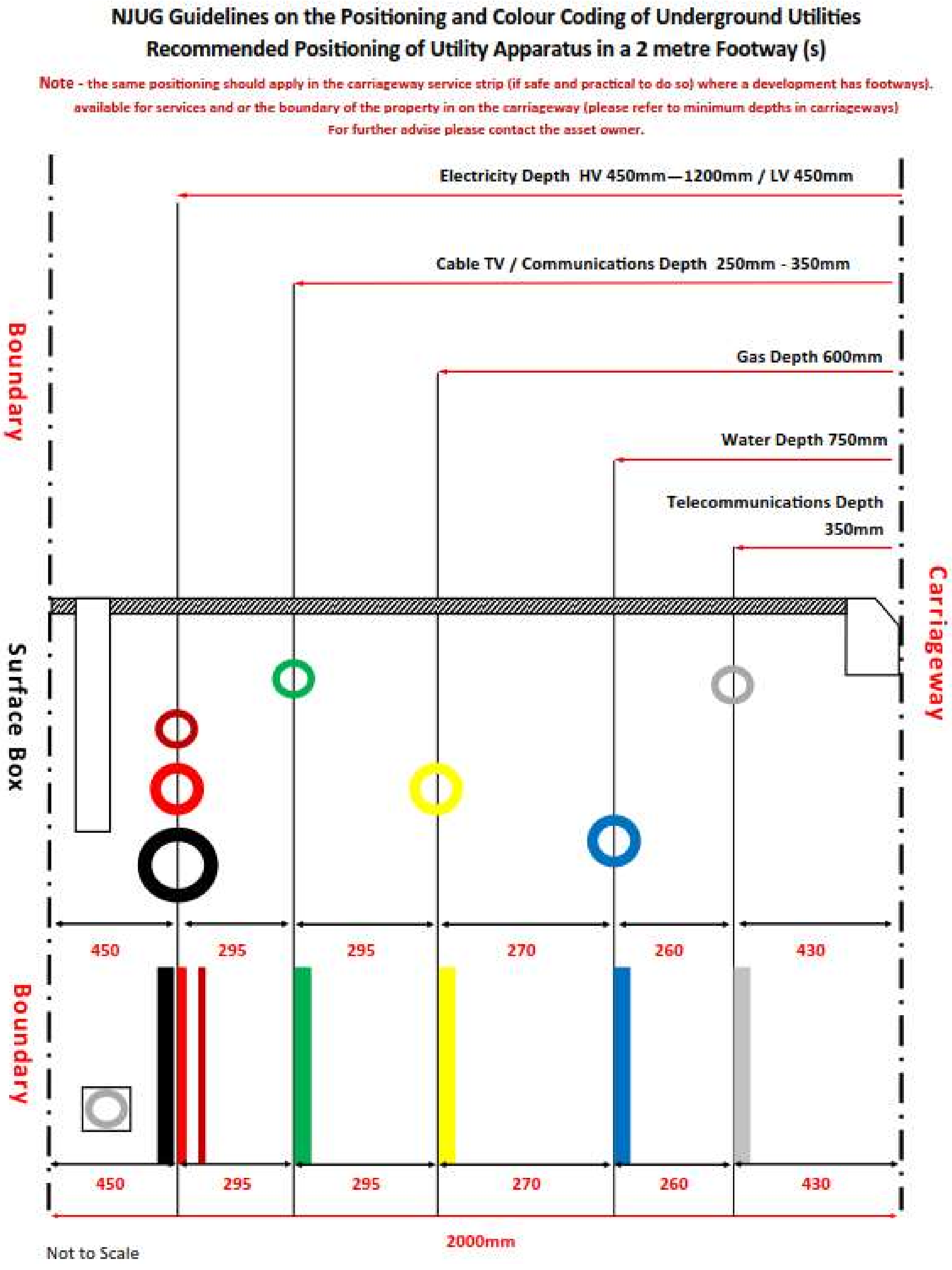


Figure 20 ERF Constrain 4 Utility maps Sewer (Left) Water (Right)

Our initial design involves using the land north of the underpass entrance where most of the existing services are already run (electricity is run to the south of the entrance likely due to its relatively shallow depth required).

Initial modelling indicates a 200mm S3 Insulated pipe would have to be buried at a minimum depth of 1m to the base of the trench and a maximum of 3.1m, given the relative flexibility in buried depth we believe it will be possible to go under all the existing services baring the sewer and water over which the pipe would run. The manhole schedule was reviewed and the surface foul that runs in this location is buried to a depth of 2.33m to the crown of the pipe, there is no depth given to other services however they are likely to follow the National Joint Utilities Group (NJUG) guidance for buried services (see image below).

Figure 21 ERF NJUG Depth Guidelines



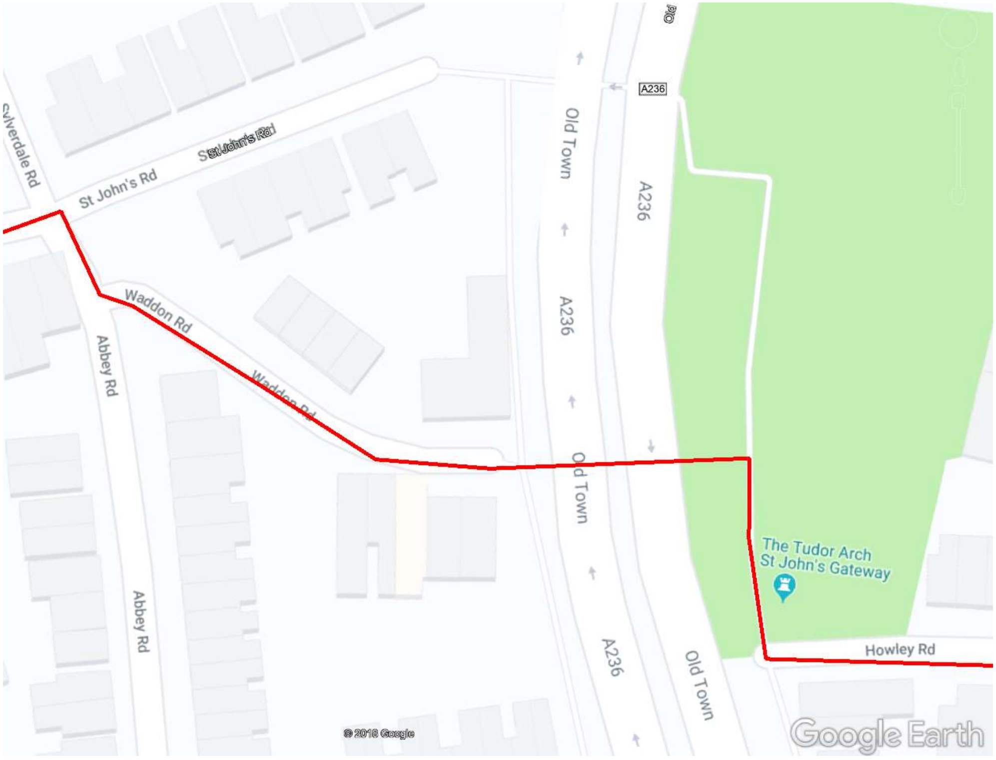
If the other services follow this guidance it will be possible to install the DH pipe between the foul water and the 4” water distribution pipe, it is recommended that a trial pit is dug here to confirm depths.

Alternatives

While undertaking the route survey we investigated alternatives to this route should it prove impractical:

Our main alternative to travelling down St Johns Road would be to cross the A236 just north of Howley Road across into Waddon Road.

Figure 22 Alternative Route to St Johns Rd



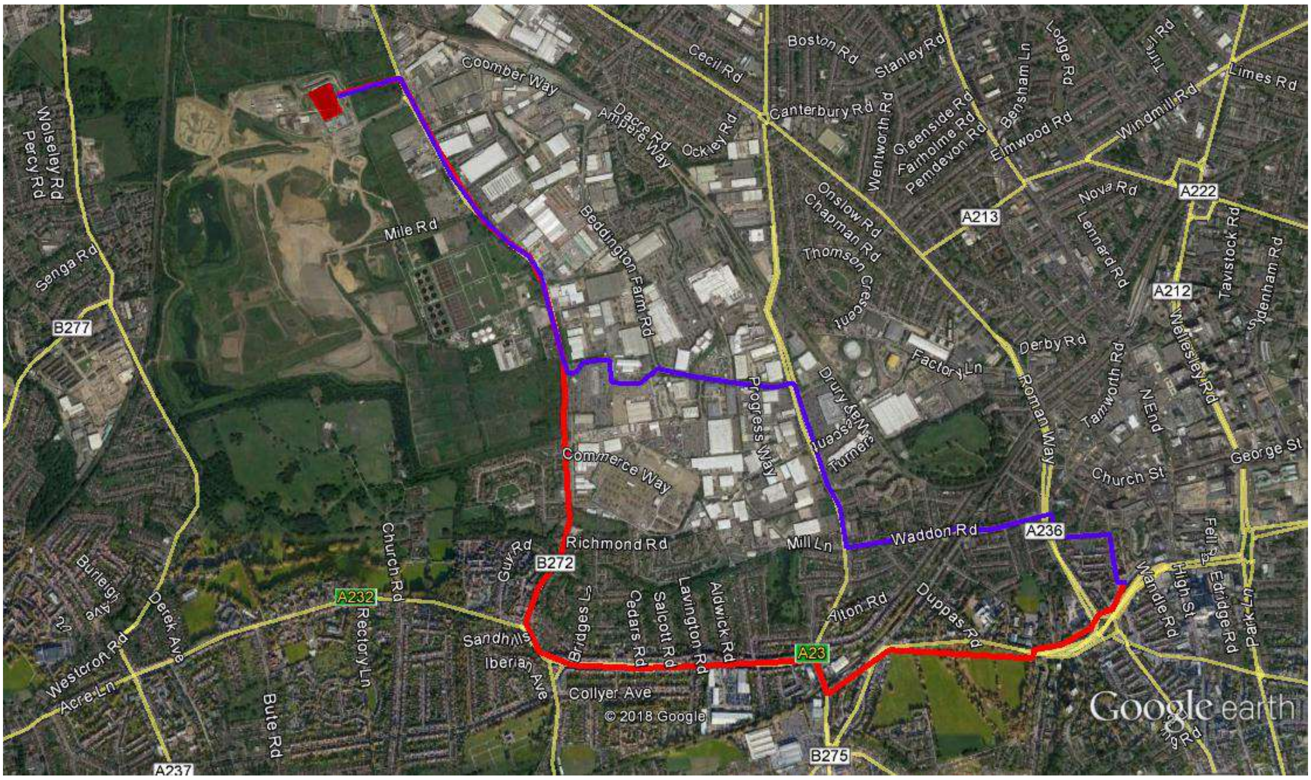
The main barrier to this is presence of a crash barrier wall on the A-Road (see images below), the foundations of the barriers are unlikely to be very deep and it should be possible to go underneath them, a sewer line does this already and it may prove a better alternative if the results of a trial dig at St Johns Rd are negative.

Figure 23 Crash Barrier at proposed alternative crossing

ERF CONNECTION DE-RISKED ALTERNATIVE

As the Waddon Rd Pipe Bridge crossing is so vital, WSP investigated an alternative route that remove the need to use the crossing, the proposed alternative is shown in red while the initial route is shown in blue:

Figure 24 Alternative ERF Connection



This route involves a substantial detour increasing the total length of the ERF connection by 12%. However, there are a few benefits that would offset the increased length:

* ERF Constraints 1,2,3 and 4 are avoided. However, the Purley Way railway crossing is likely to bring its own set of constraints although we believe utilities through the new route are likely to be more typical as opposed to the “high value“ assets that run in high density through Purley Way.
* If there was a desire by the council to pursue projects in Waddon, Beddington and other surrounding areas additional capacity up to this point could be allowed for new DH schemes in these areas (providing there is capacity at the ERF site). However, this route does not go through some of the current areas of Purley Way, which may limit the potential for future connections.

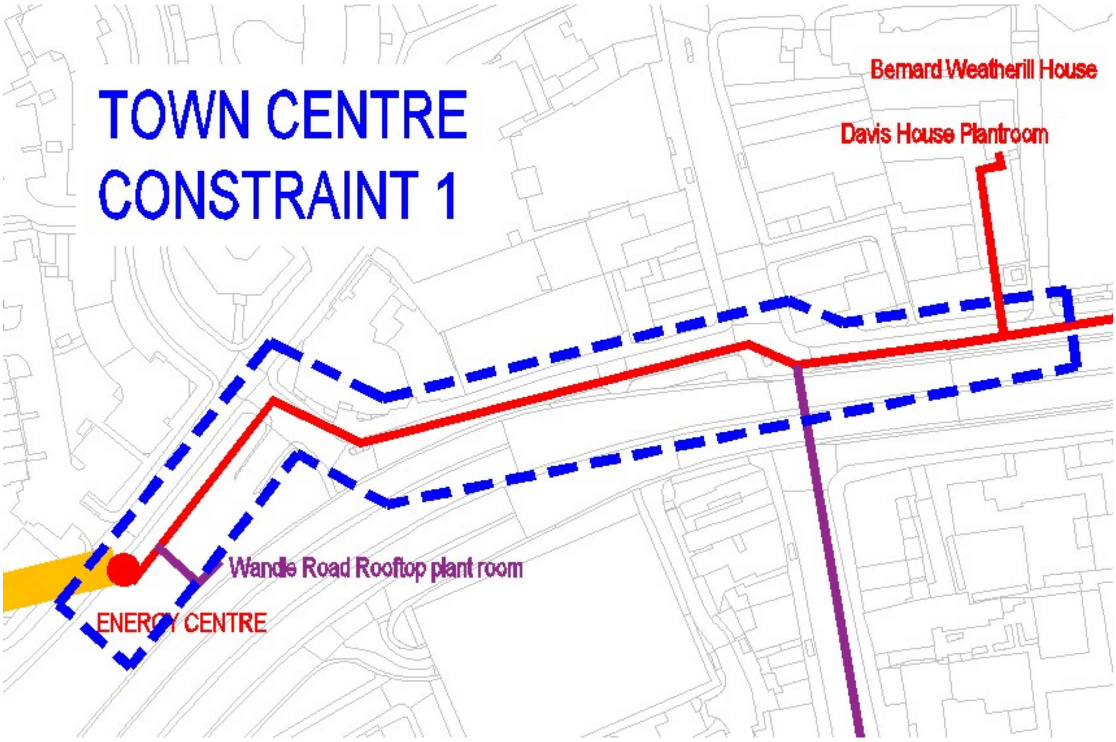
The rail crossing would now be at Waddon Station on Purley way, WSP understands that this bridge is to be renovated in the near future including widening it. If as part of the widening works the required DH pipework could be integrated in the designs, then this would be a relatively low risk alternative to using the pipe bridge over the rail line at Waddon Road. **A critical action for this route is therefore to establish the potential to influence designs of this Purley Way bridge.**

Figure 25 Proposed New Bridge at Waddon Station

We have modelled initial costs for the route via the Waddon Road crossing pipebridge at £8.3m, this does not include for allowances to reinforce or replace the existing pipe bridge and so the final cost will likely be higher. The new route is estimated to cost approximately £9.0m; this is an increase in costs of £730k or just under 9%.

TOWN CENTRE CONSTRAINT 1

Figure 26 Town Centre Constraint 1 Map



<u>Relevant Utility Maps (page numbers refer to Groundwise Report 19170JS)</u>

HV-Pages 15&18

Gas-Page 107

Water-Page 431

Sewer-Page 421

Comms-Pages 134,144,175

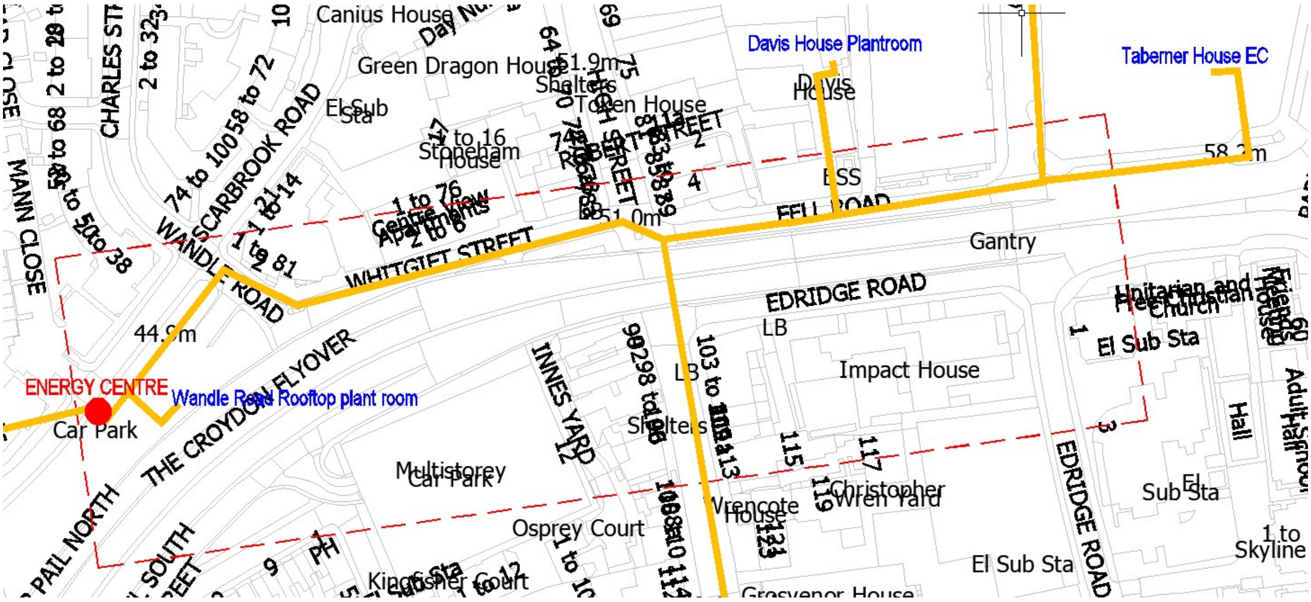
<u>Summary description</u>

This area extends from the energy centre to Fell Road.

Utilities present in the area include (but are not limited) to:

- HV is present along Scarbrook Road, however, the utility maps are unclear of their capacity
- Large diameter watermains that run as large as 21"
- Surface water sewer mains that are 1350mm in diameter at their largest
- Foul & Combined water sewers that are as large as 450mm
- SKY Fibre Cable as well as other communications infrastructure

Figure 3-27 - Proposed DH route nr Wandle Rd Energy Centre



The proposed DH route has been designed so as to avoid Scarbrook Road as far as practicable as this is where the bulk of the utilities run. The DH pipework is proposed to be routed through Whitgift Street where the bulk of the larger utilities are sewers that according to the manhole schedule should be at a sufficient depth as not to present a significant barrier to DH pipework installation.

The intersection of Scarbrook and Wandle Roads is likely to present a constraint due to the sheer number of utilities bisecting one another, it is recommended that one or more trial pits are dug here to identify how the area should best be navigated.

Figure 3-28 - Utility mapping nr Wandle Rd Energy Centre

The intersection of Scarbrook and Wandle is likely to present a constraint due to the sheer number of utilities bisecting one another, it is recommended a trial pit is dug here.

Figure 29 Scarbrook road at Wandle Intersection Looking SOUTH WEST

Figure 30 Scarbrook/Wandle Intersection looking SOUTH WEST

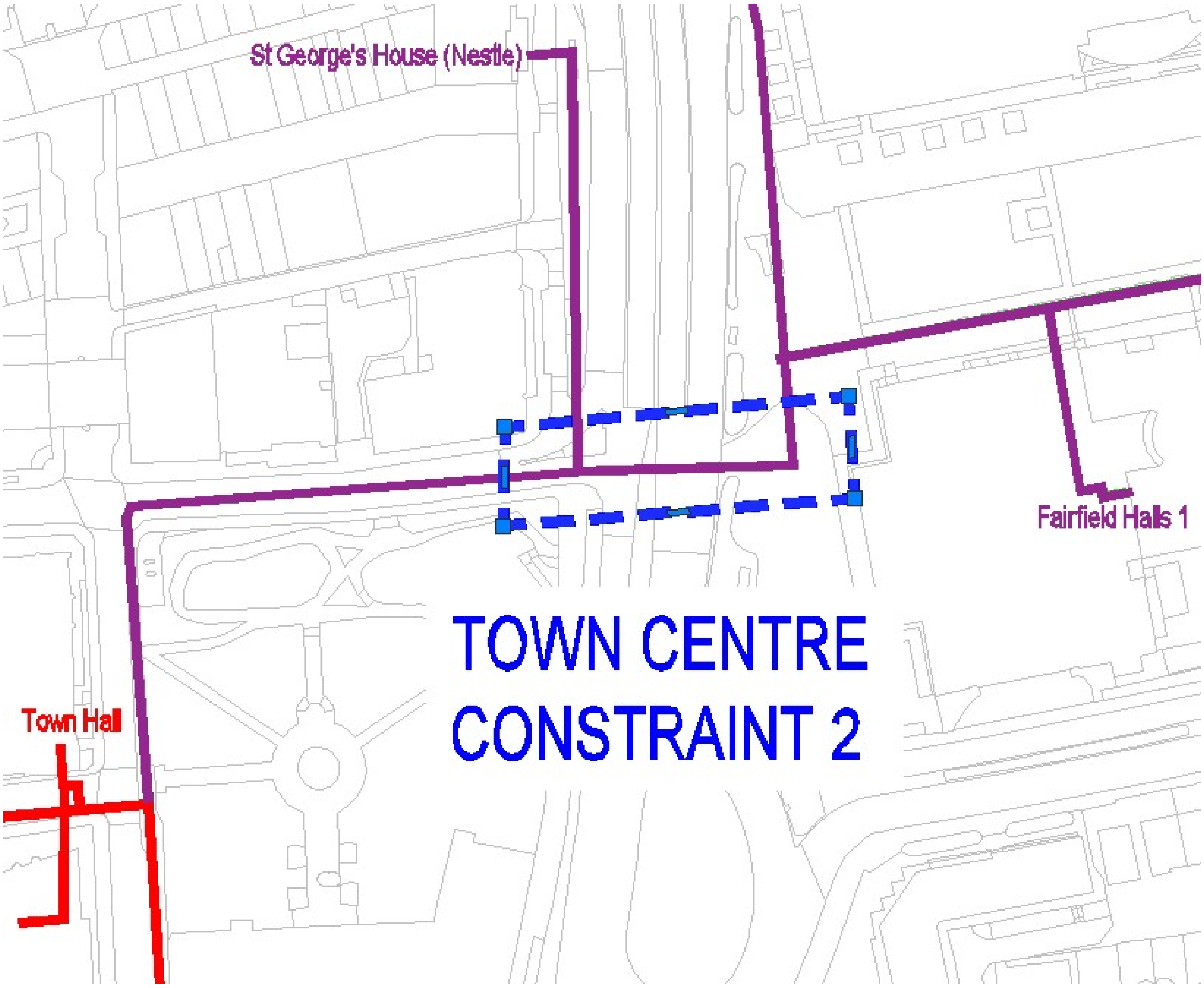
Figure 31 Whitgift St at High St looking WEST

Figure 32 Whitgift St at High St looking EAST

Figure 33 Fell Rd at High St looking EAST

TOWN CENTRE CONSTRAINT 2

Figure 34 Town Centre Constraint 2 Map



Relevant Utility Maps (page numbers refer to Groundwise Report 19170JS)

HV-Pages 16 & 19

Gas-Page 107

Water-Pages 428 & 430

Sewer-Page 411 & 418

Comms-Pages 138, 140, 153, 161, 171 ,172, 175, 188

Summary description

This area involves the crossing of the A212 or Park Lane as it is known at this section.

Utilities present in the area include but are not limited to:

- HV running adjacent to the A212 as well as bisecting it
- 12” Water main running along the A212 on the west side as well as +100mm distribution pipes
- Surface water sewer mains
- Foul & Combined water sewers that at numerous points running as large as 450mm
- Fibre Cable running adjacent to the College as well as other communications infrastructure

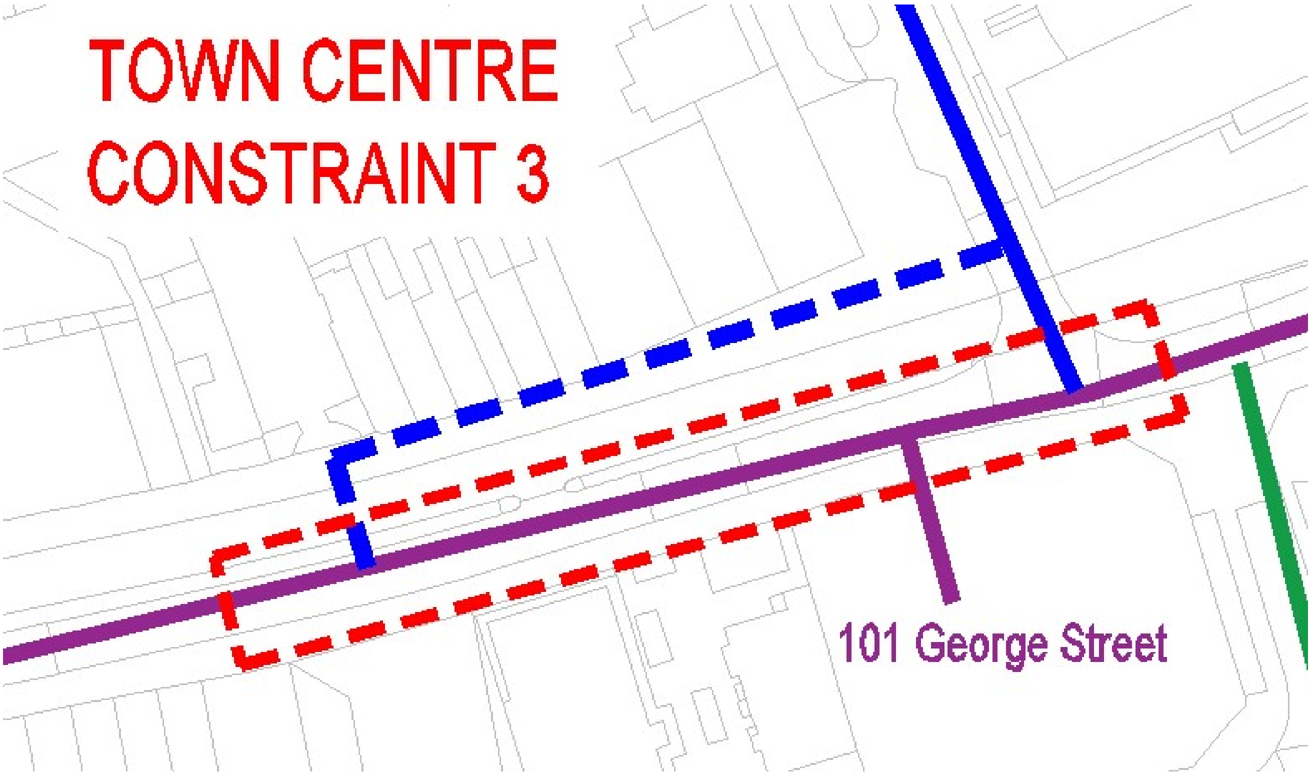
The A212 has a pedestrian underpass that from the utility mapping appears to house some HV lines. However, WSP’s site surveys indicated that the logistics of getting the pipe into and out of the underpass duct would be difficult and WSP estimated that the duct is unlikely to have adequate space for district heating pipes above 50mm. We have instead provisionally designed the crossing to occur between Katherine Street and Fairfield Halls.

Figure 35 Looking WEST towards Katherine Street from Fairfield Halls

Figure 36 Looking NORTH up Park Lane, Entrance to Katherine St to the right

TOWN CENTRE CONSTRAINT 3

Figure 37 Town Centre Constraint 3 Map



Relevant Utility Maps

HV-Page 16

Gas-Page 107

Water-Pages 428

Sewer-Page 411

Comms-Pages 138,153,172,175,188

Summary description

This area involves crossing George Street under the tram line to allow access to Dingwall Road:

- Although there are utilities present in this area, they are not in such a concentration that they are expected to be out of the norm for a London borough, the tram crossing will however require special measures. Discussion with TFL the tram operators has yielded the following information:
  1. Cut and cover is not permissible on Tram networks.
  2. The tramline sits on a 450mm thick concrete slab.

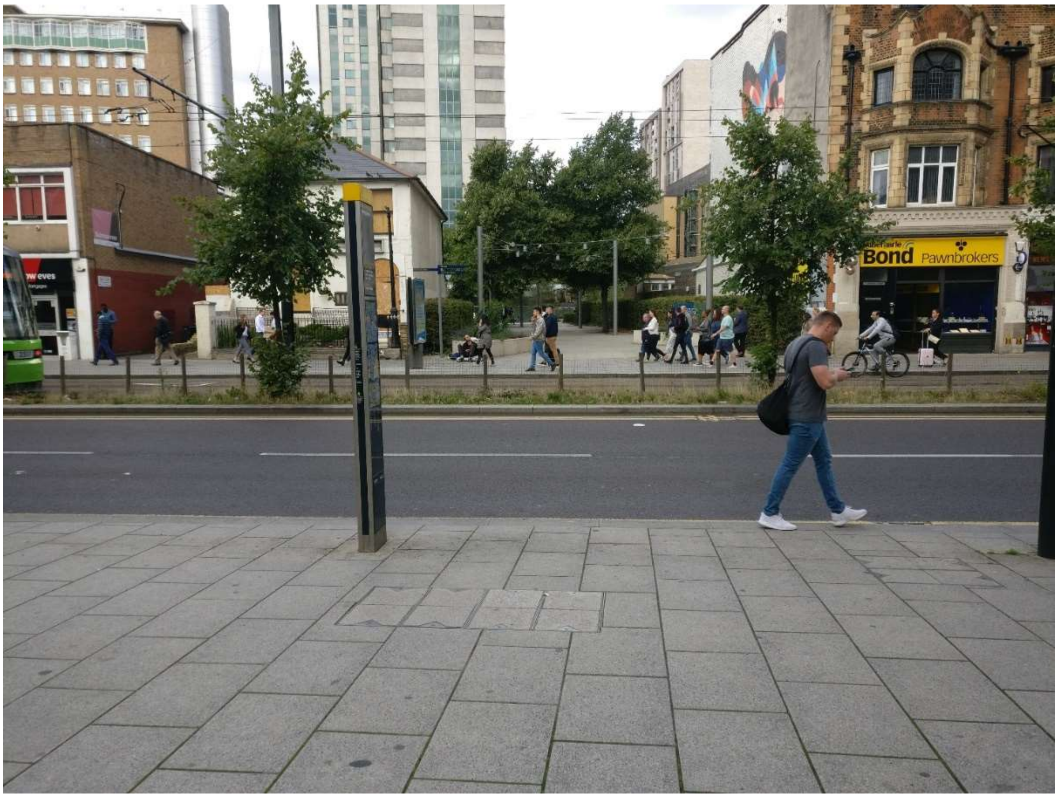
We are continuing to liaise with TFL to understand their specific requirements for going under the tramline. However, we are aware that National Rail requires at least 4m of depth for going under level crossings meaning thrust boring or similar would be required. WSP’s working assumption at this stage is that a thrust boring / directional drilling solution is required at this point.

The council own a large part of land on the south of George Street adjacent to the college if this was available this would be our preferred spot for directional drilling (dotted blue line in map above) however ownership of the strip of land on the opposite side of the street is unknown.

Figure 8 Junction of George St and Dingwall Rd

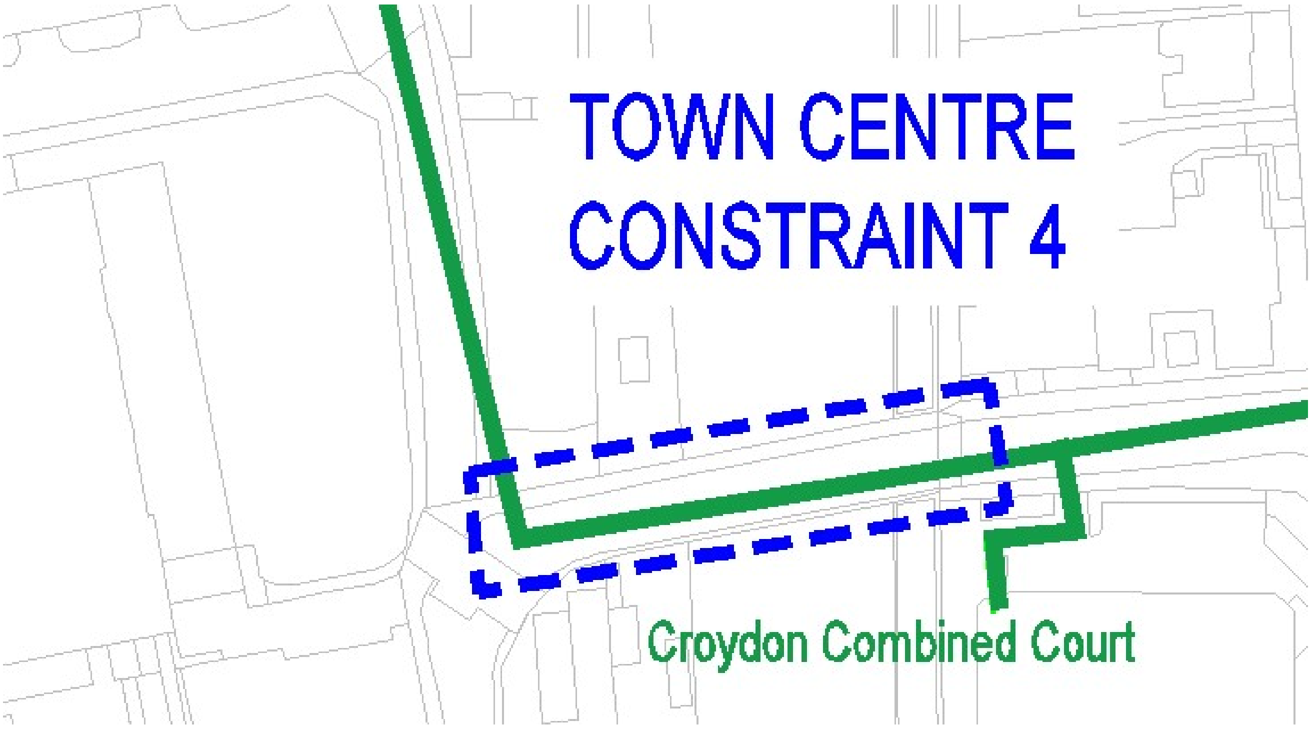
Figure 9 Looking north up Dingwall Rd from George St

Figure 3-38 - Preferred location for directional drilling looking north



TOWN CENTRE CONSTRAINT 4

Figure 39 Town Centre Constraint 4 Map



Relevant Utility Maps

HV-Page 16

Gas-Page 107

Water-Pages 428

Sewer-Page 411

Comms-Pages 138,153,172,175,188

Summary description

This area involves crossing the railway line using an existing road that previously served a now demolished multi-storey car park. Visual inspections of the structure indicate it to be structurally sound and we have liaised with the Council to learn what its plans for the bridge are. WSP's current understanding is that the options for the bridge are closely linked to the Fairfield Housing Planning Application, which is expected to be submitted in late Sept / early October 2019. The bridge is understood to be owned by Network Rail (see ownership plan in appendix), and the intention is that the structure is re-opened to form a pedestrian bridge to increase accessibility to the Fairfield Halls development at podium level. This is outlined in the Fairfield Masterplan[1] document (p89).

Figure 10 Looking west across the Bridge from Hazledean Rd

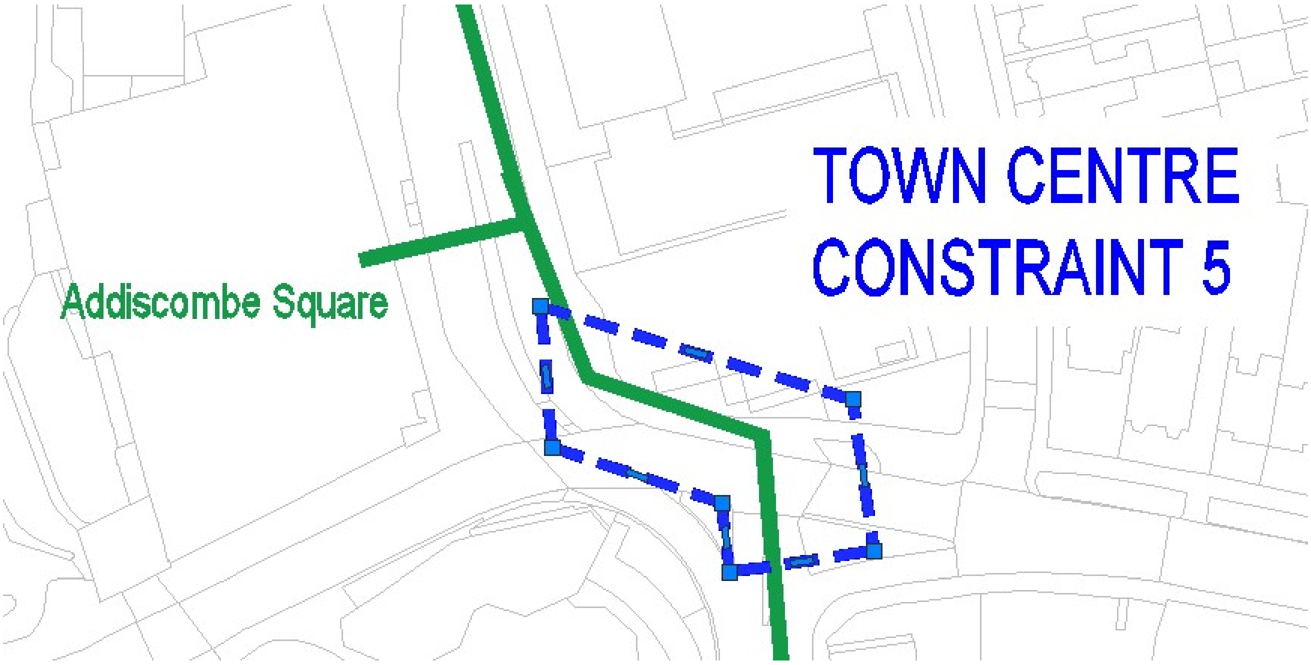
[1] https://www.croydon.gov.uk/sites/default/files/articles/downloads/fairfield-mplan.pdf, accessed 16th September 2019.

Figure 11 View of Bridge from West side of track adjacent to Croydon College

Figure 12 View of Bridge looking South East at College Rd

TOWN CENTRE CONSTRAINT 5

Figure 40 Town Centre Constraint 5 Map



Relevant Utility Maps

HV-Pages 14,16, 66

Gas-Page 107

Water-Pages 428

Sewer-Page 411

Comms- Pages 138,153,170,176,188

Summary description

This area involves crossing the tram line to gain access to Cherry Orchard Road, additionally the area has some HV present.

Figure 13 Looking north-west at Tram crossing where Addiscombe Grove becomes Cherry Orchard Rd

4 PIPE SIZING

4.1.1. The design of DH pipework is based upon a number of key assumptions in terms of technical inputs / parameters. The aim is to optimise selections based on a whole life cost view of the capital of installation, the pumping costs, and the heat losses anticipated over the project lifecycle.

4.1.2. General parameters

- Pipework assumed to be made of pre-insulted medium grade steel carrier pipes of roughness factor 0.0457mm
- Series-3 Insulation
- Network flow temp of 95°C available at ERF plant (see discussion below on temperatures).
- Average ground temperature is 8°C
- Domestic Hot Water diversity is based on DS439
- No diversity on domestic space heating has been applied
- Commercial diversity is assumed to peak at 80% based upon +5 commercial connections, (the CIBSE code of practise suggests total diversity can be as high as 70%)

4.1.3. Commercial and domestic connection sizing as per Report WP1B.

4.2 PIPEWORK SELECTION

TWIN PIPES

There modelling has been undertaken assuming a pair system, that is two separate pipes for flow and return as opposed to a twin system where both flow and return pipes are housed within one pre-insulated body.

Figure 4-1 - Single pipe (left hand image) vs twin system (right hand image)

Although generally twin systems are lower in capital cost and heat losses there a few reasons we have modelled a pair system:

- Twin systems require welders with enhanced skill as the two steel pipes are closer and are best welded when pipes are out/above the trench. Typically networks till now in the UK have been pair systems and as a result, welders with in depth knowledge of twin systems are not as common as on the continent.

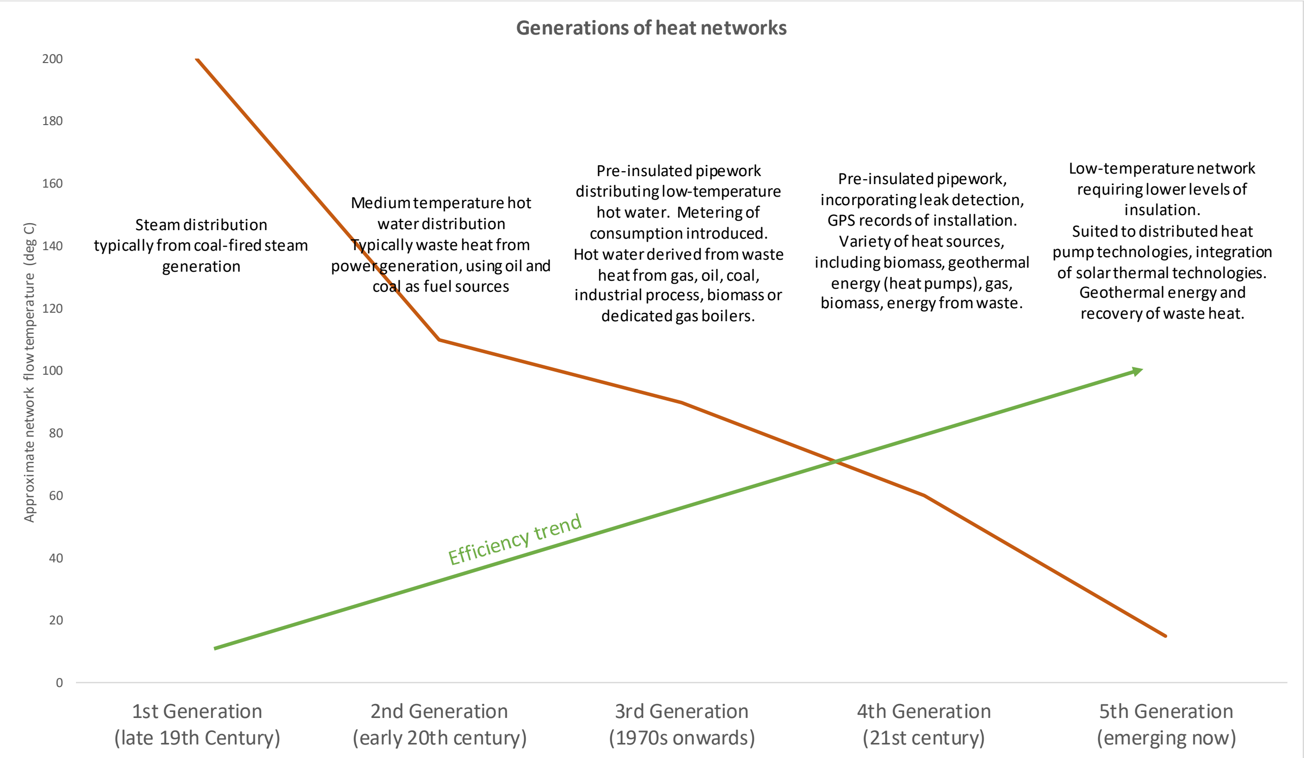
- They require greater space for changes of direction and take up more height in a trench section owing to their greater diameter. Given the number of utilities present in Croydon this could prove problematic.
- The pipes are heavier and so require greater co-ordination when lifting into trench and close supervision to ensure pipes are vertically aligned. Due to the number of vital road links in Croydon the network will traverse this would increase installation time and therefore disruption.

We may have to use twin pipe under the key rail and tram crossings as in these key areas, minimising overall drilling requirements will be important, and overall capital costs for installation will likely be lower using a twin system, owing to having to install only one pipe rather than two.

4TH GENERATION NETWORKS

The various generations of heat networks are understood to be as follows:

Figure 4-2 - Generations of heat networks



4th generation networks are therefore those that operate at comparatively low temperature (i.e. 50 to 60 deg C – although definitions vary on this figure), and which are compatible with a number of emerging low carbon heat source technologies.

However, for the networks under consideration in Croydon as part of this project, the two key heat sources are:

- Gas-fired CHP engines based at the Wandle Road Energy Centre
- The Beddington ERF

Both of these sources are capable of producing heat at >90 deg C, and there is no significant efficiency increase that could be realised with lower flow temperatures. In this context, the only rationale for a much lower network flow temperature would be in order to reduce heat losses. This would, of course, be of benefit to the project, but must be weighed up against the potential problems of compatibility with existing building systems (and indeed new development systems that might not have been designed to be compatible with lower temperatures) and the increased capital cost of the larger diameter pipework required to distribute the heat.

In this instance, the current proposal is to develop the project in two phases.

- An initial phase to 'kick-start' the scheme based around the council-owned properties (BWH, Town Hall, Central Library, Davis House).
- Expansion to encompass the new development sites

In order to operate the initial kick-start phase at a '4th generation' network temperature, the internal systems of all the council properties would have to be modified in order to ensure that the end-user requirements can be met with the lower flow temperatures. This is anticipated to be both a costly and difficult intervention, as it would likely involve significant changes to controls, internal heat distribution systems, heat emitters and would give rise to disruption as these systems were upgraded. These changes would add expense to the project and given that the only benefit would be a reduced level of heat loss could not be justified on economic grounds in WSP's view.

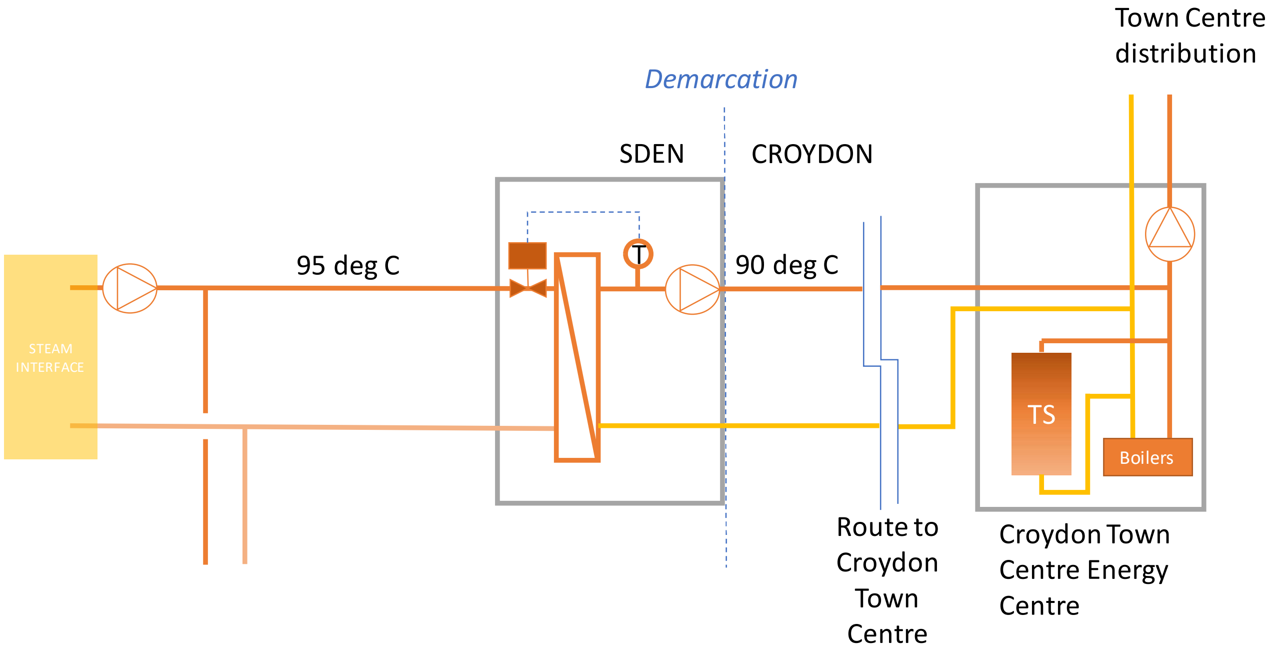
On the basis of this rationale, a network flow temperature of 95 deg C (see discussion below) in the Town Centre network has been adopted for modelling purposes.

4.3 NETWORK TEMPERATURES

Through dialogue with Sutton DEN (SDEN), WSP has established that the maximum temperature that should be expected from the ERF plant is 95 deg C. This is assumed to be limited by the current contract that SDEN has with Viridor for the exclusive purchase of heat. It is beyond the scope of this project to interrogate the basis of this agreement, but it is WSP's view that there is unlikely to be any technical reason why heat could not be delivered at a higher temperature. This could therefore be the subject of discussions between Croydon and Sutton DEN as the project progresses, in order to see if there might be potential to increase this temperature at peak winter periods, in order to allow for additional transmission of heat to the town centre, and potentially to increase the efficiency of heat transfer (in terms of pumping energy).

The arrangement in simplified form that is proposed for this project's assessment is illustrated below:

Figure 4-3 - Assumed demarcation (at ERF site boundary)



This arrangement has the following attributes:

- SDEN retains control of a complete hydraulic system
- SDEN operates the supply to the Croydon ERF link as a customer substation – i.e. with responsibility for maintaining temperature on the secondary side of the PHX for onward supply to Croydon
- A clear demarcation of maintenance responsibility / billing
- A need to identify space on the ERF site for the substation / pumping plant
- A need to organise control of the pump for the link to match the control strategy for the town centre network
- Allows Croydon to retain control of potential additional customers along the route to the town centre
- Hydraulic separation at the ERF site means that the flow temperature to the town centre is lower than would be seen if this separation were to be at the town centre.
- No hydraulic separation is proposed in the town centre energy centre in order to preserve as wide a temperature differential as possible on the ERF link.

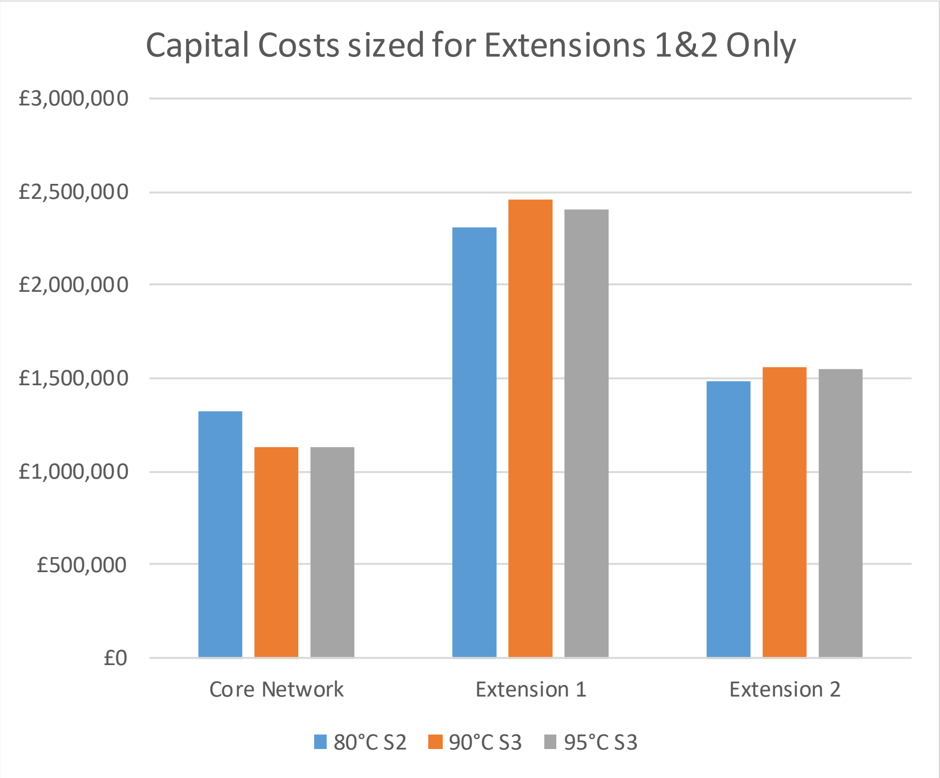
This approach suggests that in order to maintain a 5 deg C approach temperature at the interface, that a 90 deg C flow temperature from the ERF towards the town centre would be seen. WSP's hydraulic model of this system shows that at peak periods, the heat losses en route would result in an approximate 1 deg C reduction in flow temperature of the ERF link at the Wandle Road EC. However, during peak winter periods, boilers will be operating in the Wandle Road EC, and in order to minimise the capital cost of installation of the Town Centre network, during these peak periods, it is proposed that the Town Centre network operates at 95 deg C (ie. with the boilers operating to raise the ERF supply temperature).

EVALUATION OF DIFFERENT NETWORK TEMPERATURES AND FUTURE PROOFING

We have analysed the impact on costs and heat losses for varying levels of future proofing of extents of the network. This is designed to help inform discussions of the degree of future-proofing that the network should be design for, given the implications in terms of existing cost.

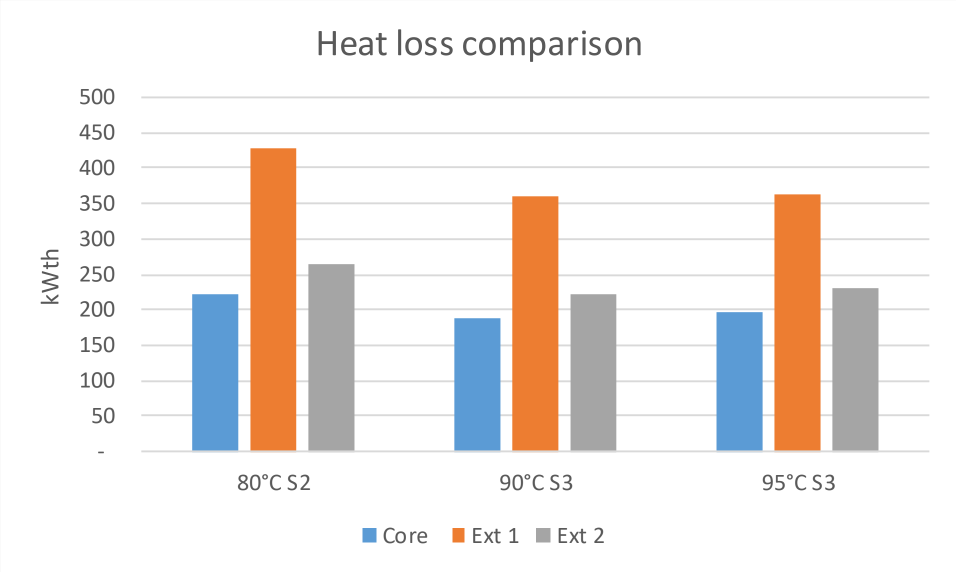
The results of this analysis are shown below:

Figure 4-4 - Capital costs based on different temperature and insulation levels



This graph illustrates that for the core network (where there are a number of customers with relatively high return temperatures), that increasing the supply temperatures from 80 to 90 deg C allows the diameters of pipework to be reduced and cost savings to be realised. However, as the temperature is further increase from 90 to 95 deg C, the additional cost of the pipework insulation largely offsets the diameter reductions, resulting in a very small (approx. 1% net saving).

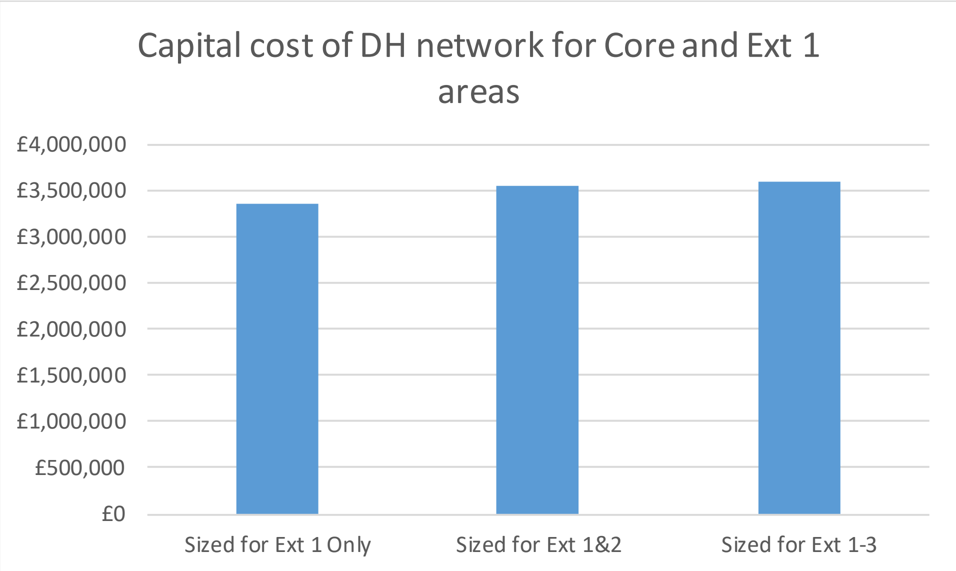
Figure 4-5 - Heat losses based on area and insulation levels



This graph shows that as insulation levels are increased between series 2 and series 3 pipework that heat losses are reduced. The increased insulation of the Series 3 pipework offsets the increase in temperature from 80 deg C (Series 2) to 95 deg C, and under the 95 deg C Series 3 option, heat losses are lower (by approximately 12%).

In terms of future-proofing the following graph has been developed:

Figure 4-6 - Future proofing costs (for Core and Extension 1 areas)



This graph (shown for 95 deg C, Series 3) shows that in order to future proof for the network to have the capacity to serve the Ext 2 area, there is a cost burden of approximately £200k on the base cost of a network sized only to serve Core and Ext 1. In order to serve the full extent of network considered in this report, the additional cost for the Core and Ext 1 network is estimated at approximately £240k (approx 7% increase).

On the basis of the results above, and the operational philosophy that the network in the town centre will operate on a variable temperature, variable flow basis, it is suggested at this stage that the network should be sized on network flow temperature of 95 deg C.

The degree of future proofing that should be incorporated in the network will be considered in WP1D, where the potential benefits of the 'east of the railway' connections and other loads will be considered in the wider project context.

4.4 TECHNICAL RISKS / ISSUES

This section allocates a number of technical risks into three categories of risk severity:

- Critical
- Significant
- Other

NB that this does not address purely commercial risks that will be considered in the techno-economic and commercialisation phases of the project. This section only addresses the potential technical impediments to scheme installation.

Table 4-1 – DH Pipework critical technical risks

CRITICAL RISK LOCATION	DESCRIPTION	POTENTIAL MITIGATION
Waddon Road Railway Crossing	The risk at this crossing is that it is not possible to identify a feasible and viable means of installing a district heating pipework crossing at this location. This would jeopardise the whole ERF link.	Identifying alternative means of crossing the railway. At present, the preferred alternative options are either to to cross close to the pedestrian bridge to the north of Waddon Road, or to use the complete alternative 'Purley Way railway crossing' route.
Purley Way Railway Crossing	The risk at this crossing is that the Purley Way bridge widening designs cannot be amended to accommodate DH pipework or that some other technical impediment means that this crossing is not possible.	Seek advice with bridge widening project design team as soon as possible.

Table 4-2 – DH pipework significant technical risks

SIGNIFICANT RISK LOCATION	DESCRIPTION	POTENTIAL MITIGATION
Hazeldean Bridge railway crossing	There is uncertainty surrounding the future of this bridge and whether it would be possible to integrate DH infrastructure in the proposals that may emerge. The risk would be that this means that an alternative means of crossing to the eastern side of the Brighton main line would have to be found (or the scheme not extended to the eastern side of this railway line).	Alternative route identification. The primary alternative route would be the George Street crossing, but this is thought to be very heavily serviced in the pavement areas, potentially lacking in sufficient depth to accommodate DH pipework in the roadway, and is not a preferred option. However, in the absence of other options, this would be worth investigating. The Barclay Bridge is thought to be too shallow to accommodate DH pipework.
Tram crossing 1 (George Street to access Ruskin Sq)	The risk here is whether it will be possible to develop suitable designs that meet the approval of TfL to allow the crossing of the Tram route with DH pipework. The impact would be that the heat network (and potentially PW connection) could not be made to the significant loads at Ruskin Sq.	The mitigation approaches here would include identifying alternative crossing points, alternative installation methodologies and ensuring that proposals meet the TfL requirements.
Tram crossing 2 (Addiscombe Rd to Cherry Orchard Rd)	The risk at this crossing point is similar to the above, but where the impact would be not being able to connect the Cherry Orchard development sites, and Addiscombe Sq site.	As above, mitigation approaches here would include identifying alternative crossing points, alternative installation methodologies and ensuring that proposals meet the TfL requirements.

Table 4-3 – DH pipework other non-standard risks

OTHER RISK LOCATION	DESCRIPTION	POTENTIAL MITIGATION
Purley Way utility density and traffic volume	The impact of the density of utilities and traffic in Purley Way on DH installation will be primarily to increase potential costs of installation. These factors are considered unlikely to represent insurmountable impediments to the DH route installation.	Careful planning of installation route and methods. Adopting methods of installation where impacts on traffic flows are minimised as far as possible.

4.5 UNDERGROUND DISTRIBUTION NETWORK HEAT LOSSES

In order to calculate annual heat losses for the distribution network (up to the customer energy transfer stations), the following method has been applied:

- Generate a schedule of pipes based on
- Losses per m by size
- Total losses instantaneously at peak temps

NB that this methodology does not take account of variable operating temperatures on a seasonal basis, which in theory should reduce heat losses below this calculated level. However, WSP's experience of installed heat networks is that heat loss levels are typically higher than calculated. For this reason, the potential reduction in losses from flow temperature reduction has not been taken into account, and a further allowance for miscellaneous other heat losses (e.g. imperfect installation, exposed pipework sections, valves, fixings, etc.) has been added to the theoretical calculated figure. This additional allowance is shown below:

Table 4-4 – Allowance for heat losses above calculated values

	Heat loss factor
Heat loss allowance for miscellaneous factors	Additional 25% over calculated heat losses based on pipework supplier information and ground / pipework temperature differentials

5 PIPE-SIZING OUTPUTS

The pipe-sizing schedules outlined here are based upon the inclusion of all loads to the west of the Brighton mainline within the scheme (i.e. Core, Ext1 and Ext2). Report WP1D will examine the viability of the inclusion of individual loads within the scheme boundary, and therefore the overall network costs and recommended scales of network extent may evolve in later phases of the project from those shown here.

Based on the inclusion of these loads, the following pipes schedule has been calculated for the town centre area:

5.1 TOWN CENTRE PIPEWORK SCHEDULE

Table 5-1 – Initial estimate of pipework costs – Town Centre

Diameters (nominal) (mm ID)	Cost per m (trench) (£ capex)	Length of this diameter in this option	Cost
mm (ID)	£ / m Trench	m	£
50	£1,055	17	£17,577
65	£1,211	498	£602,660
80	£1,332	165	£219,665
100	£1,421	799	£1,135,190
125	£1,553	330	£512,945
150	£1,636	167	£273,391
200	£1,717	204	£350,021
250	£1,891	587	£1,110,783
300	£1,983	436	£864,738
TOTAL			£5,086,970

This schedule does not include for additional costs that might be anticipated for the high-risk areas of the network, which WSP are continuing to investigate. These additional costs will be included within reports WP1D or WP1E.

The ERF connection and transmission leg diameter has been calculated on the basis of the following method:

- Generation of a load duration profile for the initial assumption of scheme extent (i.e. Core, Ext1 and Ext2).
- Calculation of an energy supply level that would meet > 75% of the overall network heat demand (including losses)
- Consideration of pumping head and potential threshold changes in capacity with different pipe sizing assumptions

5.2 LOAD DURATION CURVE ANALYSIS

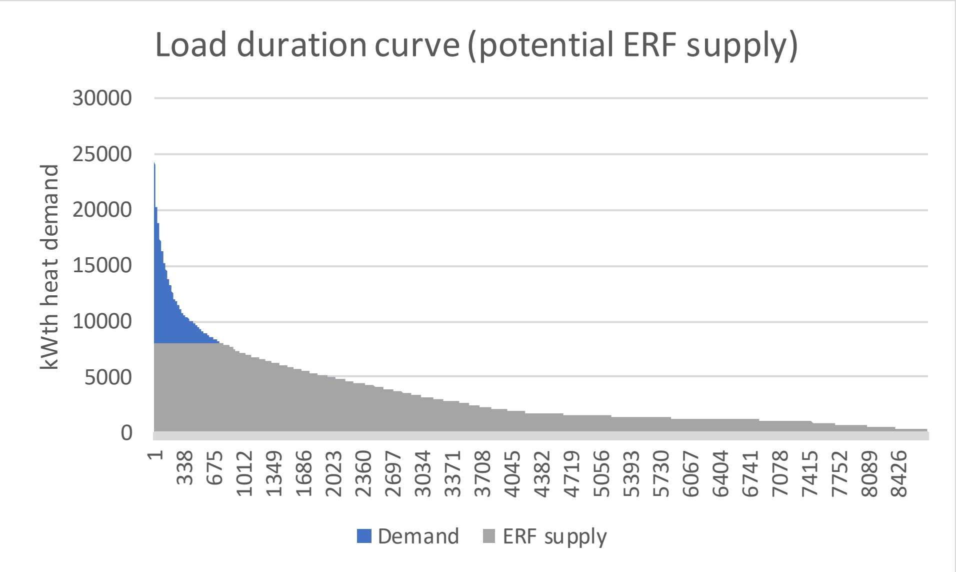
The following represents the heat load duration curve of the demands for the town centre system, incorporating site internal heat losses, estimated buried pipework losses within the town centre, and also approximated losses on the ERF link. These figures are tabulated below:

Table 5-2 – Heat loss estimation

	Buildings / development sites (MWh p.a.)	Site / building internal heat losses (MWh p.a.)	Town Centre heat losses (buried network)[2] (MWh p.a.)	ERF link losses[3] (MWh p .a.)	Total
Heat demand	25,128	1,177	989	1750	29,044

On the basis of the calculated load duration curve, the following chart shows the potential portion of the load that could be met by the ERF plant (assuming 100% availability of the ERF supply):

Figure 5-1 - Load duration curve showing ERF plant supply level



In this instance, the following figures are illustrated:

[2] Assuming Series 3 insulation
[3] Assuming Series 3 insulation, 105 deg C flow temperature, 250mm network.

Table 5-3 – Indicative ERF supply capacity proposed (kWth)

	ERF supply capcity (kWth)	Percentage of demand met (%)
Heat demand	8,000	91%

As an initial point for cost estimation of potential overall scheme costs, this represents the selection that has been made for the ERF link. The following table shows the estimated costs of the ERF link (not accounting for allowances for particular constraints / impediments):

Table 5-4 – ERF link cost estimate

Diameters (nominal) (mm ID)	Cost per m (trench) (£ capex)	Length of this diameter in this option	Cost
mm (ID)	**£ / m Trench**	**m**	**£**
250	£1,891	4373	£8,269,000
TOTAL			**£8,269,000**

As above, please note that these costs do not include allowances for overcoming the identified constraints. These additional costs will be presented in WP1D or WP1E.

WSP has also issued enquiries to a number of DH suppliers, requesting cost estimates for both the town centre installation and also estimates for overcoming the various impediments identified. We will incorporate the responses to these enquiries and cost inputs into subsequent report issues.

Appendix A

LAND OWNERSHIP AROUND HAZELDEAN BRIDGE

LAND OWNERSHIP ILLUSTRATION

Figure A-1 - Cropped image of Drawing 19000-05 rev P1, dated 8/12/2016

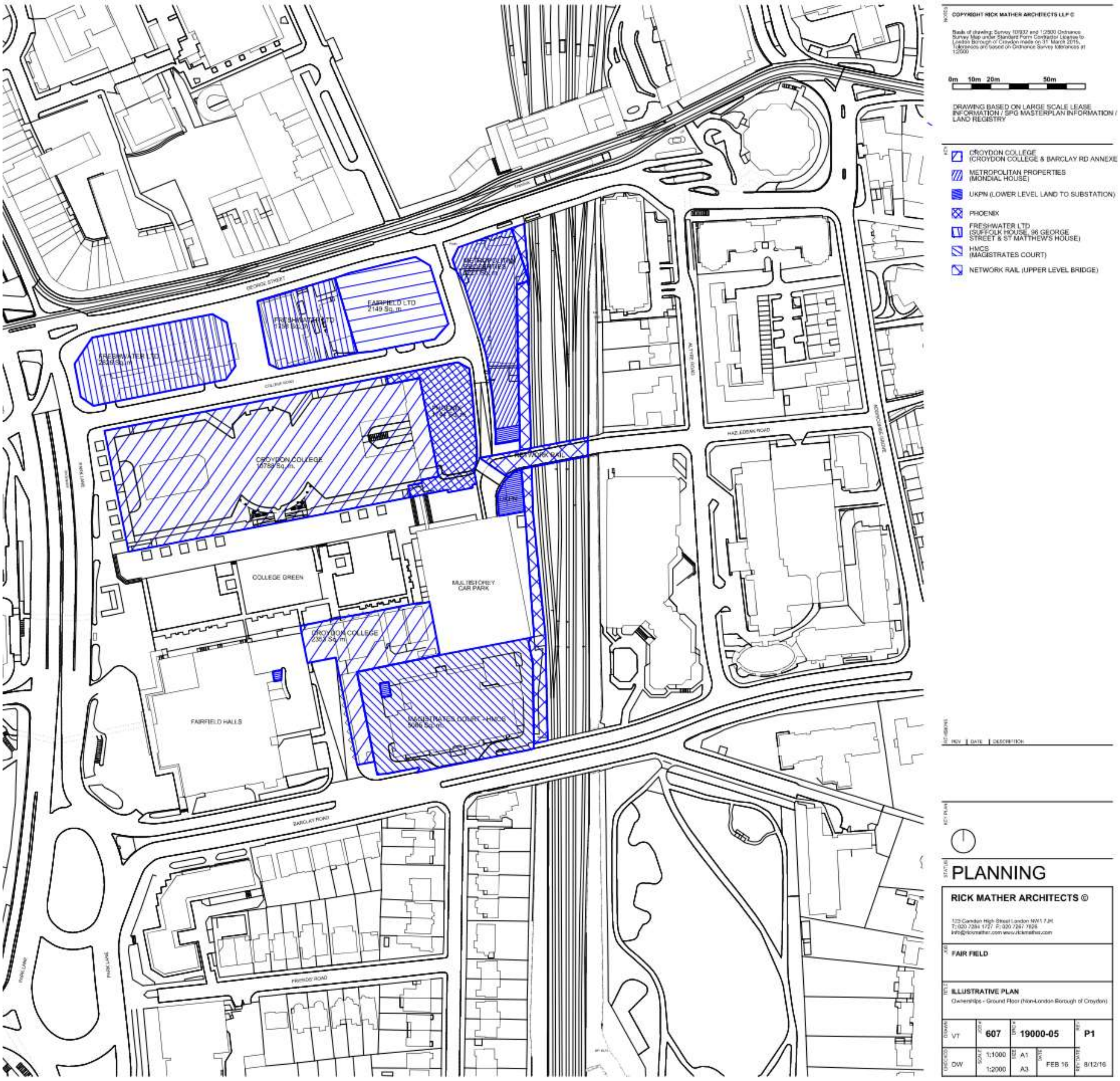
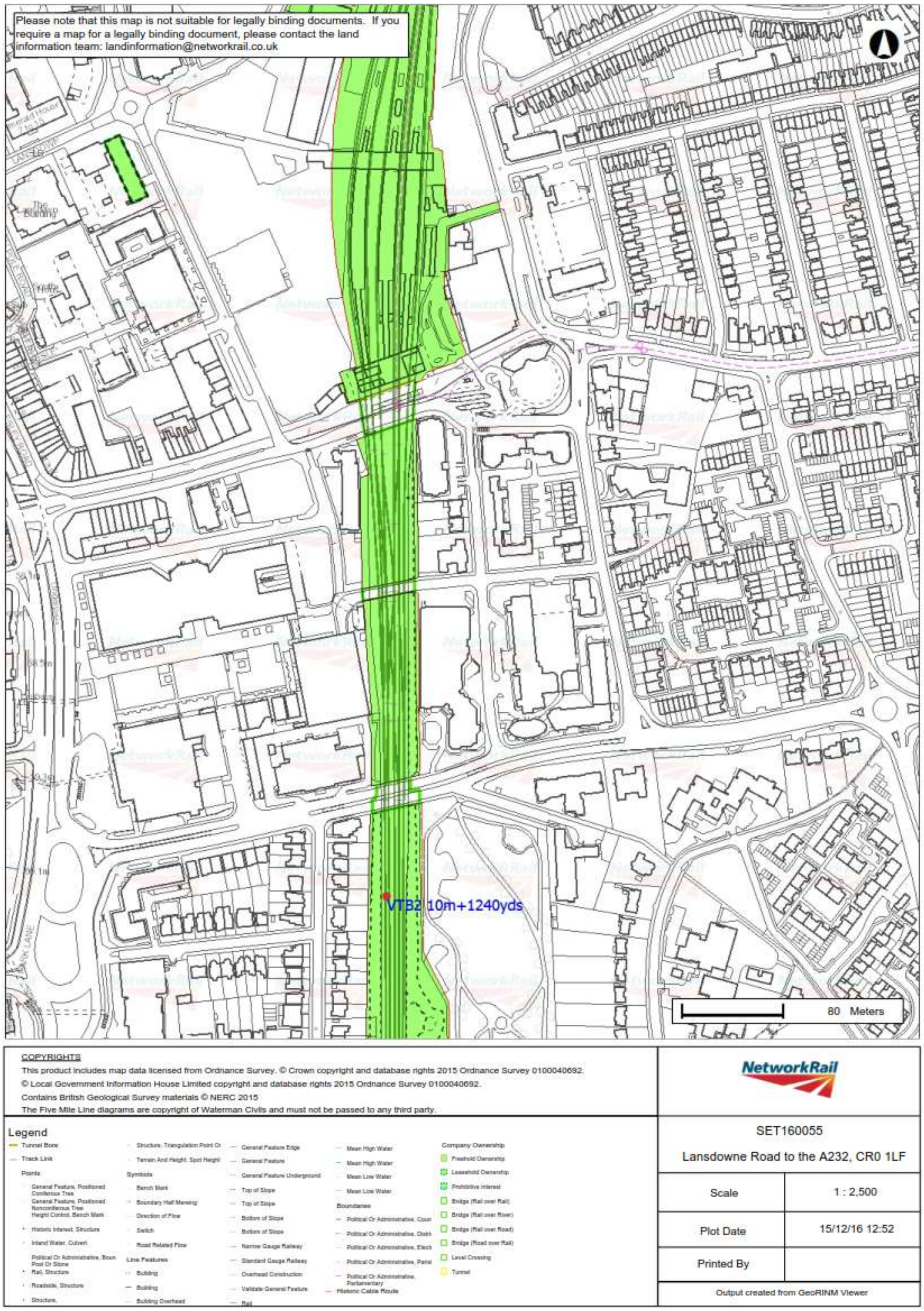


Figure A-2 - Network Rail ownership (Groundwise)



The image appears to show the Hazeldean bridge in 'Company Ownership' (as per Groundwise Report 19170JS), although the boundary on the western side of the railway is slightly different from the planning application drawing above. This may be linked to the demolition of this section of the bridge.

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London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1D)

DECEMBER 2019 (INC MINOR REVS MAY 2020)

CONFIDENTIAL

London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
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Signature				
Checked by	Bruce Geldard	Bruce Geldard		
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Authorised by	Bruce Geldard	Bruce Geldard		
Signature				
Project number	70057109	70057109		
Report number	WP1D	WP1D		
File reference				

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FIGURES

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EXECUTIVE SUMMARY

This WP1D report for Croydon DEN outlines the energy centre development work that has been undertaken, further work that has been carried out on the ERF DH link (following the issue of the WP1C report), and the cashflow model assumptions and results.

The option presented in this report shows a scheme that has excellent potential to deliver carbon savings to the town centre. However, an overall capital cost of around £33m is estimated to deliver the full scheme, and the revenues projected for the project are not sufficient to allow the scheme to deliver a positive whole life cost, even when assuming 40% capital grant.

The scheme presented here is based around:

- A kick-start core network that serves the Croydon Council buildings (BWH, Davis House, Central Library, Town Hall) to be installed initially with gas-fired CHP and boilers and a private wire network
- Installation of a district heating link to Beddington ERF plant to start operating in 2025, and expansion of the 'core' network to serve new development sites

This scheme is configured to use CHP in the initial phase to help generate good operating margins through the sale of private wire electricity and heat to the core customers. Expansion to additional new development customers is only considered possible when the ERF link is in place and the carbon content of heat is sufficiently low to be of interest to new developments.

There are no doubt refinements and value engineering exercises that could reduce the overall cost of this scheme. However, it is WSP's view that in its current form the project will not be deliverable on the basis of the overall balance of costs to project revenues.

It is concluded that either

- an alternative delivery route (i.e. where investment is made in the key strategic infrastructure (the ERF link) without expectation of an immediate return on investment, similar to road-building projects) or
- alterative scheme configuration (i.e. eliminating all top-up and standby plant at the Wandle Road Energy Centre)
- must be pursued in order to create a deliverable scheme.

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1 INTRODUCTION AND SCOPE

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. One element of this is the potential development of a district heating network, where the aspiration would be to provide new and existing buildings a cost-efficient means of moving from natural gas as the dominant fuel, to a lower carbon and renewable fuel mix

A feasibility study was completed in 2017 which indicated that an initial scheme based on new development and existing public-sector buildings was economically viable. The council has allocated a site for the scheme energy centre. With new developments having to meet the London Plan Zero Carbon target, the best longer term low carbon heat supply option would be to connect to the Beddington Energy Recovery Facility (ERF). This commission aims to provide greater confidence in the viability of this supply option, and an alternative based on gas-fired CHP in the identified energy centre.

The objective of the work is to develop a viable scheme that can proceed to procurement.

The scope of the overall commission therefore comprises:

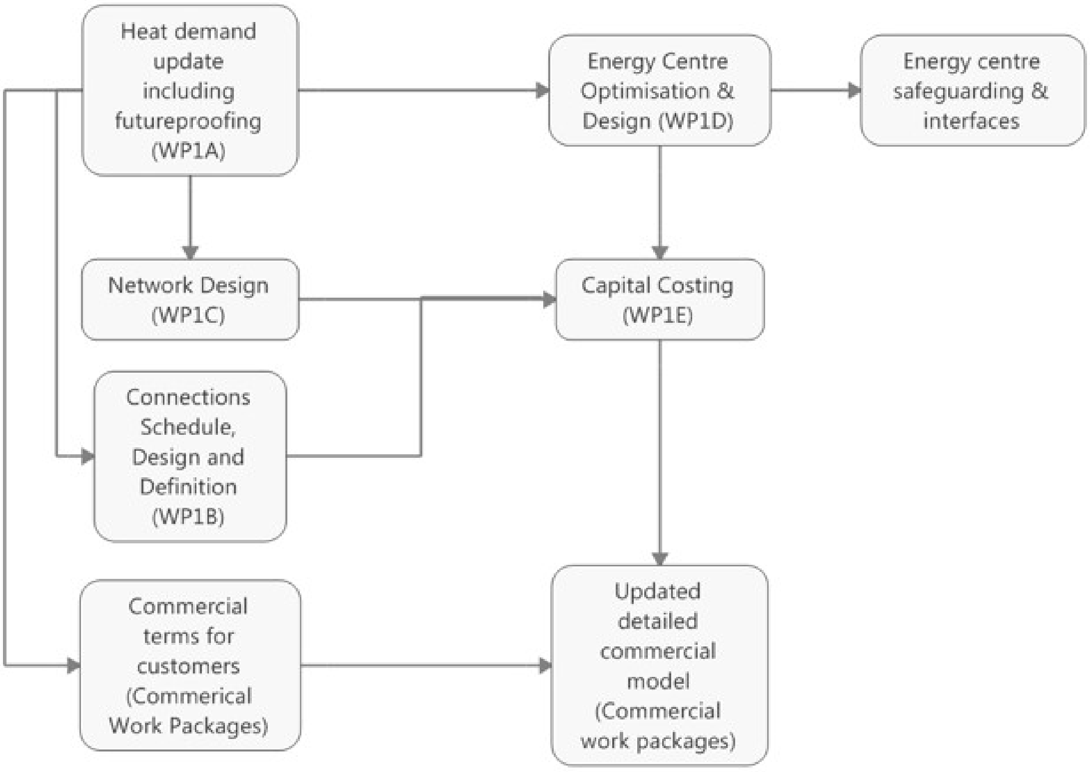
- A review of the 2017 feasibility study
- Updating the heat demands and techno-economics (according to the current phasing of new development)
- Establishing a preliminary system design, along with the capex and opex to a good degree of certainty – including the option of connection to the Beddington ERF plant
- Carrying out a commercial evaluation and identify the business models options that could be taken forward by the Council.

The scope of work is split into five work packages:

- **Work Package 1A:** Heat demands and consumptions. Power demand and consumption for potential 'private wire' supply to civic centre buildings.
- **Work Package 1B:** Distribution and supply to end users
- **Work Package 1C:** Heat network infrastructure
- **Work Package 1D:** Energy Centre
- **Work Package 1E:** Cost schedule for energy centre plant and pipe network

The workflow of the work packages and their relation to the commercial modelling work packages is summarised in Figure 1-1.

Figure 1-1 - Flowchart summarising key outputs of Technical work pages and their relationship to Commercial work packages



This report represents the deliverable **Work Package 1D – Energy Centre design and scheme optimisation.**

2 LOADS UPDATED DURING PROJECT DEVELOPMENT

This section briefly updates the load summary presented in previous work packages, in the light of additional information and loads not identified at the time of compilation of the previous work packages.

The key additional loads are:

- The Edridge – a residential development at 4-20 Edridge Road
- College Tower – a mixed use development bounded to the west by Croydon College and to the north by 101 George Street.
- Fire station upgrade – no details were available at the time of compilation of this report, hence this is only noted as a potential future opportunity to integrate into on-going design development.

Integrating these loads into the overall scheme has updated the overall projected heat demands to give the following summary figures:

Table 2-1 - Updated annual demands

MWh	Annual heat demand	Annual electricity demand (Croydon core buildings only)
Full build-out	**27,018**	**9,138**

These correspond to the following updated heat demand profiles and load duration curves:

Figure 2-1 - Heat demand profile and load duration curve

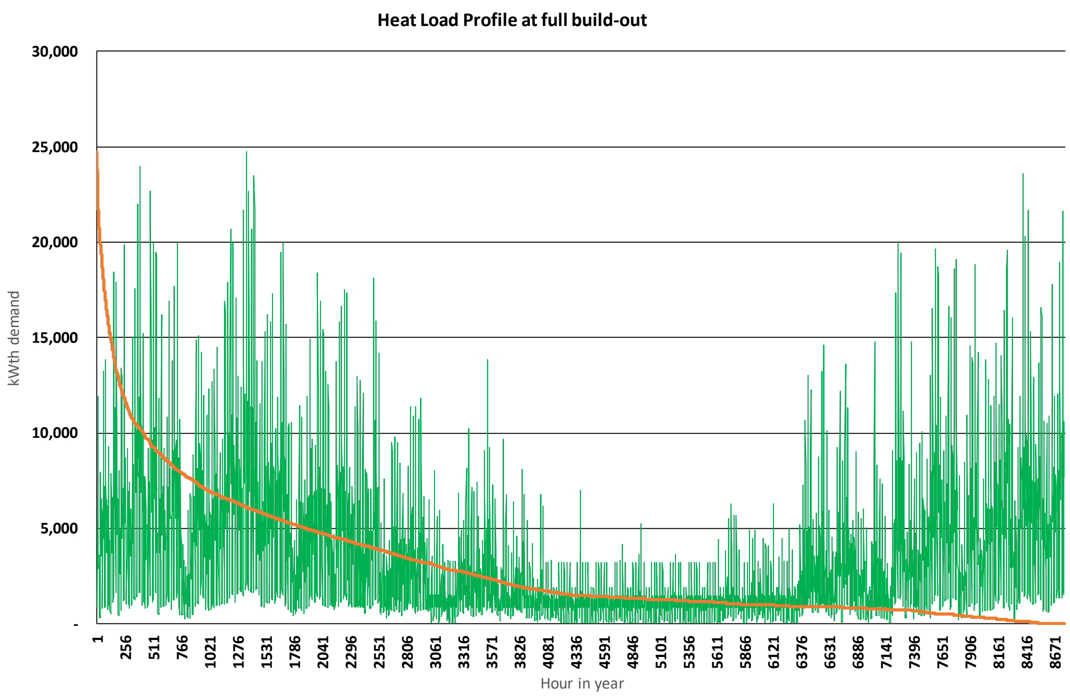
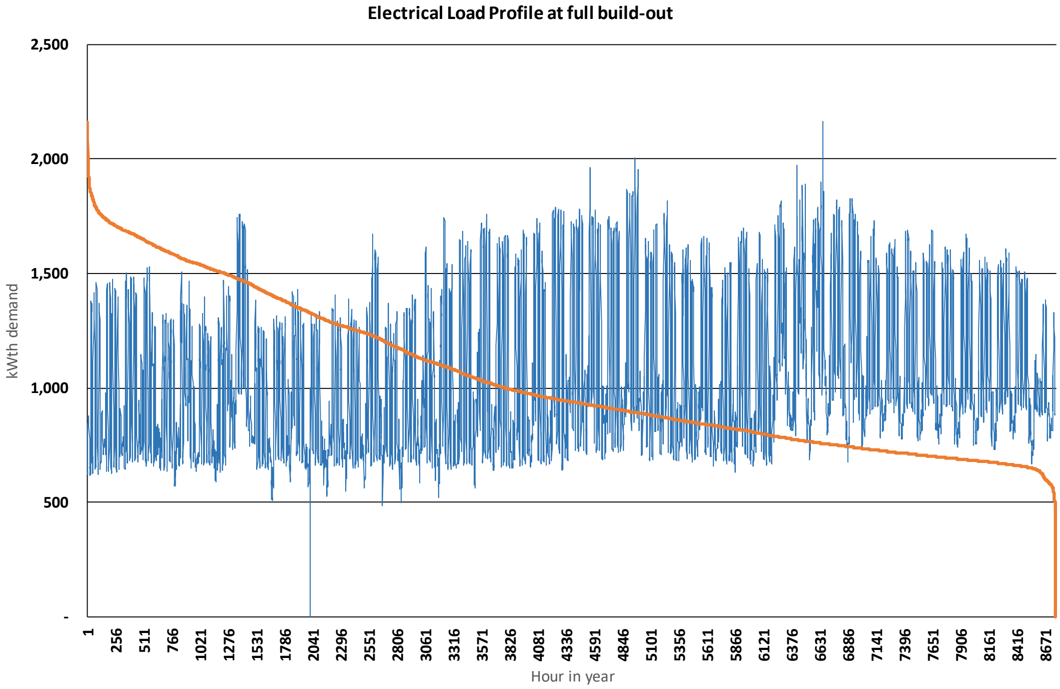


Figure 2-2 - Electrical demand profile



3 SCHEME OPTIMISATION

3.1 GENERAL SCHEME CONFIGURATION

This section considers the overall configuration of the scheme and some of the considerations that have contributed to the overall shape of the proposed option.

3.1.1. CARBON PERFORMANCE

In the context of the global emissions crisis and climate emergency, it is paramount that this scheme is developed in such a way that results in overall emissions reductions. The aim must be to decarbonise the provision of heat to residents and businesses in Croydon. However, at the same time, the scheme needs to strive to deliver a financial return.

The more environmentally beneficial heat supply option for this project is the use of ERF heat offtake. It is only with the decarbonisation of heat supply through the use of this ERF heat that the supply of heat from the project will become attractive to new developments.

In this analysis it is assumed that the SAP10 (potentially linked to Part L 2020) or the Future Homes carbon standard will apply by the time that the project is implemented, as per the timetable in the recently published consultation document[1] on the Future Homes carbon standard, as replicated below:

Figure 3-1 - Roadmap to the Future Homes Standard, from Future Homes Standard consultation

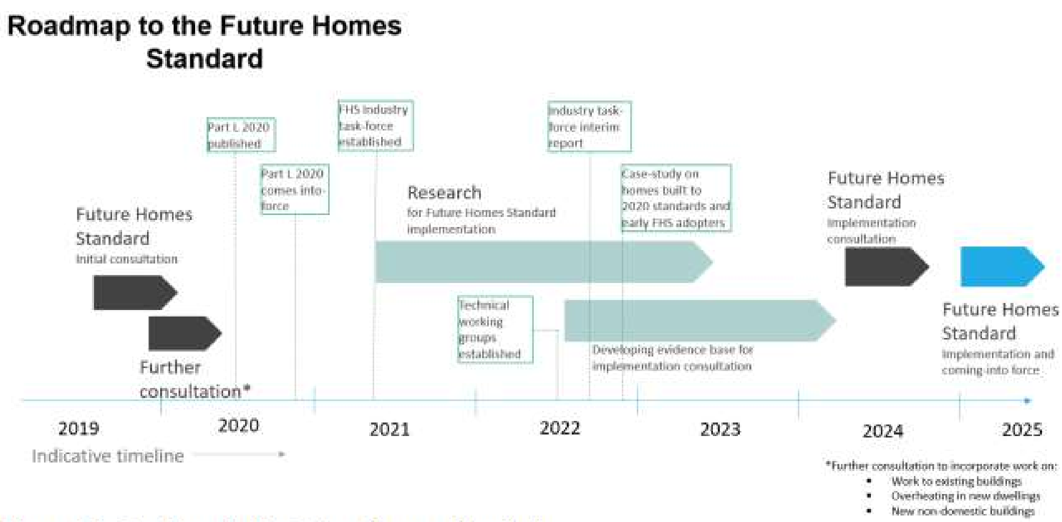


Figure 2.1: Roadmap to the Future Homes Standard

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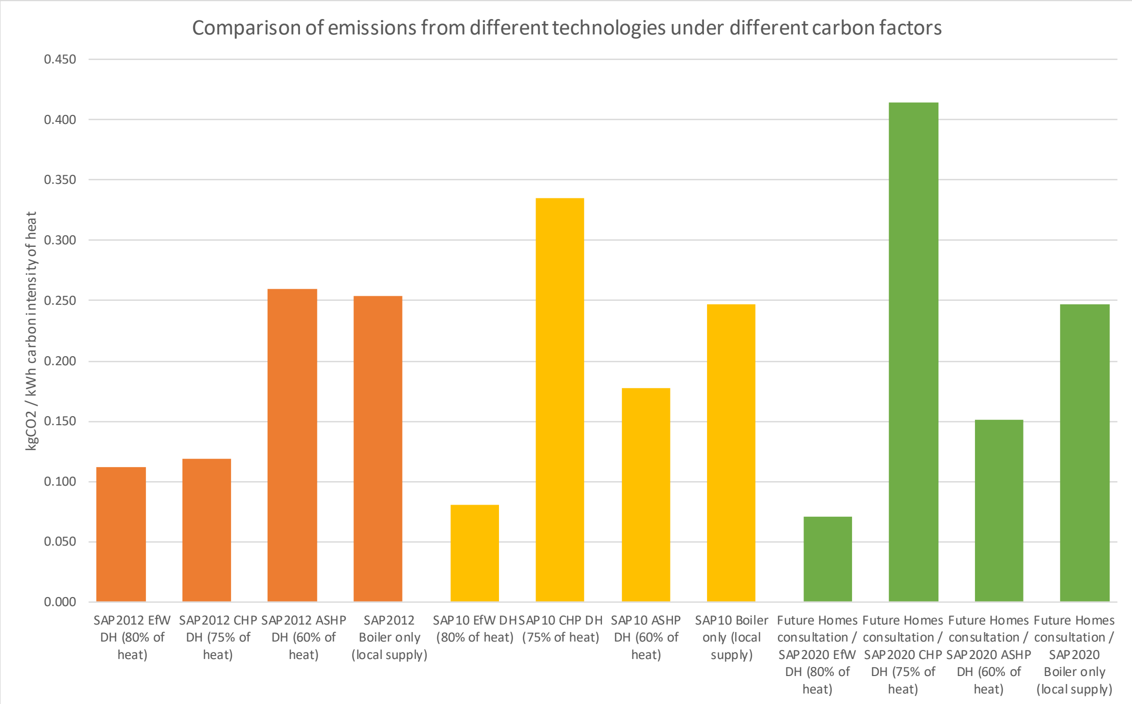
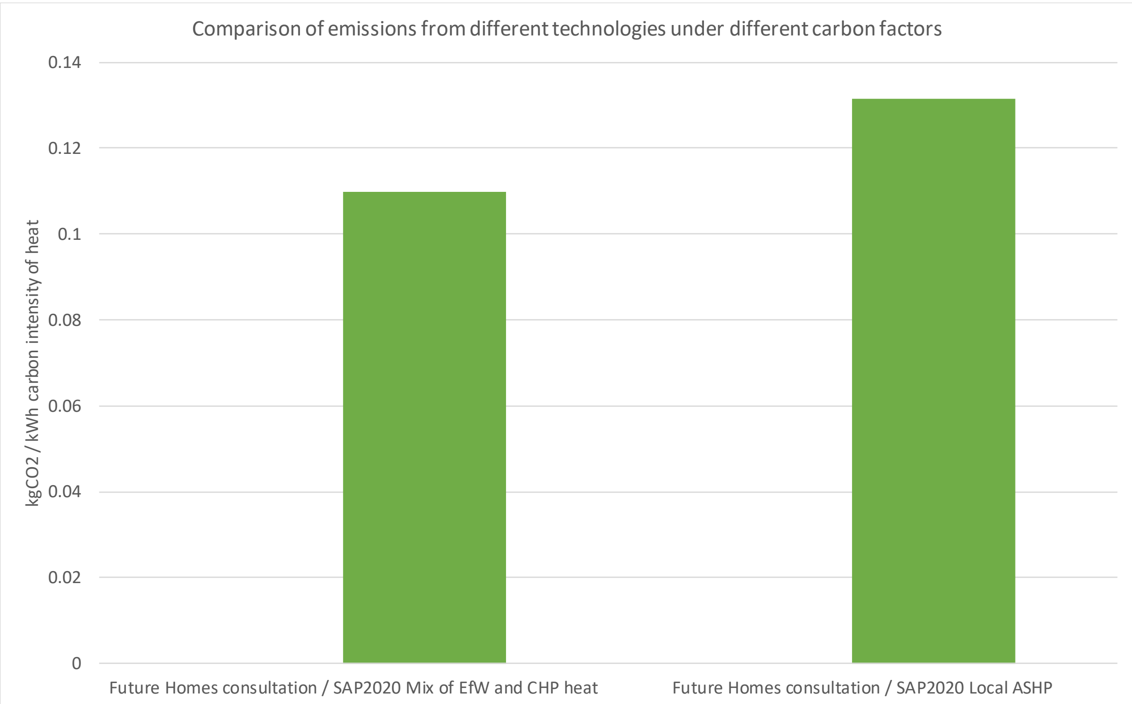
1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835536/Future_Homes_Standard_Consultation_Oct_2019.pdf, accessed 11th October 2019

A brief comparison of the carbon intensity of heat that could be expected from different technologies under the various carbon factors is shown below:



This shows that the use of EfW heat (assumed to be ‘Waste heat from power station’) is the lowest carbon source of heat under all the scenarios shown here.

It is worth noting that a mix of heat from EfW and CHP can deliver a lower overall carbon intensity of heat than from a local ASHP supply under the Future Homes standard, as illustrated below:



This illustrates that with judicious operational decisions (i.e. to maximise the value of CHP operation by only operating during periods of high electricity value, in this instance assuming 75% of heat demand met by EfW and 15% by CHP), that a combination of EfW supply and CHP supply could provide an effective means of generation cost-competitive, low carbon heat supply to the system.

As the mix of CHP supply rises above the level illustrated here, there would be only a commercial (as opposed to carbon factor and commercial) motivation for sites with ASHP as their counterfactual technology to connect. From this perspective, this level of CHP operation is modelled as the upper limit for the phase of network when new build developments should connect.

3.1.2. CASHFLOW PERFORMANCE

There is a significant investment required for the Council to implement this project. From this perspective, it is key for the project to 'de-risk' the investment as far as possible. Several avenues for this will be explored through the commercialisation and technical phases of this project, and will be anticipated to include:

- Phasing the growth of the scheme
- Establishing commitment from developments as far as possible before investment is made
- Developing a kick-start phase of the scheme based around gas-fired CHP heat supply and core Council loads.

3.1.3. GRANT FUNDING

It is anticipated that the scheme will require an element of grant funding to allow it to proceed to implementation. The 'Heat Network Investment Project' (HNIP) is designed to assist with projects of this nature. However, this grant funding is a competitive bidding process where applicants are evaluated on the basis of the carbon savings projected for each unit of grant funding requested (amongst other criteria). This means that it is essential that the project delivers carbon savings against the existing baseline. There are therefore two potential approaches that WSP would see:

- Option A – proceed with the kick-start scheme without applying for any HNIP grant funding, and to make an application to HNIP for the ERF link element of the scheme.
- Option B- approach the scheme as a single project and request grant funding on the basis of the overall combination of CHP and ERF elements of the project.

At this stage, Option B has the theoretical potential to receive greater grant support (primarily linked to the higher capital cost), but WSP would suggest that it is the wider questions around risk, financial performance, and how to deliver the project which will determine the route by which to approach HNIP. On the basis that the HNIP process evaluates metrics such as carbon saving per grant sought, Option A would deliver a higher figure than Option B.

3.1.4. DEVELOPMENT PROGRAMME / OBLIGATIONS

As noted above, the new developments in the Croydon town centre area fall into a number of different potential categories in terms of their potential connection to the DH network:

- Development consented and in construction / constructed

- Development consented but not yet constructed
- Development in Planning application stage
- Development at pre-planning stage
- Concept development

The lead-time for the development of a district heating scheme is generally likely to be comparable to the lead-times for new developments. This means that the majority of the sites that are currently consented by the planning system will be largely constructed, or at least in the construction phase, by the time that the DH network is available. This implies that there is likely to be limited leverage available to obligate connection by the time that the DH network is installed. The incentive for connection is therefore more likely to be commercial.

3.1.5. SDEN HEAT SALES VOLUME

It is understood that the greater the volume of heat purchase from SDEN, the lower the price is likely to be on a per unit basis. This must be confirmed through negotiation with SDEN, and is partially contingent on the ability of SDEN to purchase heat from Viridor primarily at the 'base load' tariff stipulated in the SDEN / Viridor contract. Nevertheless, up to a point, as more developments are connected to the scheme, the lower the price of heat purchased from SDEN could become. This would either allow greater margin to be seen by the scheme operator, or alternatively, for lower heat prices to be offered to connections, which would potentially increase the take-up rate. In any case, it will advantageous from an economic, environmental and cashflow perspective to connect as many loads as possible as early as possible in the overall project lifecycle.

3.1.6. IMPLICATIONS OF GENERAL CONSIDERATIONS FOR SCHEME CONFIGURATION

The elements of the scheme outlined above suggest that:

- The scheme must include the ERF link – without this, the project will not save carbon, and is therefore not sustainable
- The scheme must seek to maximise heat sales from the ERF link as soon as possible to deliver the best possible cashflow performance – this means expanding the customer base beyond the 'core' council loads as soon as possible following ERF link construction.
- There will always be an element of risk that Croydon must accept with the 'chicken-and-egg' requirement to have commitments from potential heat customers to justify the link, but simultaneously, having the difficulty of obtaining commitment from customers when the link is not in place. Hence the initial 'core' scheme which will help to establish the scheme and de-risk overall delivery.

3.2 SPECIFIC SCHEME OPTIMISATION

The approach adopted towards scheme optimisation as part of this project has incorporated a number of steps, outlined in more detail in the sections below:

- Load selection
  - Considering the value that the addition of different loads brings to the overall scheme, and the level of future-proofing that the scheme should incorporate

- Plant selection (CHP and thermal storage units)
  - Considering the economic impact of different variants of plant configurations, primarily based on the 'Core' scheme
- Plant selection (ERF link capacities and thermal storage)
  - Considering the economic impact of ERF link capacities and thermal storage, primarily based on the 'Core, Core expansion, Ext 1 and Ext 2' scheme.

3.3 LOAD SELECTION

It is clear that the connection of a small demand site via a long (and hence expensive) pipework link is unlikely to enhance the economic performance of the scheme, as the margin of benefit from heat sales will not recoup the costs of putting in the connection.

We have attempted to quantify whether particular loads (or sets of loads) are likely to add benefit to the scheme, through making a set of capital cost and operational margin assumptions for the scheme[2]. A number of factors are included within this assessment, which are listed below:

- Cost of pipework link
  - Pipework installation in typical urban 'cut and cover' approach
  - Estimated costs for overcoming abnormal obstacles
- Cost of substation connection
  - As estimated and listed in WP1B
- Margin of 'generated' heat
  - Based on either estimated costs of heat generation from mix of CHP and boilers, or on the cost of purchase from SDEN and the additional cost of boiler heat
  - Incorporating the additional maintenance cost of the pipework link
- Value of heat and power (CHP only) sales
  - Based on counterfactual cost of customer generating its own heat, and at this stage of analysis, without allowing for any margin of saving from the DH supply of heat
  - Value of potential PW sales.
- A notional 'margin' of value that has to be surpassed for a connection to be considered 'viable'.
  - Under the assumptions above, a particular connection would only be considered 'viable' if it generates a positive NPV contribution to the overall

[2] NB that this analysis was undertaken without confirmation of SDEN heat prices.

scheme above a certain threshold. In this analysis, a 15 yr period and a 6% discount rate have been used to assess whether a load gives a positive contribution to the scheme or not.

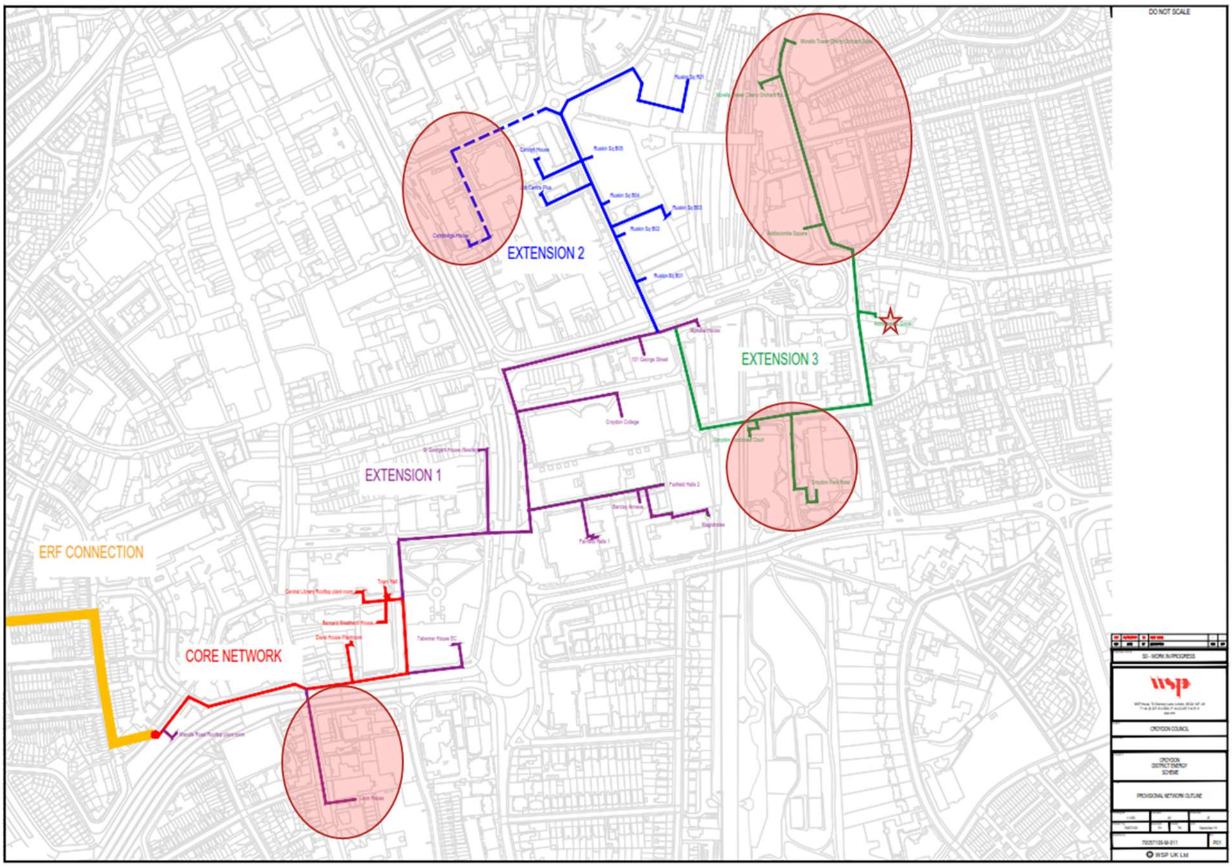
3.3.1. COST OF PIPEWORK LINKS

The loads tested in this manner were:

- Those loads above the Cherry Orchard Rd tram crossing
  - Morello Tower (Cherry Orchard Garden and Cherry Orchard Road)
  - Addiscombe Square
- The loads east of the Brighton mainline
  - Croydon Combined Court
  - Croydon Park Hotel
- Cambridge House
- Leon House

These loads are illustrated on this image:

Figure 3-2 - Load zones tested for viability



The small starred load on the east of this image (Addiscombe Grove) is not analysed separately, as this site has such a small demand, that it would only be connected if the intermediate section between the Croydon Park Hotel and Cherry Orchard Rd area were installed.

The following table shows the costs that have been compiled for these 'additional' sections of pipework. The approach here has been to resize all of the network based on the inclusion / exclusion of these individual loads. The figures illustrated here are based upon a 95 deg C flow temperature, Series 3 insulation

Table 3-1 – Network pipework costs for north of Tram (Cherry Orchard Rd)

	Network cost with loads included	Network cost with loads excluded	Differential
Morello Tower and Addiscombe Square	£6,760,000	£6,077,000	£683,000
Additional estimated abnormal costs[3]	£175,000	n/a	£175,000
Substation costs	£219,500	n/a	£219,500
Total connection cost	**£7,154,500**	**£6,077,000**	**£1,077,500**

Similarly, the following table shows the cost of the network to serve the loads to the east of the Brighton Main Line

Table 3-2 – Network pipework costs to cross Brighton Main Line

	Network cost with loads included	Network cost with loads excluded	Differential
Croydon Combined Court and Croydon Park Hotel[4]	£5,797,000	£5,087,000	£710,000
Additional estimated abnormal costs[5]	£150,000	n/a	£150,000
Substation costs	£288,000	n/a	£288,000
Total connection cost	**£6,235,000**	**£5,087,000**	**£1,148,000**

[3] Assumes directional drilling under the tramlines.
[4] NB the small load of Addiscombe Grove has been excluded from this analysis.
[5] Assumes integration of DH Pipework is possible within a new pedestrian bridge design.

In the case of Cambridge House and Leon House, the 'network cost with load included' has been based around the loads to the west of the Brighton mainline only (i.e. excluding EXT3).

Table 3-3 – Network costs of Cambridge House connection

	Network cost with loads included	Network cost with loads excluded	Differential
Cambridge House	£5,087,000	£4,687,000	£400,000
Substation costs	£48,500	n/a	£48,500
Total connection cost	**£5,135,500**	**£4,687,000**	**£448,500**

Table 3-4 – Network costs of Leon House connection

	Network cost with loads included	Network cost with loads excluded	Differential
Leon House	£5,087,000	£4,844,000	£243,000
Substation costs	£80,000	n/a	£80,000
Total connection cost	**£5,167,000**	**£4,844,000**	**£323,000**

3.3.2. AVERAGE MARGIN FROM GENERATED HEAT

In order to estimate the cost and margin available from generated heat, the following preliminary assumptions have been made (please note that these are refined later in this report – these are initial estimates for the purpose of evaluating these potential heat connections only).

Table 3-5 - CHP generation margin assumptions

	Value	Notes
CHP electrical efficiency (GCV)	37%	Typical mid-range CHP value
CHP heat efficiency (GCV)	39%	Typical mid-range CHP value
Percentage of heat demand met by CHP	80%	Typical value for modern network with significant thermal storage volume

Boiler efficiency	85%	Estimated non-condensing boiler value
Distribution losses (as percentage of site heat demand)	10%	Estimated based on base-of-block sales
CHP maintenance cost	1.00	p/kWhe Typical mid-range CHP value
Cost of gas	2.25	p/kWh (2018 annual value, QEP, table 3.4.1 excluding CCL, medium consumer)
Cost of electricity	11.14	p/kWh (2018 annual value, QEP, table 3.4.1 excluding CCL, medium consumer)
Value of exported electricity	6	p/kWh (WSP estimate based on wholesale value (BEIS reference case projections, volume weighted average, 2018) and including estimate of embedded benefits).

The margin generated per kWh of heat supplied under this set of assumptions also depends upon the volume of electricity generated by the CHP unit and sold on a PW network. A range of potential values is shown here:

Table 3-6 – Private wire sales assumption for margin calculation

Percentage of generation sold via private wire (where no reduction in value is offered by PW sales rate)	Benefit to scheme operator from supply of each unit of heat (p/kWh)
10%	1.59
50%	3.31
80%	4.6

Any power not sold on the PW network is assumed to be exported.

It can be seen that this proportion of electricity sold via private wire significantly impacts the benefit that is derived from each unit of heat generation.

ERF connection solution

Similarly, under the ERF solution, the following assumptions are made regarding the margin available:

Table 3-7 – ERF margin assumptions

Element	Value	Notes
Percentage of heat demand met by ERF link	90%	Typical value for modern network with significant thermal storage volume
Boiler efficiency	85%	Estimated non-condensing boiler value

Distribution losses (as percentage of site heat demand)	15%	Estimated based on base-of-block sales, and combined ERF and town centre systems
Cost of gas	2.25	p/kWh (2018 annual value, QEP, table 3.4.1 excluding CCL, medium consumer)
ERF heat purchase cost	0.5	p/kWh (estimated)

It can be seen that the overall calculation of margin has less contributing factors under the ERF solution. The key variable here is the cost of heat purchase from SDEN. This will be subject to negotiation, and hence the value illustrated here can only be an estimate at this stage.

On the basis of the figures above, the value margin for heat supplied under an ERF solution is as follows:

Table 3-8 – ERF estimated heat sales margin

	Benefit from supply of each unit of heat (p/kWh) (ERF supply solution)
Margin for units of heat supplied	1.83

It is worth noting from the comparison above that the CHP solution, appears to offer significantly greater potential margin on each unit of heat sold, over the ERF link solution. This is one of the key reasons for supporting the CHP solution initially to 'kick-start' the scheme and de-risk the initial project development.

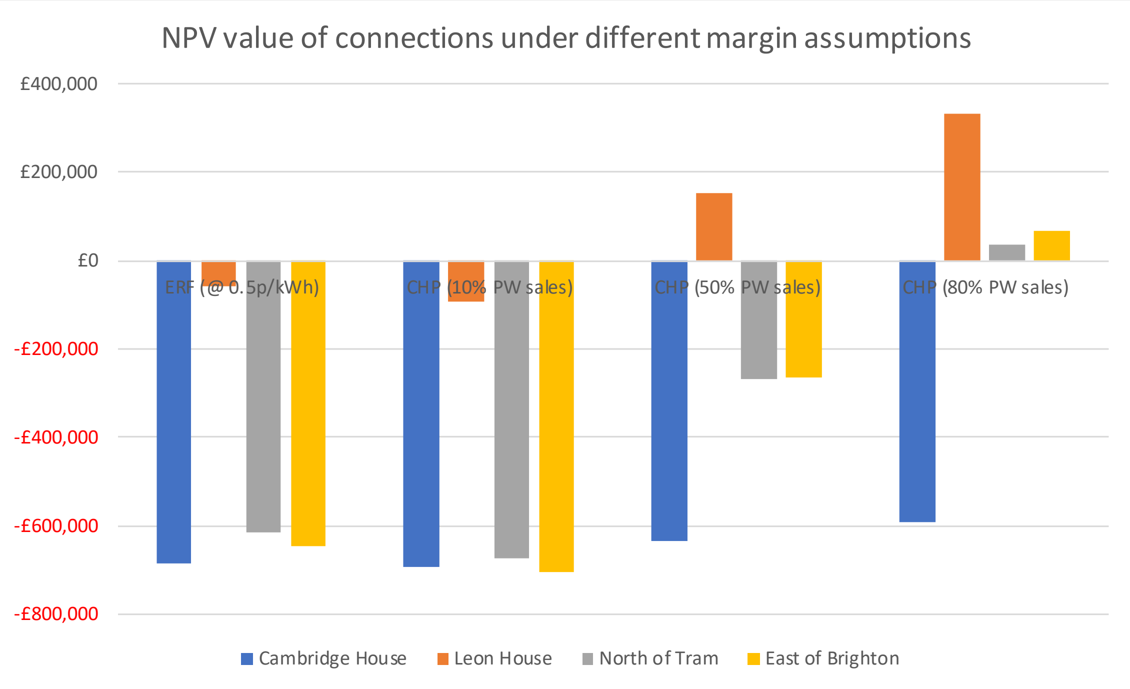
Whole life cost margin for individual connections

The following table and graph outline the analysis that evaluates the potential benefit of the individual connections.

Table 3-9 – Whole life cost margin for connections

	ERF (@ 0.5p/kWh)	CHP (10% PW sales)	CHP (50% PW sales)	CHP (80% PW sales)
Cambridge House	-£685,000	-£694,000	-£635,000	-£590,000
Leon House	-£58,000	-£91,000	£151,000	£333,000
North of Tram	-£616,000	-£673,000	-£267,000	£37,000
East of Brighton	-£645,000	-£707,000	-£264,000	£68,000

Figure 3-3 - Whole life cost margins for connections



It can be seen from these figures that it is only under the assumption that a high proportion of generated electricity is sold via private wire that any of the connections appear to be of whole-life cost benefit to the scheme. The best-performing connection in this analysis is the Leon House connection. This analysis was carried out before consideration of the Edridge development site, the addition of which should further improve the whole life performance of the connection to this zone.

On the basis of this analysis and consideration of the additional difficulties anticipated in crossing the TfL or Network Rail infrastructure to reach these areas of load, it is the recommendation of this report only to pursue a connection to Leon House of the loads analysed here.

4 PLANT SELECTION (CORE SCHEME)

In order to identify a suitable size of plant for the ‘Core scheme’ (i.e. the kick-start phase based around the council properties), an analysis has been undertaken of the comparative performance of the key primary supply units for the identified loads.

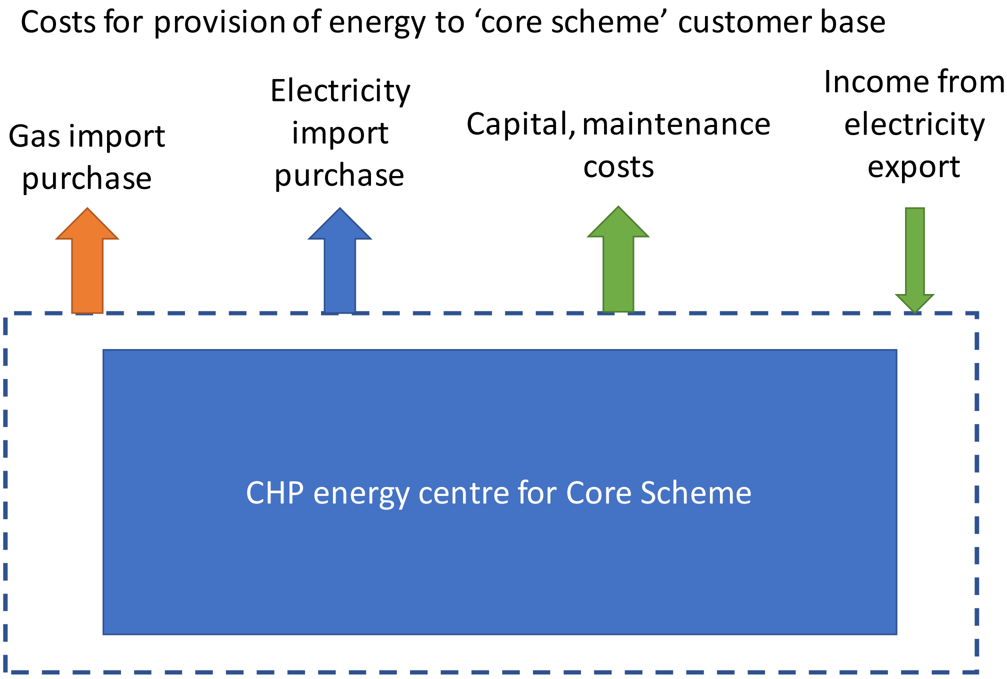
This analysis is based on the approach that the majority of elements of the overall supply solution will be ‘fixed’ irrespective of the capacity of the primary plant. For example, it is assumed that the top-up and standby boiler capacity would not change with the selection of CHP or thermal storage capacity (as neither CHP nor thermal storage are considered to be able to contribute towards delivery of sufficiently resilient heat). Similarly, in this analysis the assumption is made that the physical size of the energy centre and therefore overall costs will remain the same irrespective of selection of CHP capacity.

The analysis therefore only considers those factors that are directly impacted by the different selections of primary plant. These factors are:

- CHP capacity
- Thermal store capacity
- CHP capital and maintenance cost
- Thermal store cost
- CHP fuel consumption
- Electricity import / export balance (note it is assumed that PW sales volumes remains constant – e.g. that under all scenarios the full volume of the PW demand is met by supply through the EC)
- Boiler fuel consumption

The overall approach is illustrated here:

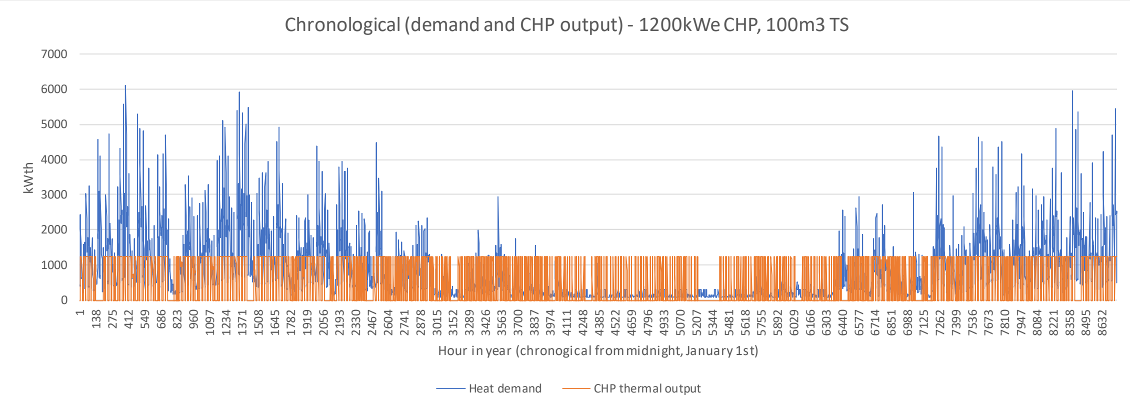
Figure 4-1 - Schematic illustration of cost of heat considered (core)



This approach is used to identify the *least cost* means of providing the required heat and power to the identified core scheme customer base (i.e. it is assumed that heat revenue is the same under all options of plant selection).

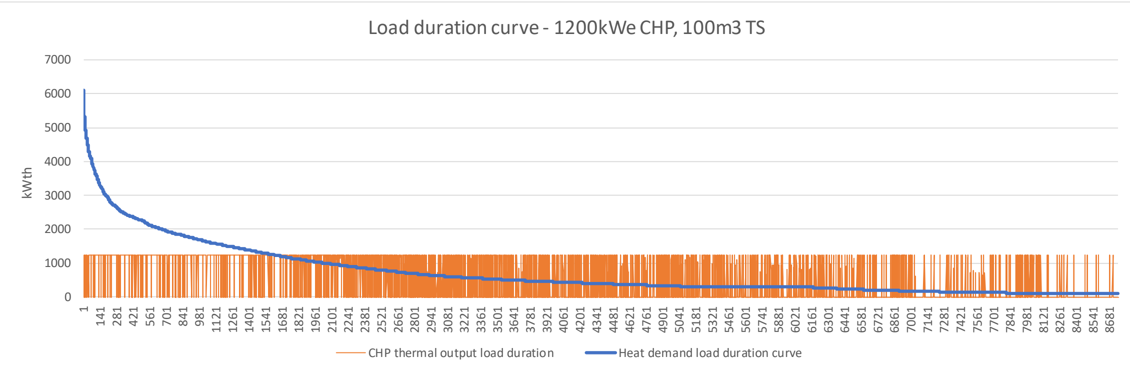
The modelling of each of the options for which results are presented has been carried out on an hourly basis over an annual period, allowing for the operation of thermal storage in combination with the primary heat source (CHP units). An example of the chronological output of this modelling and a load-duration curve arrangement of the same operation is shown below to illustrate how the modelling has been carried out.

Figure 4-2 - Chronological illustration of CHP operation



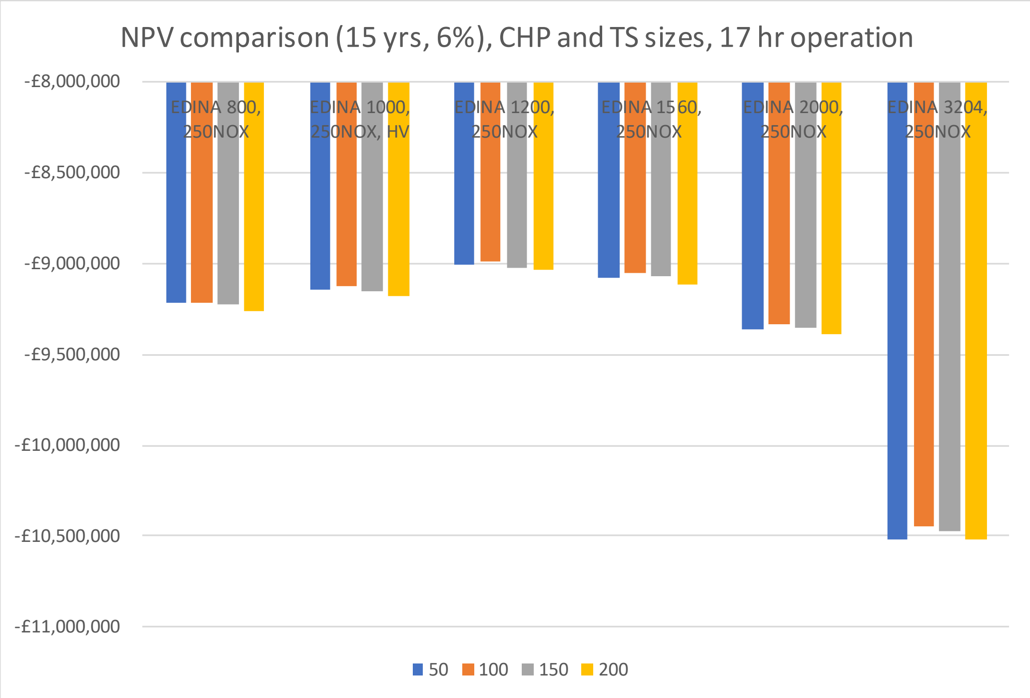
The outages periods visible on this graph represent assumed non-availability periods for the CHP – i.e. when it is assumed that the CHP unit would require either scheduled or unscheduled maintenance.

Figure 4-3 - Load duration curve illustration of CHP operation



The results from this analysis are shown in graphical form below:

Figure 4-4 - CHP size and thermal storage capacity comparison



This graph allows both different engine capacities and different thermal storage volumes (in combination with the different engines) to be compared on a cashflow performance basis. This graph illustrates that the best performing option is a 1.2MWe CHP unit in combination with a 100 cubic metre thermal storage volume.

Aspects of the energy balance modelling that contribute towards these overall results are shown below:

Figure 4-5 - Percentage heat demand met by CHP

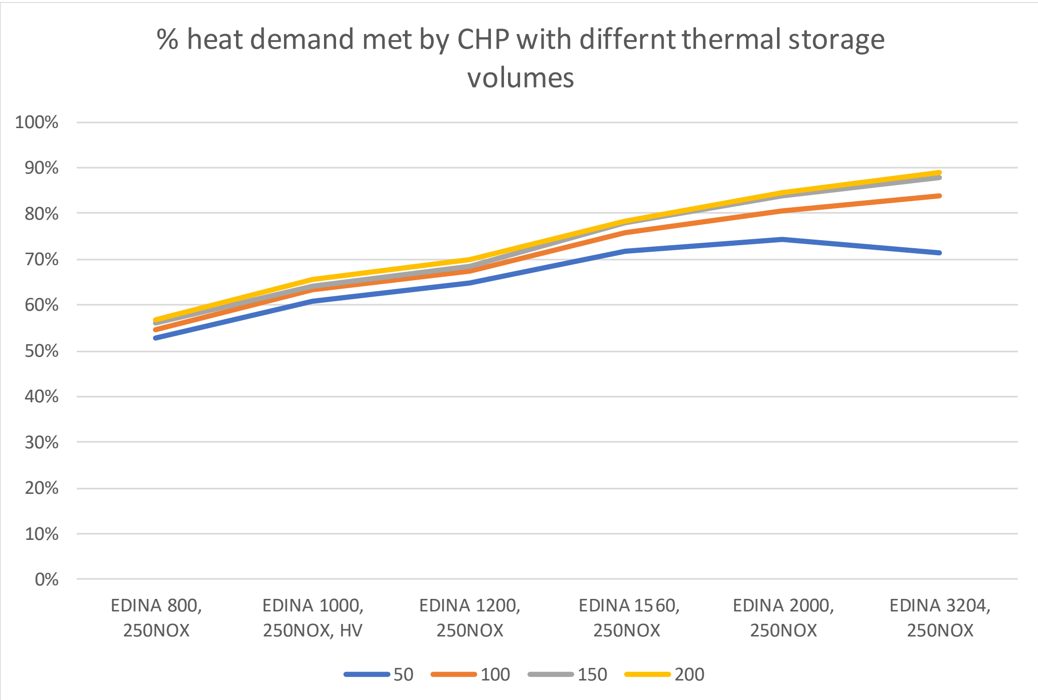
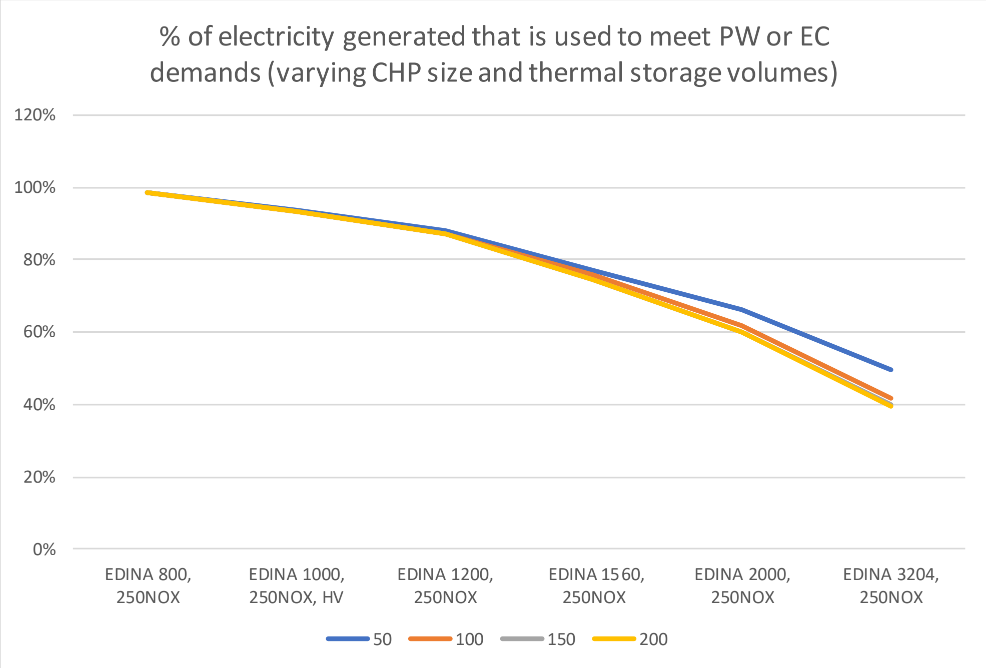


Figure 4-6 - Percentage of electricity generated and used by on-site system



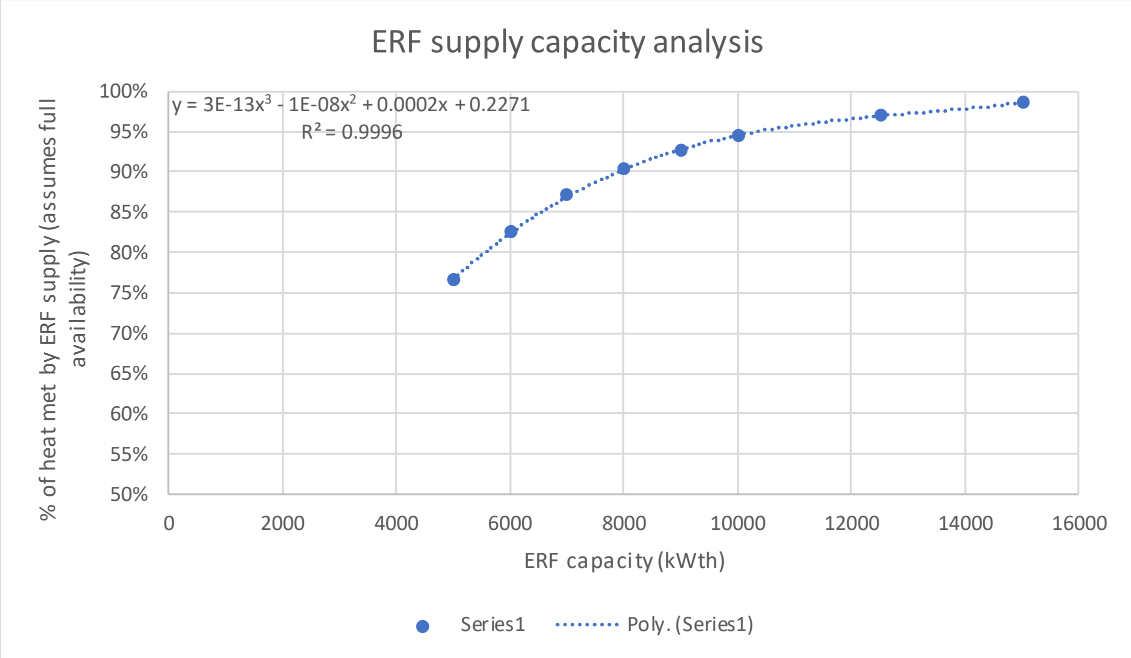
As the CHP size is increased (particularly in line with increasing thermal storage volumes), a greater proportion of the overall heat demand can be met by the CHP unit. However, at the same time, the proportion of the CHP generated electricity that is used by the PW network decreases. The balance of these two factors, and their comparative value give rise to the 'optimised' selection as described above.

4.1 ERF CONNECTION CAPACITY

The sizing of the ERF connection capacity has been carried out on the basis of consideration of the anticipated total annual load of the scheme at full build-out. A base-load only connection is recommended, in order to reduce the diameter of the connecting pipework, and hence the connection costs of this long link, which represents a significant cost factor in the overall scheme.

One initial element of analysis of the ERF connection capacity considered the connection capacity against the percentage proportion of the total demand that the connection could meet. The graph of this relationship is shown below (assuming full availability of ERF heat):

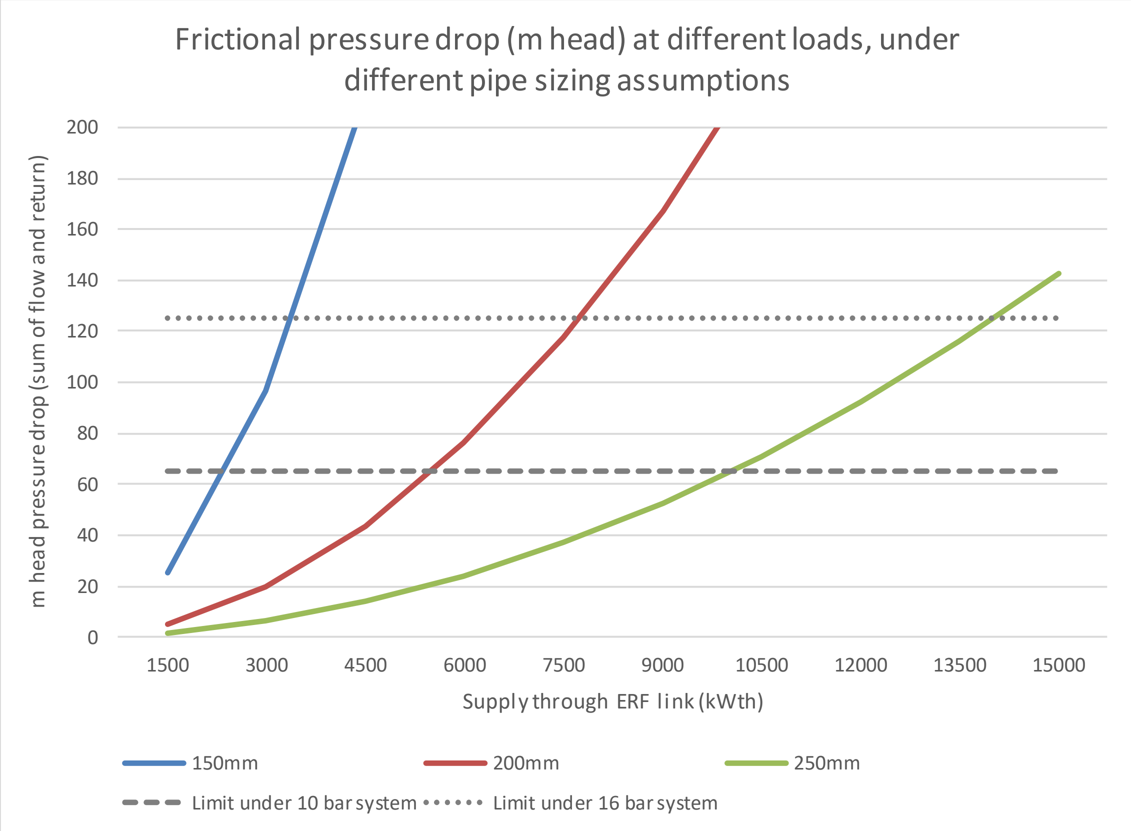
Figure 4-7 - ERF link capacity against potential demand met



The preferred capacity based on this load make-up would be at a point where there are diminishing marginal returns for the additional capacity. In WSP's view, on this graph, this zone lines in the region of 7MW to 9MWth.

Other considerations for the ERF link capacity include the carrying capacity of different diameters of pipework. It would, of course, also be possible to introduce a diameter change along the network link route, but a simplistic analysis of single diameters is shown below:

Figure 4-8 - Pressure drops for ERF link



This graph shows the pressure drop attributed to frictional losses calculated for the different pipework diameters at different load points, with an allowance for bends / fittings, an estimated temperature differential (approx. 30 deg C) based on the customer demands (i.e. the anticipated mix of DHW and space heating), and typical steel pipework parameters.

The graph shows two notional limits (linked to a PN10 or PN16 system) for allowable pressure drop relating to frictional losses (accounting for static pressurisation requirement to account for elevation difference) and an allowance for pressure drop across the heat exchangers at the Wandle Road EC.

The graph illustrates that the 150mm DN pipework frictional losses are too high for either pressure-rating above approx. 3MWth supply. The 200mm DN pipework link can supply approx. 5MWth supply under a 10 bar system, and approximately 7.5MWth under a 16 bar system. This is a close match to the preferred capacity on the graph above (Figure 3-9), and also is a close match to the available 'base load' heat capacity (7.2MWth) available to SDEN under the Viridor contract.

The 200mm DN link would arguably provide sufficient capacity to serve the base-load of the town centre, but there is limited flexibility in this. If further heat were required from the ERF, then at this diameter of pipework, additional pumping stations would have to be installed along the pipework route (requiring space and implying significant cost), or a more complicated pumping arrangement where both flow and return legs were pumped could be considered (potentially complicating connection of customers along the route). Given the significant uncertainty on the exact loads to connect to the network, and also the aspiration to expand the scheme, the use of 200mm DH pipework could be a limiting factor in the future. **For this reason, the use of 250mm pipework for the ERF link is**

recommended is order that there is flexibility retained for the supply of additional volumes of heat.

4.2 THERMAL STORAGE CAPACITY

The capacity and potential benefit of additional thermal storage capacity under the ERF link scenario is primarily contingent upon whether there is a large differential between the day and night-time cost of heat from the ERF, and the degree to which the use of thermal storage might enable SDEN to purchase more 'base load' rather than 'supplemental' heat from Viridor. For the majority of the year, the connection capacity will cover the majority of load fluctuations, and store size suggested to match the Core scheme CHP will allow for a degree of 'buffering' of supply.

However, if there were a very significant differential between night and day heat tariffs the use of thermal storage would allow the Croydon EC to purchase larger volumes of heat at night (when heat would be assumed to be cheap) and redistribute this during the day-time period, thereby avoiding the need to purchase heat at the higher day-time tariff. This would increase operational margins, but at the capital cost of additional storage volume.

Thermal storage vessel capacity will also be useful to ensure that low levels of summer-period demand can be met without significant temperature drop along the ERF link. At very low flow rates, the temperature seen at the Wandle Road energy centre could significantly degrade, and the availability of thermal storage will allow an appropriate minimum flow rate to be maintained on the link to ensure adequate temperature supply to the energy centre.

It is WSP's view at the current stage of project development that the commercial structures of the heat offtake are potentially flexible through time, and that at the very least allowance should be made in designs for the inclusion of additional thermal storage volume over the 'core' scheme design. The current approach to the development of the energy centre has sought to maximise the volume of thermal storage capacity to retain flexibility for the system, although it is not possible to quantify the benefit of this readily at this stage.

5 BASIS OF DESIGN

5.1 INTRODUCTION

This section provides an overview of the Energy Centre and wider scheme requirements that have been costed in the project.

5.2 OVERVIEW

A new Energy Centre facility shall be provided to house the plant and equipment serving the proposed District Heating (DH) network.

At Day 1, the primary heat source for the DH network Low Temperature Hot Water (LTHW) system shall be a gas fired Combined Heat and Power (CHP) unit, with top-up and standby heat provided by gas fired boiler plant.

Thermal storage capacity shall be provided to extend the run time of the CHP plant and reduce the heat supply requirement from the boiler plant.

A heat supply from the Beddington ERF is due to be installed in 2025 to provide the base load heat supply for the DH network. When the heat supply from the EfW facility is available, this shall take precedence over the CHP unit (except if electricity prices dictate that CHP operation is preferable).

The DH network shall be designed to operate with flow and return temperatures of 95/65 deg C at peak, reducing to 85/55deg C during the summer. The EfW heat supply will be delivered at a maximum temperature of 95degC. The heat interface shall therefore be designed for a maximum DH network side temperature of 90degC, allowing a 5degC flow side approach temperature. The boiler plant shall be used to achieve the required 95degC flow temperature of the DH network (towards the town centre) at peak times when the boiler plant will be required to run to provide supplemental heat.

5.3 ENERGY CENTRE BUILDING

It is proposed that the energy centre building shall comprise a two-storey steel portal frame structure with mono-pitched roof and insulated composite cladding panels fixed to the façades and roof.

A stair core shall provide access to the first floor and roof levels. Separate fire escape may be required and this should be checked as designs are taken forward.

The following internal rooms shall be provided:

- Ground floor main plant space housing the boiler plant and containerised CHP unit
- First floor plant space housing the DH primary pumpset, EfW heat interface and ancillary mechanical services equipment
- HV switchroom
- LV switchroom
- Transformer room
- Control room
- WC / shower room
- Ground & first floor fire lobbies

The electrical switchrooms shall comprise blockwork partition walls with lightweight timber/plasterboard lid at a minimum slab to soffit height of 4m.

The control room & WC/shower room partition walling shall be of a lighter weight construction. The minimum fire rating of the partition walling and internal soffits shall be 1hr.

External double door access shall be provided on the north facade for general plant movement from the main ground floor plant area. Secondary means of escape shall be provided on two opposing facades to suit the maximum permitted fire escape distances.

Demountable ventilation louvres / facade panels shall be provided at ground floor level for removal of the CHP and boiler plant.

A removable access hatch shall be provided in the first-floor slab to allow plant replacement from first floor level. A permanent lifting beam shall be installed above the opening to facilitate plant movement to ground level.

Electrical DNO substation and gas pressure reduction station kiosks shall be provided adjacent to the main Energy Centre building.

An illustrative outline design of the Energy Centre, the indicative preferred network routes for the town centre and ERF link are shown below:

Figure 5-1 - Energy Centre location / outline

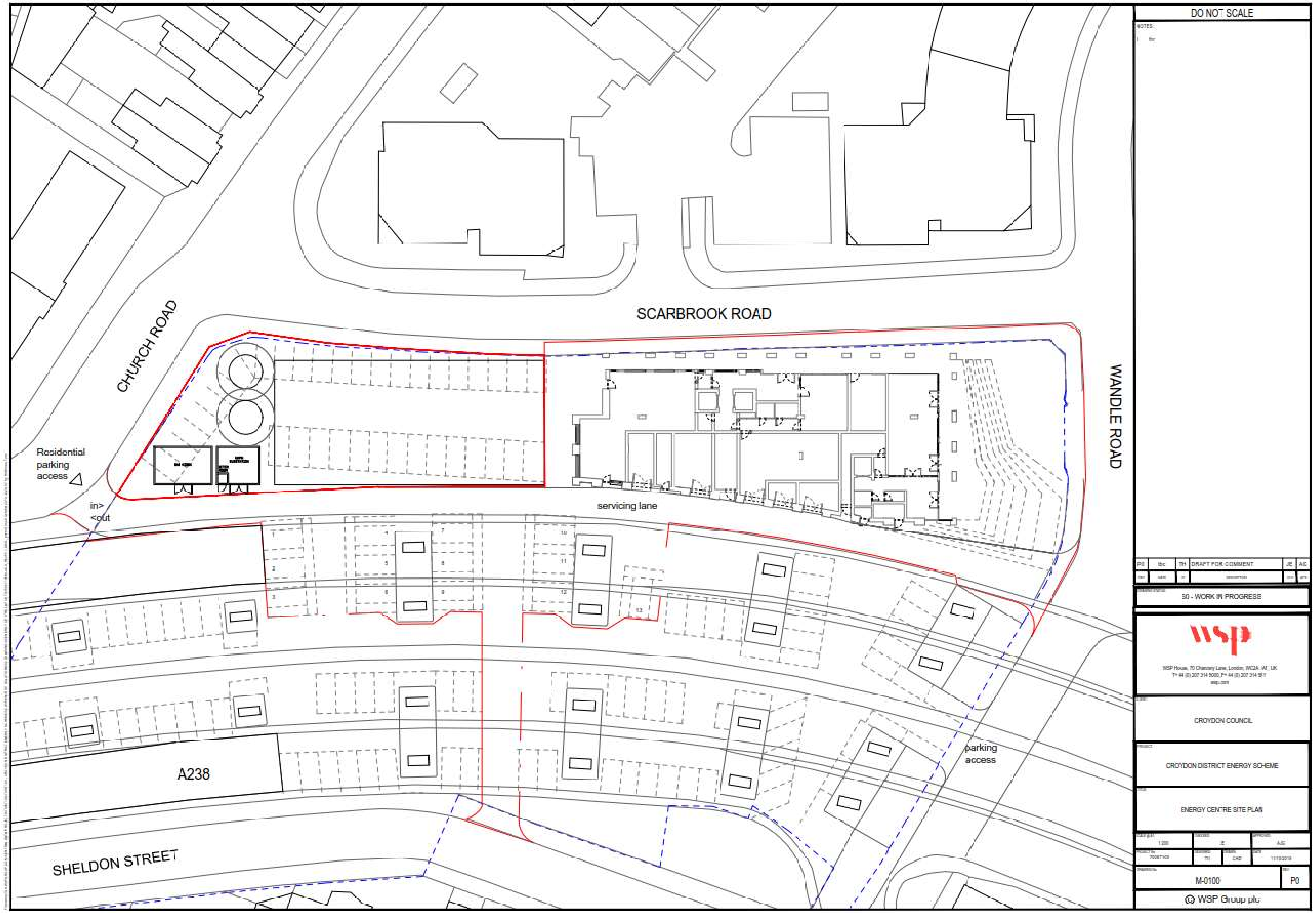


Figure 5-2 - Energy Centre ground and first floor indicative layouts

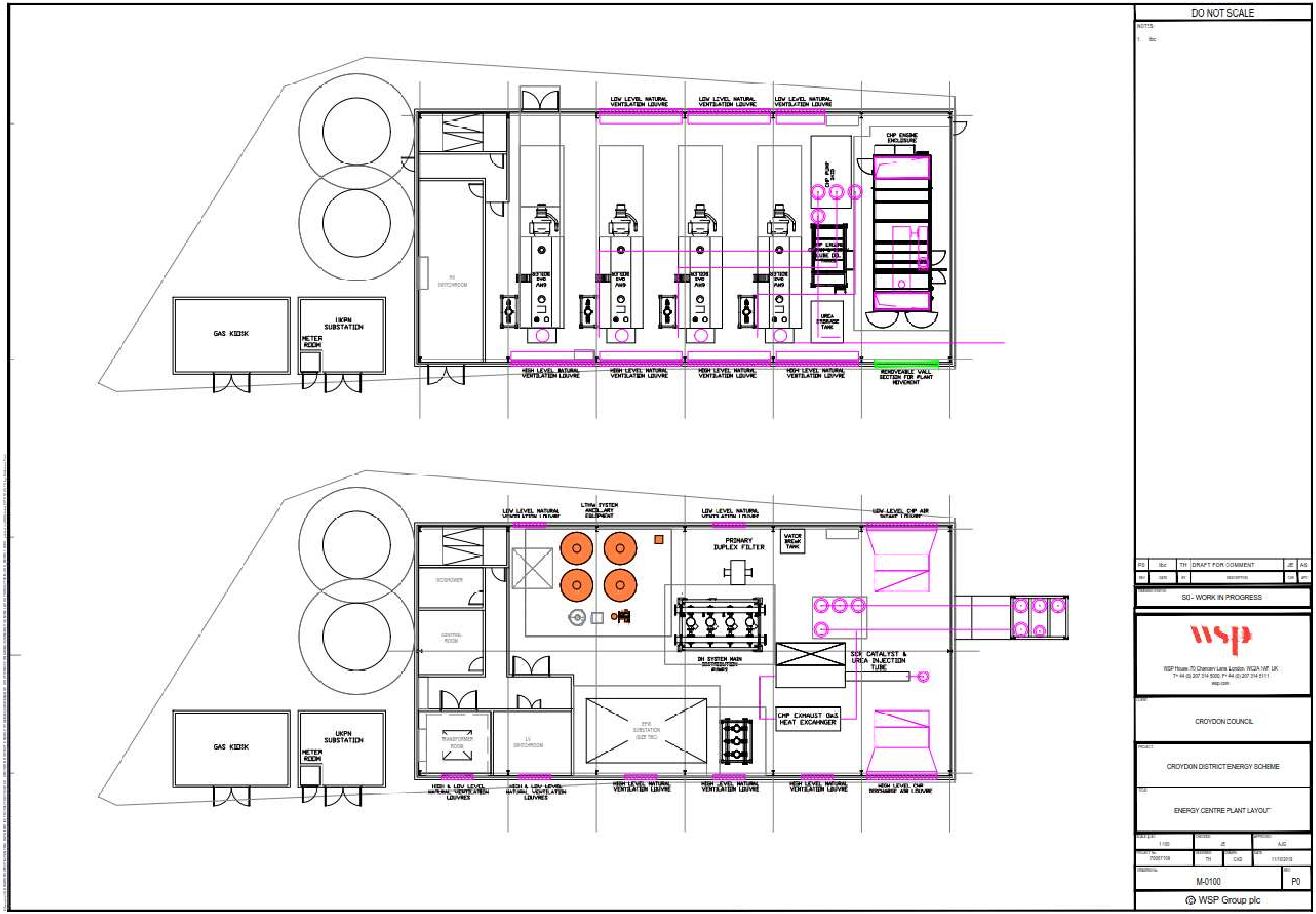


Figure 5-3 - Energy Centre indicative flue arrangement

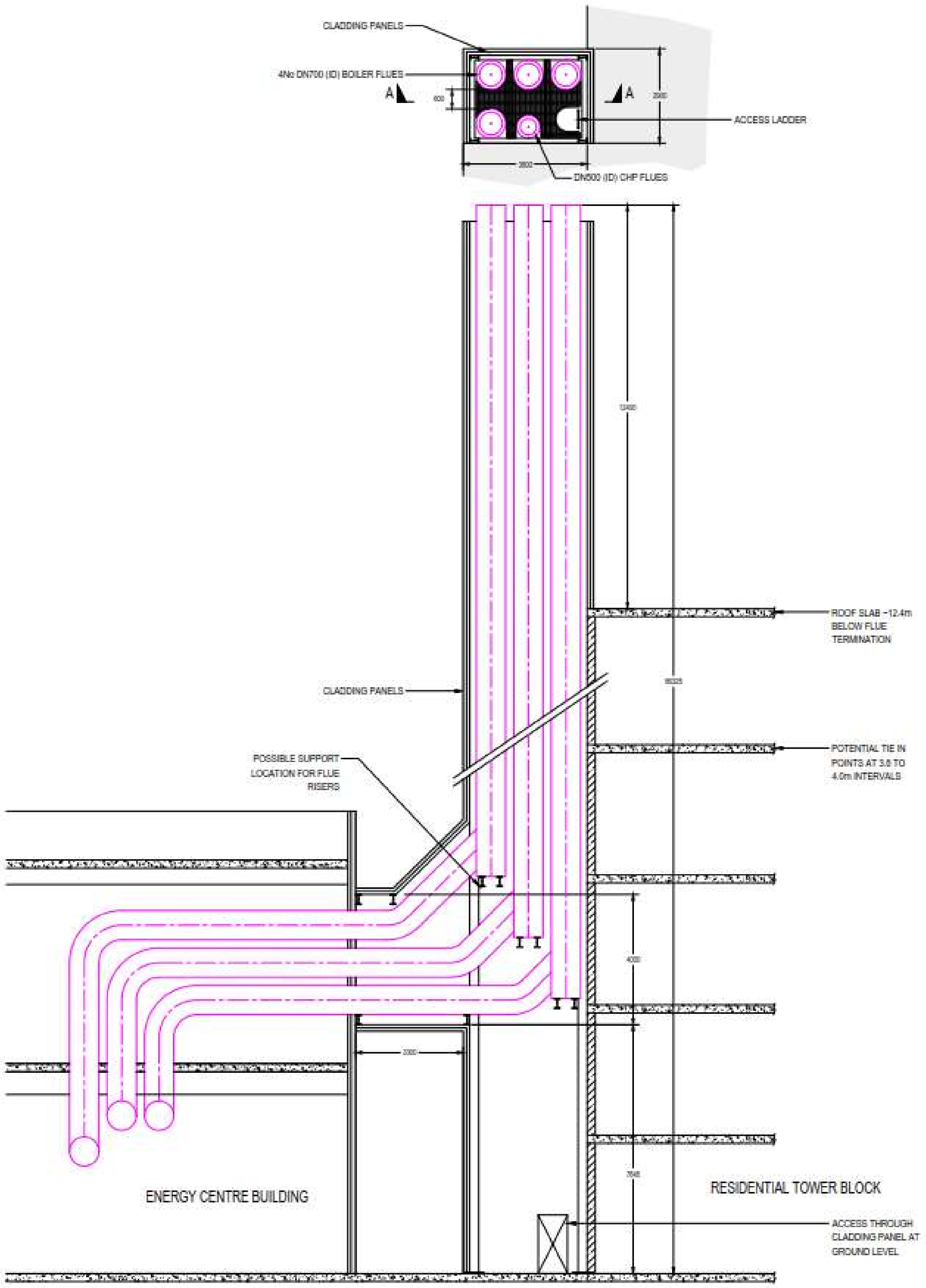


Figure 5-4 - Town Centre proposed DH route

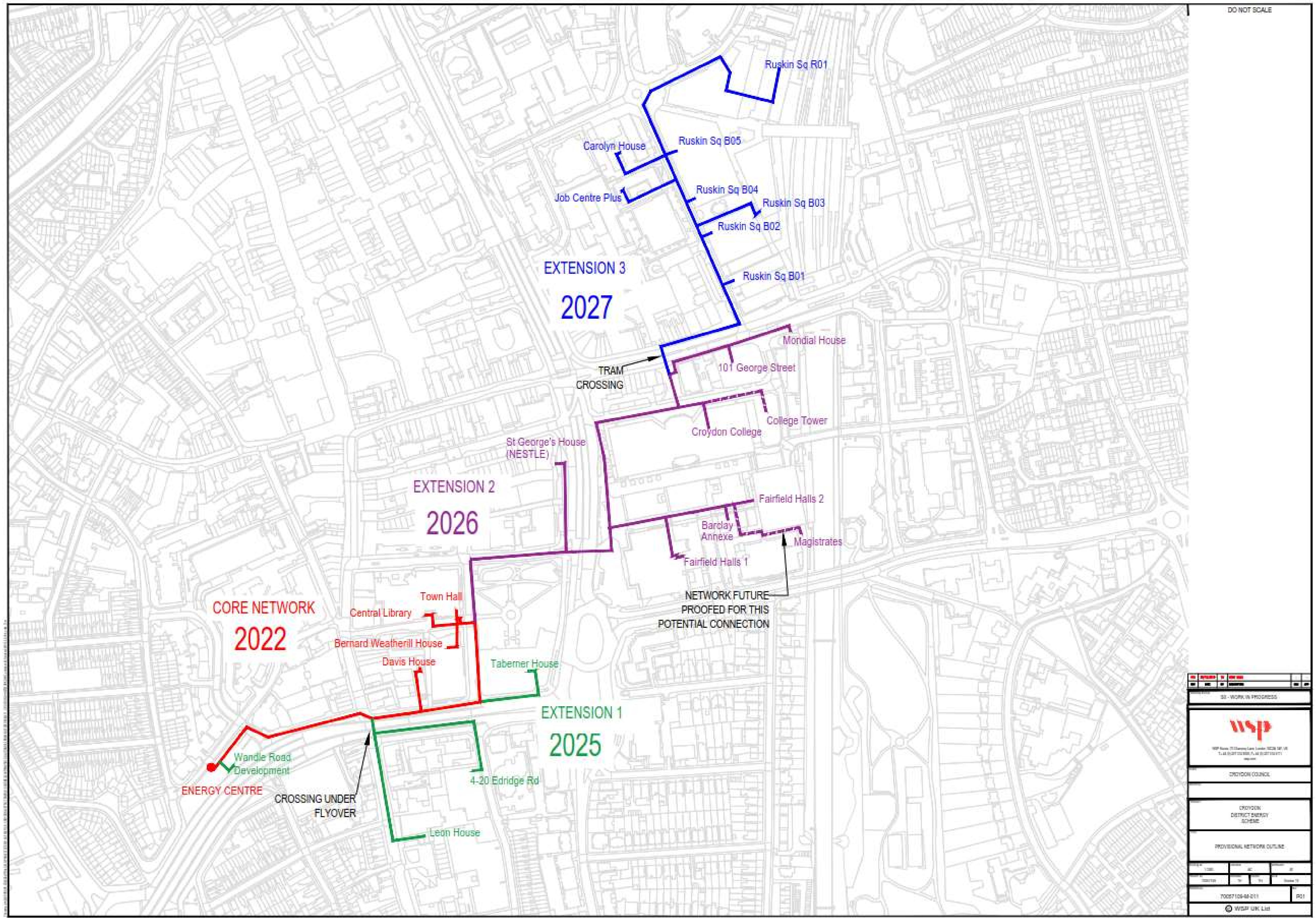


Figure 5-5 - ERF link DH route as costed

WSP has considered a number of alternative ERF link routes, some of which are discussed in report WP1C. The ERF link shown in the drawing above (Figure 5-5) is the route costed as part of this report, which has been selected as it is considered that there is an appropriate level confidence that this route is deliverable, based in particular on the tram and railway crossings required.

WSP has elicited views from a wide range of specialists both within WSP (rail / highways / tunnelling / bridges) as well as external contractors (thrust boring / DH installation) in order to evaluate an appropriate approach to network rail crossing at this stage of project development. The key views of the crossing can be summarised as follows:

- There is always an element of risk and uncertainty until the full BAPA (Basic Asset Protection Agreement) process has been completed. This process is lengthy and costly, and hence must reside outside of the scope of this study. The anecdotal advice from various parties is to allow for more than a year of liaison with NR to complete this process.
- Different levels of oversight and concern apply to different NR lines, and hence experience in one location might not necessarily be directly transferrable to other locations. In some locations thrust boring has been allowed to be carried out with trains operating at a reduced speed. Other sites have had to wait for line closure in order to carry out works[6].
- In general, thrust boring is perceived to be a preferred approach to UTX (under track crossings) as this technique gives rise to relatively little heave and settlement of the ground, and hence reduced risk of disruption to NR services.
- NR only start to engage meaningfully on the BAPA process when they have received a fee.
- NR strongly deters UTXs that pass under existing level crossings (one of the reasons that the proposed WSP ERF link route avoids the Beddington Lane tram stop junction, where it would be difficult to avoid crossing under the level crossing).
- NR is, of course, keen to ensure that there is no impact on the structural integrity of neighbouring infrastructure. This is the reason that close to the Jubilee Bridge (Roman Way) the cost ERF link route is proposed between Cornwall Road and Lower Church Street (and not adjacent to the Roman Way bridge itself)

A further discussion has also been held with a member of the Council dealing with the provision of power to the Westfield site. It is understood that the reinforcement required for Westfield is a new extra high voltage (EHV) supply, that will also have to cross the railway and tram in a similar location to the proposed DH route. The Westfield EHV reinforcement route is currently proposed at the south-east corner of

[6] NB as a non-statutory utility, district heating pipework projects do not have the statutory right to demand a railway closure. Hence DH installation works must in some locations wait to 'piggy-back' on the line closures requested by third parties to allow for works to be carried out.

Wandle Park, via a thrust-bore crossing, leading onto Rectory Grove. If the Croydon DEN project progresses further, then it is strongly recommended that the Council tries to combine the EHV and district heating requirements in a single civil works contract. This would both potentially allow overall cost savings to be seen across both projects, and equally, could also reduce the overall highways disruption that the two projects might cause. If this combined approach is possible, then a significant section of the potential route could be shared between the two projects. Based on WSP's understanding of the proposed UKPN EHV reinforcement route, under this combined approach, the following overall network route (Figure 5-6) or a variant of this, would be recommended. However, it should be noted that this route includes a further tram crossing at the western edge of Wandle Park, where WSP has not had the opportunity to investigate UTX options. However, if this route can be delivered, this would allow the project to benefit from accessing additional demands in the Purley Way area.

Figure 5-6 - Alternative potential ERF link route - if combining with UKPN EHV route (UKPN EHV approximate estimated route shown in orange)

5.4 ENERGY CENTRE PRIMARY PLANT

The Energy Centre shall house the following plant and equipment:

- Packaged gas engine CHP unit complete with intake and discharge ventilation systems, bulk lubrication oil storage tanks, exhaust gas heat recovery unit and Selective Catalytic Reduction (SCR) equipment for NOx emissions reduction
- Gas fired boilers and associated shunt pumps
- Energy from Waste heat interface and associated shunt pumps (installed at a later date when the EfW heat supply is available)
- District heating pump set
- Ancillary lthw plant
- Natural gas supply system
- Mains cold water system
- Welfare area mechanical ventilation, space heating and domestic hot water (DHW) systems
- HV & LV power distribution systems
- Plant control system

The thermal storage vessels shall be installed external to the energy centre building. The current design includes 2No. 100,000l thermal storage vessels connected in series.

5.4.1. CHP

The CHP shall be a containerised 1.2MW unit comprising a gas engine and High Voltage (HV) alternator.

The CHP LTHW heat recovery system shall be designed to achieve a flow temperature of 95degC. The LTHW circuit shall include a duty/standby shunt pump located on a skid external to CHP container.

Attenuated air intake and discharge ventilation systems shall be ducted to first floor level weather louvres with the air intake at low level on the north facade and the discharge at high level on the south facade.

The CHP exhaust system shall comprise primary and secondary silencers and an Exhaust Gas Heat Exchanger (EGHE).

A dry air cooler (DAC) shall be located at roof level to provide heat rejection from the CHP low grade heat rejection circuit. As a lightweight roof construction is proposed, the DAC shall be installed on supporting feet that spread the load across a larger area. Access for major maintenance operations to be developed as designs are progressed.

2No 3000l bulk clean and waste lubrication oil tanks shall be provided local to the CHP unit. An external oil fill/drain cabinet shall be installed on the south facade. During filling/draining of the bulk tanks, it is proposed that the delivery tanker/vehicle is located on the service road to the south of the Energy Centre building.

The GLA document proposes a NOx emissions limit of $95mg/Nm^3@5\%O_2$ for CHP plant. To achieve this NOx emissions rate, Selective Catalytic Reduction (SCR) equipment will need to be installed in the CHP exhaust system upstream of the EGHE. The Energy

Centre layout makes allowance for this equipment at first floor level. The SCR equipment includes the following items:

- Urea injection tube and catalyst installed within the exhaust
- Bulk urea storage tank (size to be confirmed in detailed design phase)
- Urea fill cabinet located on the south facade of the building
- Urea day tank and compressed air system for urea injection

During filling of the bulk urea tank, it is proposed that the delivery tanker is located on the service road to the south of the Energy Centre. Transport planning to be carried out at next stage of design.

5.4.2. EFW INTERFACE

The EfW heat interface (at the Wandle Road Energy Centre) shall comprise 3No. skid mounted gasketted plate heat exchangers each sized for 33% of the total design duty of 8MW.

The heat interface shall be designed for the following operating temperatures:

- EfW flow & return: 95/70
- DH network flow & return: 90/65

An LTHW shunt pump set shall be provided comprising 3No duty pumps with each pump sized to match the capacity of a single plate heat exchanger.

Multiple plates and pumps are proposed to improve the turndown of the heat interface and to provide a level of resilience if one of the plates needs to be taken off line for maintenance. If the plates are designed for a 10% turndown, the EfW interface will be capable of delivering a minimum load of 270kW. Below this load it would be necessary to buffer the thermal stores and, once buffered, disable the EfW interface and discharge the heat from the thermal stores.

The heat substation shall include a primary side differential pressure control valve (DPCV), modulating 2-port control valves on the primary side of each plate and 2-port shut-off valves on the secondary side of each plate to allow the substation to be operated in a duty/assist/assist configuration.

5.4.3. BOILERS

24MW of boiler capacity shall be provided with an N+1 level of resilience. The design proposal comprises 4No. boilers of 8MW capacity each to achieve this.

The boilers shall be steel shell and tube boilers with a fully modulating pressure jet burner. A backend protection circuit shall be provided to protect the main boiler shell from thermal shock and prevent the formation of condensation.

The LTHW system shall be capable of operating the boilers at very low loads without cycling the burners. To achieve suitable boiler run time when only a small amount of top-up heat is required it is proposed that boilers would be permitted to partially buffer the thermal stores. The boilers will then be disabled when this charge level is reached. If the load on the boiler exceeds the minimum turndown of the boiler, the boiler shall continue to run but shall be prevented from charging the thermal store.

5.4.4. FLUES

The boiler and CHP flues shall be routed to high level via the adjacent residential development, which is due to commence construction at the time of writing. It is proposed that the flues shall exit the Energy Centre building at first floor level and span the external walkway between the Energy Centre and the adjacent residential building. The flues shall then rise vertically supported within a structural steel support frame. An access ladder shall be provided within the footprint of the structural support steelwork to provide access for inspection of the flue system. Intermediate platforms shall be provided regular intervals. The steelwork structure shall be enclosed with cladding panels. The type and colour of the cladding panels shall be agreed with the Architect responsible for the residential building; a brick effect cladding panel has proposed during early discussions with the Architect, however a lighter cladding system, such GRP, may be more cost effective due to the reduce weight.

5.4.5. PLANTROOM VENTILATION

The main boiler room shall be naturally ventilated to provide combustion and cooling air requirements. Acoustic louvres shall be installed at low level on the north facade and at high level of the ground floor level on the south facade to provide a cross flow of air across the plant space. The louvres shall be sized in accordance with IGE/UP/10.

Natural ventilation shall also be provided in the following areas to limit the temperature rise:

- First floor plant area
- Transformer room
- HV & LV switchroom

5.4.6. DH PUMPSET

The primary district heating pumpset shall comprise N+1 main pumps capable of delivering the design flow (equivalent to a future load 24MW at 30K deltaT). A smaller "jockey" pump shall be provided to ensure efficient operation at low loads. The sizing of the jockey am main pumps shall be optimised to maximise pumping efficiency across the full load range.

Differential pressure monitoring shall be provided across the network to ensure that suitable pressures are being achieved. The index run differential pressure reading shall be used for the pump speed control.

5.4.7. LTHW ANCILLARY EQUIPMENT

The LTHW System ancillary equipment shall include the following:

- Pressurisation and expansion equipment
- Vacuum degassing
- Inline and side stream filtration equipment
- Chemical dosing equipment
- Corrosion rate monitoring
- pH monitoring

The pressurisation and expansion plant shall a spill and fill type system to control the system static pressure to within +/-0.25bar of the setpoint pressure.

A bunded chemical enclosure shall be provided to house the dosing chemicals. A dosing pump shall be installed to inject the chemical into the LTHW system at the required dose.

5.4.8. GAS SUPPLY SYSTEM

The gas supply to the boiler plant shall be medium pressure. All gas supply pipework shall be fully welded to minimise potential leakage points. The incoming Energy Centre gas supply and the supply to each individual boiler shall be separately metered. All gas meters shall include temperature and pressure correction to ensure accurate recording of gas usage.

A slam-shut valve shall be located at the boundary of the energy centre for the isolation of the Energy Centre gas supply in the event of a fire or gas leak.

5.4.9. COLD WATER SYSTEM

The cold water system shall be provided to serve the following requirements:

- Make-up water for the DH network
- Plantroom wash down (via BIB tap)
- Welfare facilities

Each supply shall be separately metered and the readings logged on the BMS.

The DH network make-up water shall be softened using an ion exchange water softener. A break tank and booster set shall be provided if required to deliver the required supply pressure. Should the mains cold water supply pressure be deemed sufficient, alternative means of back-flow shall be permitted, subject to approval by the water authority.

5.4.10. HV DISTRIBUTION SYSTEM

The electricity supply to the energy centre shall be at 11kV HV. We have considered two incoming feeders to provide N+1 resilience to the energy centre. Each feeder shall be capable of accepting the full load, including the private wire loads.

The DNO intake room equipment selection will be subject to UKPN's final design but it is likely to be a 5 panel 11kV HV switchboard.

Refer to the Single Line Diagram (Figure D-1) for typical arrangement.

A customer side private wire HV switchboard is included in the design. We have allowed interlocking between two incomers to avoid the parallel operation of two incoming feeders. The HV switchboard shall also include provision for two CHP connections and energy centre parasitic load transformers.

The HV Switchgear system as shown in the single line diagram shall be provided complete with:

- ✓ HV panels for indoor applications
- ✓ Vacuum circuit breaker
- ✓ Circuit breakers shall be equipped with circuit earthing switches.
- ✓ DC supply for controls including appropriately rated battery and charger in cubicle for each switchboard.
- ✓ Facilities for local and remote operation

- ✓ Main incomers and transformer feeders
- ✓ CHP connection feeders
- ✓ Voltage transformers
- ✓ Current transformers
- ✓ Busbar earthing
- ✓ Auxiliary switches
- ✓ G99 and other protection relays
- ✓ Meters
- ✓ Anti-condensation heaters
- ✓ All system safety interlocks
- ✓ Control and monitoring interfaces
- ✓ Emergency Power Off (EPO) buttons with a lift up covers
- ✓ BMS interfaces for status monitoring and meters.

It should be noted that the final 11kV CHP connection arrangement is supplier specific and any CHP supplier specific requirements shall be integrated into the design during the next design stage/within the CHP package, such as localised HV circuit breakers for CHP.

A 11kV private wire with open ring arrangement is also considered to avoid the parallel operation of incoming feeders.

5.4.11. LV DISTRIBUTION SYSTEM

All plant and equipment within the Energy Centre (excluding the CHP output) shall operate at low voltage (415V no load).

Two numbers of 11kV/415V transformers shall be provided to step down the incoming HV supply voltage to 415V (no load). The transformers shall be typically KNAN hermetically sealed type transformers.

The transformer rooms shall be typically mechanically ventilated. The transformer shall be also monitored for oil and winding temperature via BMS. An over temperature alarm and tripping shall be provided.

The Energy Centre equipment and services shall be fed either directly from the LV Switchboard or from secondary Power Distribution Panels (PDPs) and distribution boards (DBs).

The LV power supplies to various mechanical loads shall include but not limited to the following:

- Water treatment plant
- Ventilation plant
- LTHW plant
- Distribution pumps
- Water conditioner
- Economiser pumps

- Weather compensation pumps
- Pressurisation
- Sidestream filters
- DB for general lighting, emergency lighting and small power
- DB for external lighting
- UPS distribution board; and
- DNO room distribution board.

5.4.12. BUILDING MANAGEMENT SYSTEM

The mechanical and electrical services plant and equipment shall be controlled and monitored by an open protocol Building Management System (BMS).

The BMS shall provide the following key control functions:

- Sequencing of the CHP, EfW heat interface and boiler plant based on thermal store charge level
- EfW interface temperature control
- Boiler and EfW shunt pump sequencing and speed modulation in line with demand
- DH pump sequencing and speed control
- Fault and status monitoring of all plant and equipment

Metering shall be provided in the following locations as a minimum, with the meter output linked to the BMS for live indication of operational parameters and long-term operational performance assessments:

- Heat metering:
- Primary DH network
- Each heat generating plant item, including the boilers, CHP and EfW interface
- Gas supply to each individual boiler and CHP
- Overall Energy Centre gas supply
- HV and LV power supplies for assessment of CHP import/export and energy centre parasitic requirements

A BMS server shall be installed within the Energy Centre control room to run the headend supervisor software and for historical data logging (minimum 10 year storage capacity). Touchscreen user displays shall be installed within the control room and in each control panel.

The BMS network shall be connected to the internet for remote monitoring and shall be configured to issue text and email alerts for all necessary alarms (alarm list to be agreed with the Client). Remote access shall be via web browser.

The BMS shall be configured to generate automatic reports on the operational performance and efficiency of the Energy Centre plant and systems. This shall include but not be limited to the following key items:

- Average CHP electrical and thermal efficiency in period
- Average boiler efficiency in period
- % annual heat demand met by CHP and EfW sources
- Parasitic electrical demand as a % of total heat demand in period

- Network heat loss (from Energy Centre to customer heat interface) as a % of customer heat demand in period
- Carbon savings compared to a base case (calculation methodology to be agreed with the Client)

Reporting period to be daily, weekly, monthly or yearly.

5.4.13. ANCILLARY ELECTRICAL SERVICES

Ancillary electrical service systems shall include the following:

- Earthing and bonding
- Lighting (normal, external, emergency)
- Small power
- Fire Alarm system
- Natural gas & carbon monoxide detection system
- Security
- UPS (serving the fire, gas and ammonia detection and alarm systems, security systems, small power in control room, leak detection and control system/BMS.)
- Lightning protection system
- Electric heating in switchrooms.

5.4.14. WELFARE FACILITIES

A dual plate indirect heat interface unit served via the district heating system shall be used to provide space heating and doemstic hot water services to the Control Room and welfare areas.

A small heat recovery ventilation unit shall be installed for fresh air ventilation to the Control Room providing a minimum of 12l/s per occupant in accordance with Building Regulations Approved Document F. The ventilation system shall be activated via PIR to minimise power usage when the Energy Centre is unoccupied.

Extract ventilation shall be provided for the WC and shower facilities providing a minimum air change rate in accordance with Building Regulations Approved Document F. The extract system shall be enabled and disabled via the local lighting circuit and be complete with run-on timer to provide a minimum 30 minute run time.

5.5 UTILITIES

5.5.1. POWER

The power supply to the Energy Centre shall be derived from a new DNO substation as described above.

HV cabling shall be routed below ground from the DNO substation to the adjacent HV switchroom at ground floor level within the Energy Centre.

5.5.2. GAS

The gas supply to the Energy Centre shall be a medium pressure supply of nominally 100mbar (final requirements to be determined during the detailed design phase). A utility Pressure Reduction Station (PRS) shall be housed within a separate enclosure (adjacent to the DNO electrical substation). The enclosure shall be designed to withstand a gas explosion within the enclosure.

Buried PE gas pipework shall be routed from the PRS to the Energy Centre.

5.5.3. WATER

A metered mains cold water supply shall be provided to the Energy Centre. The supply, including utility meter, shall be terminated at the site boundary by others. The Contractor shall be responsible for connecting onto this buried supply and extending into the Energy Centre.

5.5.4. TELECOMS

A telecoms connection shall be provided to the Energy Centre. This shall comprise at a minimum a broadband connection for remote access of the Building Management System, security systems, and a dedicated connection for remote monitoring of the CHP unit.

5.6 PLANNING CONDITIONS

5.6.1. ACOUSTICS

It envisaged that planning condition compliance will require noise breakout from the Energy Centre to be no greater than the existing background noise level at the nearest residential receptors (NSR 2 on the opposite side of Scarbrook Rd from the Energy Centre, and NSR 3 within the Wandle Rd development, south-western facade).

A background noise survey has been undertaken by WSP for the Wandle Rd residential development. This has identified a worst-case background noise level. This figure forms the basis of the acoustic treatment proposed for the Energy Centre. Final noise criteria to achieve planning condition compliance shall be determined during the detailed design phase. This shall include additional background noise surveys as required.

The proposed acoustic treatment includes the following. However, final requirements shall be determined during the next stage of the design:

- Select quieter boiler burners, to achieve a maximum sound pressure level of 70 dBA at 1 metre.
- Install 4 no. attenuators to the boiler flue exhaust paths.
- Install 1 no. attenuators to the CHP flue exhaust path.
- Install 2 no. attenuators to the CHP air intake and exhaust paths (in addition to the CHP
- enclosure).
- Install acoustic louvres to all natural ventilation openings on the façade of the energy centre.
- Install an acoustic enclosure to contain noise from the rooftop CHP dry air cooler. The enclosure may be constructed using acoustic louvres.
- Install acoustically absorptive lining (Class A performance) to control the reverberant noise levels within the energy centre. The lining should be applied to the total soffit surface area of both the ground and first floors (approximately 870m2 total coverage).

The acoustic study has shown that is it challenging to meet the night-time limits, and hence it may be necessary to introduce restrictions to plant operation at these times, alongside the mitigation measures outlined above.

5.6.2. NOX EMISSIONS

A high-level dispersion study has been carried out to determine the required flue stack height to achieve acceptable NOx emissions concentrations at the nearest receptors. A copy of this report is included within the appendices to this document.

The following Nox emissions rates and operating parameters have been modelled for the CHP and boiler exhaust at systems:

Table 5-1 – Modelled emissions parameters for NOx assessment

Parameter	**Proposed NO_x emission concentrations[a]**		**NO_x emission concentrations meeting GLA standards[b]**	
	1.2MW CHP	**6MW Boiler**	**1.2MW CHP**	**6MW Boiler**
Stack diameter (m)	0.5	0.7	0.5	0.7
Exit temperature (°C)	120	200	120	200
Exit velocity (m/s)	15	10	15	10
Nitrogen Oxides emission rates[c] (g/s)	0.2228	0.1362	0.0667	0.0847

a. Boiler 70mg/kWh (dry gas and 3% O2), CHP 250mg/Nm3@5%O2.
b. Boiler 40mg/kWh (dry gas and 0% O2), CHP 95mg/Nm3@5%O2
c. Emission rates at full load

The results of the study show that a minimum stack height of 87m (4m above the highest parapet level of the adjacent residential development) will be required to achieve a suitable level of dispersion with the worst case NOx emissions rates. If the NOx emissions rates are reduced to the GLA Guidance compliant figures, the stack height can be reduced to 85m (2m above the highest parapet level of the adjacent residential building).

5.6.3. STRUCTURAL ELEMENTS

A brief structural report has been compiled for the proposed energy centre structure, in order to provide confidence that the proposed open spans and general building design appears feasible from a structural perspective. This report is provided in the appendices to this document.

The proposal is for a two-storey structure to house the required scheme plant. The recommendation is for CFA piles and a suspended floor slab. The superstructure is proposed as a braced steel frame, and a mono-pitch roof.

6 CASHFLOW ANALYSIS

6.1 OVERVIEW

The capital cost breakdown for the scheme and sources of cost estimates are presented in report WP1E. This report therefore only presents summary figures of the capital costs to provide an indication of the overall areas of capital spend requirement.

This section of the report summarises the overall cashflow position estimated for the project, based on a number of factors, which are outlined in the sections below. These factors are:

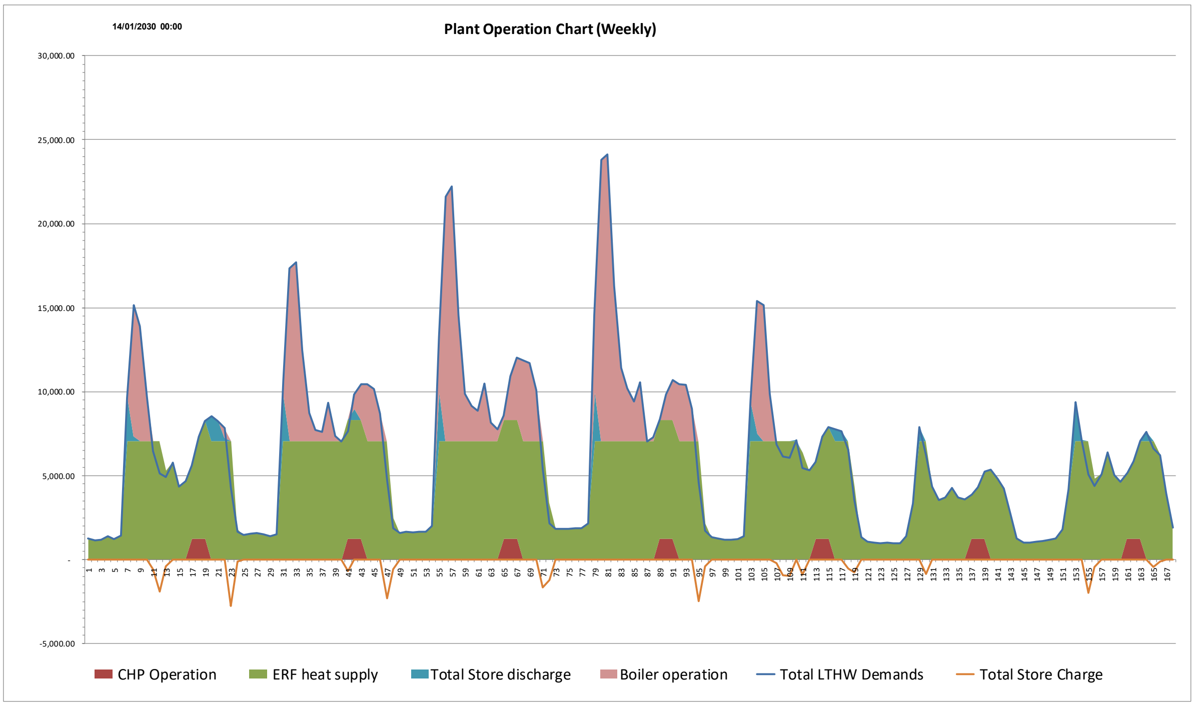
- Capital costs
- Maintenance costs
- Replacement costs
- Primary energy and billing costs
    - Fuel (gas)
    - Heat from ERF
    - Metering and billing
- Heat sales income
    - Variable and standing charge elements
- Private wire sales income
    - Variable and standing charge elements
- Connection charges (heat and power as applicable)
- Grant support

6.1.1. ENERGY BALANCE MODELLING

The cashflow analysis is built upon the energy balance modelling of the scheme that has been carried out at hourly resolution for the different years of the project load build-up. The energy balance modelling assumes that the ERF heat will be supplied in priority at all times except at notional 'red-DUOS' periods when it is anticipated that electricity sales prices may be high (depending on contract structures).

The following graph illustrates the modelled operation of the system in a winter month during a period (e.g. 2030), when it is assumed that the both CHP and ERF are operating.

Figure 6-1 - Illustrative operational chart



The overall annual energy balance figures upon which the cashflow modelling is based are shown in the appendices to this document.

6.2 CAPITAL COST

The capital cost elements of the scheme can be summarised as follows (line items include 10% contingency, except DH elements, where 5% contingency is applied):

Table 6-1 – High-level capital cost summary

Category	£,000
EC Building and Civils	£2,078
Energy Centre electrical works	£1,122
Energy Centre mechanical plant	£5,740
Substations (heat)	£2,097
Substations (elec)	£1,627
DH network in Town Centre	£5,789
Design, prelims, Overhead and profit, PM	£3,780
Testing and commissioning	£330
Subtotal	**£22,564**
ERF link costs	£10,335
Total with ERF link	**£32,899**

6.3 PRIMARY ENERGY COSTS

The primary energy costs for the scheme have been calculated on the basis of the modelled annual energy balance and the following price assumptions for fuel / heat.

Table 6-2 – Primary energy cost assumptions

	Unit cost (p/kWh) 2018 prices unless stated	Source notes
Gas to Wandle Rd EC	2.25	QEP, 2018 annual value excl CCL, medium consumer, table 3.4.1, QEP Sept 2019 (assumed supply is CCL exempt based on CHPQI for CHP operation)
Elec import to Wandle Rd EC	10.39	Assumed that import could be at a 5% reduction under the average price seen by the existing council building cluster to be connected to PW network
Heat purchase from SDEN	0.5	Estimated 2019 price – awaiting response from SDEN

As is noted elsewhere in this study, the project will be sensitive to the price assumption adopted for the purchase of heat from SDEN, and this will be an important variable for negotiation as the project proceeds.

6.4 MAINTENANCE COSTS

Maintenance costs for the CHP unit have been estimated on the basis of modelled outputs and a unit rate for maintenance provided by a CHP supplier. Other maintenance cost items have been costed on the basis of indicative percentages of their initial capital costs. Whilst the percentages applied have been tailored to suit the individual capital cost items, the general percentages used area as follows:

Table 6-3 – Maintenance cost assumptions

Item	% applied to capital cost to derive annual maintenance rate
EC building	0.25%
EC mechanical items	2%
EC pipework	1%
EC electrical items	4%

Substations (heat)	0.5%
Substations (elec)	2.5%
DH network (TC and ERF link)	1%

These figures result in the following overall breakdown of maintenance costs across the scheme:

Table 6-4 – Annual maintenance cost assumptions

	Annual maintenance cost (£,000)
CHP	£43
EC Building and Civils	£4
EC Electrical	£45
EC Mech plant	£58
Substations (heat)	£10
Substations (elec)	£41
DH network (town centre)	£58
TOTAL (town centre)	**£258**
ERF link	£98
Total including ERF link	**£356**

In the cashflow modelling of the scheme, the maintenance costs have been phased such that the costs only apply to elements after they are installed. This applies to a number of elements, such as boiler plant, which is phased to reflect peak scheme heat loads, heat substation installation, and the town centre network expansion.

6.5 REPLACEMENT COSTS

Various elements of the scheme will require replacing over time, and it assumed that the Croydon SPV that operates the scheme will bear these costs.

Key assumptions regarding lifecycles and replacement costs are as follows:

Table 6-5 – Replacement cost assumptions

	Replacement cycle (years)	% of initial installation cost borne at replacement
CHP	Not replaced	n/a
EC building and civils	Not replaced	n/a
EC electrical	30	70%
EC mech plant	25	75%
Substations (heat)	25	60%
Substations (elec)	40	60%

DH Network in Town Centre	Not replaced	n/a
TOTAL (town centre)	**n/a**	**n/a**
ERF link	Not replaced	n/a
Total including ERF link	**n/a**	**n/a**

A reduced cost at the time of replacement is considered appropriate, as at this period it is normally possible to deliver a straight replacement item, without the difficulties and costs associated with planning and delivering the initial installation.

6.6 METERING AND BILLING

This analysis has assumed that the interface for heat sales is a the 'base-of-block' substations that represent the demarcation point to the individual sites of the scheme. For each substation at a site a notional £500 p.a. charge has been applied. Where a site has been designed to have two substations (i.e. a residential and non-domestic component, for example), then this charge is applied to each substation.

6.7 HEAT SALES INCOME

Heat sales income to the scheme has been calculated on the basis of a counterfactual cost modelled for each customer on the network, and a potential reduction against these counterfactual costs to incentivise connection.

COUNTERFACTUAL COSTS

The counterfactual costs at each site have been calculated based on a series of assumptions for the specific technologies that are proposed for the counterfactual scenario.

Utility prices under the counterfactual calculations are based upon trendlines developed from the QEP gas and electricity prices (without CCL) for 2018 annual period, so that the price for utilities at each site can reflect their specific volume of consumption. These trendlines are illustrated below:

Figure 6-2 - Counterfactual gas price

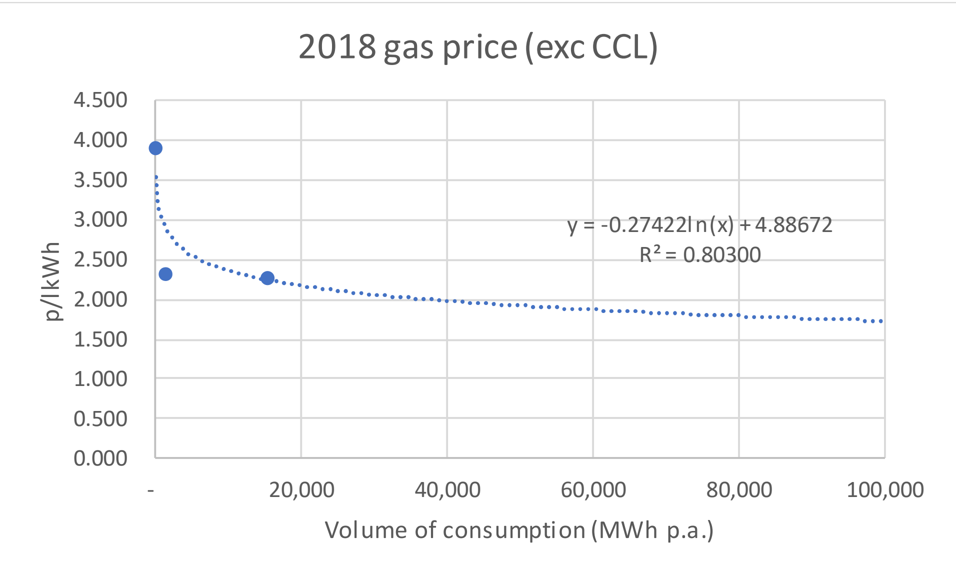
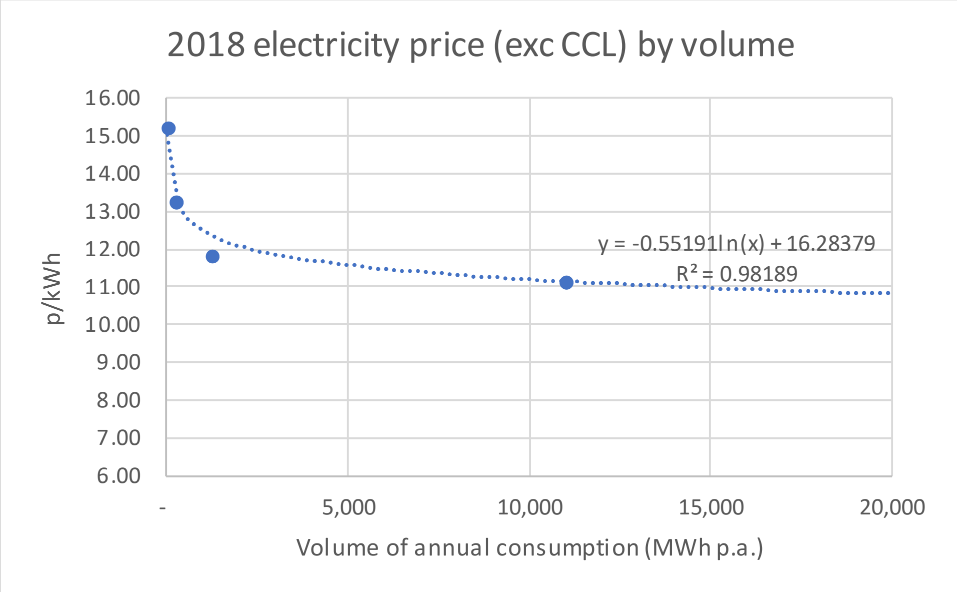


Figure 6-3 - Counterfactual electricity prices



It should be noted that the QEP publication gives prices that correspond to a range of volumes. WSP has created a trendline of prices by taking the mid-point in these ranges as the value corresponding to the price stated.

The technologies for the counterfactual scenario for each building have been derived from the planning application documents and dialogue with Croydon. The assumed technologies are listed below:

Table 6-6 – Counterfactual technology assumption

Building / development site	Technology assumed for counterfactual calculations
Bernard Weatherill House	Has not-working CHP and abs chiller. CHP @ approx 238kWe (assumed from energy statement). Abs chill size unknown. But given non-operational, this building modelled as boilers only
Town Hall	Heat from BWH. Shared elec supply with Central Library
Central Library	Boilers only
Davis House	Boilers only
Croydon Combined Court	Boilers only
Magistrates Court	Boilers only
Croydon College	Boilers only
Croydon Park Hotel (potential new load)	Boilers only
Phase 1A (Fairfield - College Green) : Resi	Fairfield Hall Concert Hall (214kWth CHP) and boilers
Phase 1A (Fairfield - College Green) : Non-resi	
Phase 1B (Fairfield - College Green) : Non-resi	n/a
Phase 2 (Fairfield - College Green) : Resi	n/a

Phase 2 (Fairfield - College Green) : Non-resi	n/a
Phase 3 (Fairfield - College Green) : Resi	n/a
Ruskin Square Commercial B01	Boilers only
Ruskin Square Commercial B02	ASHP and boilers
Ruskin Square Commercial B03	Roof mounted ASHP - connection to DH at ground floor level
Ruskin Square Commercial B04	ASHP and boilers
Ruskin Square Commercial B05	ASHP and boilers
Ruskin Square Residential Vita, B&C	ASHP and boilers
Ruskin Square Residential D, E&F	ASHP and boilers
Barclay Road Annexe : Resi	Boilers only
Barclay Road Annexe : Non-Resi	
Mondial House : Resi	Boilers only
Mondial House : Non-Resi	
Morello Tower: Cherry Orchard Road	n/a
Morello Tower: Cherry Orchard Garden	n/a
Wandle Road : Resi	Boilers only
Wandle Road : Non-resi	
Former Essex House, 101 George Street : Resi	CHP and boilers
Former Essex House, 101 George Street : Non-resi	
28 - 30 Addiscombe Grove CR0 5LP	n/a
Carolyn House : Resi	CHP and boilers
Carolyn House : Restaurant	
Queens Square / St George's House : Resi	CHP and boilers
Queens Square / St George's House: Non-resi	
Taberner House: Resi	CHP and boilers
Taberner House: Non- Resi	
Addiscombe Square (former Post Office site): Resi	n/a
Addiscombe Square (former post office site): Non-resi	n/a
Leon House: Resi	Not clear. Assume boilers only
Leon House: Non-Resi	
Job Centre plus site	ASHP and boilers
Cambridge House	n/a
The Edridge resi	CHP and boilers
The Edridge non-resi	
College Tower resi	ASHP and boilers
College Tower non-resi	

For each of the different technologies identified, WSP has made assumptions on the operation of the plant on an annual basis, and thereby calculated the total fuel consumption for the delivery of energy to the site under the counterfactual scenario.

Assumptions have been adopted regarding the cost and maintenance of the plant. This has then led to the overall calculation of costs, and an estimated total cost of heat for each connection. The technology-specific assumptions are as follows:

Table 6-7 – Boilers counterfactual assumptions

		Scale (thermal output)	Efficiency (GCV)	Maintenance cost (£ p.a.)	Replacement cost (at end of life (£/kW)
Boilers	New	1	86%	750	60
		200	86%	750	60
		500	86%	1500	55
		1000	86%	2000	45
	Existing	1	82%	900	60
		200	82%	900	60
		500	82%	1,800	55
		1000	82%	2,400	45

Table 6-8 – CHP counterfactual assumptions

	Scale (thermal output)	Thermal efficiency	Maintenance cost (p/kWh)	Replacement cost (at end of life (£/kW)	Electrical efficiency (GCV)
CHP	1	42%	2.5	£1,500	34%
	200	41%	2.2	£1,250	36%
	400	40%	1.8	£1,043	38%
	600	41%	1.4	£738	38%

Table 6-9 – ASHP counterfactual assumptions

	Scale (thermal output)	Thermal efficiency (COP)	Maintenance cost (£/kWth capacity p.a.)	Replacement cost (at end of life (£/kW)
ASHP	1	2.30	40	1000
	200	2.40	30	750
	500	2.50	24	600
	1000	2.60	20	500

It is assumed that for all of the ASHP sites that these will benefit from the Renewable Heat Incentive (RHI) or its successor (the RHI scheme is due to close in March 2021, but Government has indicated that support for heat pumps may be provided in another form). The cost of heat without this subsidy would be prohibitively high for these sites, and hence if no RHI were available, it would be anticipated that these sites would operate on a boiler-only basis.

The RHI rate assumed for ASHP is 2.75p/kWh, as per the Non-Domestic RHI tariff table (Q2 - 2019/20), for installations after 1st April 2016.

When these assumptions are applied to the counterfactual scenarios for each of the development sites, the following overall costs are calculated:

Table 6-10 – Counterfactual costs summary

	Total unit energy costs (excl CCL) (£ p.a.)	Total CCL (£ p.a.)	Avoided import (inc CCL) / value of export	Total maintenance (£ p.a.)	Total replacement annualised (£ p.a.)	RHI income (£ p.a.)	Unit heat cost elements (inc elec generation and RHI) (p/kWh)	Maintenance cost element per unit heat (p/kWh)	Replacement cost element (p/kWh)	Total cost per unit of heat demand (p/kWh)
Bernard Weatherill House	£148,012	£9,840	£0	£7,200	£14,475	£0	3.97	0.18	0.36	4.52
Town Hall	£0	£0	£0	£0	£0	£0				
Central Library	£45,889	£2,913	£0	£5,400	£5,236	£0	4.15	0.46	0.45	5.05
Davis House	£17,584	£1,076	£0	£2,700	£2,111	£0	4.29	0.62	0.49	5.40
Croydon Combined Court	£0	£0	£0	£0	£0	£0				
Magistrates Court	£0	£0	£0	£0	£0	£0				
Croydon College	£40,123	£2,533	£0	£5,400	£4,555	£0	4.17	0.53	0.45	5.14
Croydon Park Hotel (potential new load)	£0	£0	£0	£0	£0	£0				
Phase 1A (Fairfield - College Green) : Resi	£109,489	£0	£61,149	£25,790	£27,315	£0	2.63	1.40	1.49	5.52
Phase 1A (Fairfield - College Green) : Non-resi	£0	£0	£0	£0	£0	£0				
Phase 1B (Fairfield - College Green) : Non-resi	£0	£0	£0	£0	£0	£0				
Phase 2 (Fairfield - College Green) : Resi	£0	£0	£0	£0	£0	£0				

Phase 2 (Fairfield - College Green) : Non-resi	£0	£0	£0	£0	£0	£0				
Phase 3 (Fairfield - College Green) : Resi	£0	£0	£0	£0	£0	£0				
Ruskin Square Commercial B01	£31,620	£1,978	£0	£4,500	£5,693	£0	4.01	0.54	0.68	5.22
Ruskin Square Commercial B02	£40,170	£1,963	£0	£12,347	£15,217	£13,138	3.64	1.55	1.91	7.10
Ruskin Square Commercial B03	£61,333	£3,038	£0	£15,349	£18,715	£20,870	3.44	1.21	1.48	6.13
Ruskin Square Commercial B04	£52,521	£2,592	£0	£12,476	£17,299	£17,804	3.46	1.16	1.60	6.22
Ruskin Square Commercial B05	£61,333	£3,038	£0	£15,349	£18,715	£20,870	3.44	1.21	1.48	6.13
Ruskin Square Residential Vita, B&C	£52,692	£2,591	£0	£7,807	£11,124	£17,346	3.61	0.74	1.06	5.41
Ruskin Square Residential D, E&F	£62,039	£3,063	£0	£11,069	£12,738	£20,504	3.59	0.89	1.03	5.50
Barclay Road Annexe : Resi	£9,536	£571	£0	£2,250	£1,123	£0	4.18	0.93	0.46	5.58
Barclay Road Annexe : Non-Resi	£0	£0	£0	£0	£0	£0				
Mondial House : Resi	£37,377	£2,354	£0	£2,250	£4,253	£0	3.98	0.23	0.43	4.64
Mondial House : Non-Resi	£0	£0	£0	£0	£0	£0				
Morello Tower: Cherry Orchard Road	£0	£0	£0	£0	£0	£0				
Morello Tower: Cherry Orchard Garden	£0	£0	£0	£0	£0	£0				
Wandle Road : Resi	£18,491	£1,134	£0	£2,250	£2,019	£0	4.09	0.47	0.42	4.97

Wandle Road : Non-resi	£0	£0	£0	£0	£0	£0				
Former Essex House, 101 George Street : Resi	£97,499	£0	£54,201	£25,944	£22,069	£0	2.66	1.59	1.36	5.61
Former Essex House, 101 George Street : Non-resi	£0	£0	£0	£0	£0	£0				
28 - 30 Addiscombe Grove CR0 5LP	£0	£0	£0	£0	£0	£0				
Carolyn House : Resi	£37,367	£0	£18,786	£9,682	£8,710	£0	3.04	1.58	1.42	6.04
Carolyn House : Restaurant	£0	£0	£0	£0	£0	£0				
Queens Square / St George's House : Resi	£62,218	£0	£31,904	£14,872	£15,547	£0	2.92	1.43	1.50	5.84
Queens Square / St George's House: Non-resi	£0	£0	£0	£0	£0	£0				
Taberner House: Resi	£115,576	£0	£64,689	£27,022	£26,536	£0	2.62	1.39	1.37	5.37
Taberner House: Non- Resi	£0	£0	£0	£0	£0	£0				
Addiscombe Square (former Post Office site): Resi	£0	£0	£0	£0	£0	£0				
Addiscombe Square (former post office site): Non-resi	£0	£0	£0	£0	£0	£0				
Leon House: Resi	£56,802	£3,635	£0	£4,500	£5,728	£0	3.92	0.29	0.37	4.59
Leon House: Non-Resi	£0	£0	£0	£0	£0	£0				
Job Centre plus site	£40,298	£1,969	£0	£6,473	£8,453	£13,181	3.64	0.81	1.06	5.51
Cambridge House	£0	£0	£0	£0	£0	£0				
The Edridge resi	£55,103	£0	£28,122	£13,376	£13,560	£0	2.94	1.46	1.48	5.88

The Edridge non-resi	£0	£0	£0	£0	£0	£0				
College Tower resi	£42,198	£2,064	£0	£7,846	£11,203	£13,817	3.64	0.94	1.34	5.91
College Tower non-resi	£0	£0	£0	£0	£0	£0				

It can be seen from this table that despite the technological differences in the counterfactual scenarios modelled, the overall cost of heat falls within a range of approximately 4.5p/kWh to 7p/kWh.

This forms the baseline of income that could be anticipated from the scheme for heat.

Given the total heat demands at each site, and the modelled sizes of plant, it is calculated that the total counterfactual cost for heat across the customer base at full build out is £1.459m.

This total potential income to the DEN scheme divided into heat unit costs and standing charges (reflecting maintenance and replacement costs in the cashflow model).

6.8 PRIVATE WIRE SALES INCOME

The potential level of private wire sales income has been calculated on the basis of analysis of the records of the actual costs seen by Croydon for the import of power for the buildings to be connected. Across the core buildings, the following costs were recorded in 2018 (FY):

Table 6-11 – Private wire income potential

		BWH	Davis House	Civic Centre	Total
Total consumption	kWh	5,976,714	1,212,555	2,248,352	**9,437,621**
Total billed incl all charges/levies, ex. VAT		£632,947	£146,187	£252,490	**£1,031,625**
Average, incl all charges/levies ex VAT	p/kWh	10.59	12.06	11.23	**10.93**

Please note that whilst these values have been used to calculate the average unit price for electricity, the volumes used in modelling demands have been based upon the 2018 calendar year HH metered data figures, which were slightly lower.

When multiplying the modelled volumes by the average prices derived here, the total annual income (2018 prices) from PW sales available to the scheme is calculated to be £1,000,000.

6.9 CONNECTION CHARGES

The potential income from connection charges is largely contingent upon the timetable for connection of the various development sites. WSP's approach to connection charges in this instance has been to assume that these are linked to avoided capital spend. i.e. if a developer could avoid the need to invest in low-carbon plant (and potentially insulation and other fabric measures), then it could be expected that a connection charge would reflect these savings seen by the developer. Furthermore, if the supply of low carbon heat were to allow the development to avoid payment of the carbon offset charge, then this could also translate into a connection charge fee.

The following table illustrates the anticipated completion dates for the developments on the scheme. It is assumed that the DH network would have to be in place a year before this completion date to allow the development to benefit from avoided costs

Table 6-12 – Connection date / charges

	Completion date	Date after which it is not considered possible for developer to avoid costs	Proposed DH connection date	Can connection costs be expected here?
Bernard Weatherill House	Existing	n/a	2022	No
Town Hall	Existing	n/a	2022	No
Central Library	Existing	n/a	2022	No
Davis House	Existing	n/a	2022	No
Croydon Combined Court	Existing	n/a	2030	No
Magistrates Court	Existing	n/a	2030	No
Croydon College	Existing	n/a	2026	No

Croydon Park Hotel (potential new load)	Existing	n/a	2030	No
Phase 1A (Fairfield - College Green) : Resi	2019	2018	2026	No
Phase 1A (Fairfield - College Green) : Non-resi	2019	2018	2026	No
Phase 1B (Fairfield - College Green) : Non-resi	n/a	n/a	n/a	n/a
Phase 2 (Fairfield - College Green) : Resi	n/a	n/a	n/a	n/a
Phase 2 (Fairfield - College Green) : Non-resi	n/a	n/a	n/a	n/a
Phase 3 (Fairfield - College Green) : Resi	n/a	n/a	n/a	n/a
Ruskin Square Commercial B01	Existing	n/a	2027	No
Ruskin Square Commercial B02	2022	2021	2027	No
Ruskin Square Commercial B03	2023	2022	2027	No
Ruskin Square Commercial B04	2023	2022	2027	No
Ruskin Square Commercial B05	2024	2023	2027	No
Ruskin Square Residential Vita, B&C	Existing	n/a	2027	No
Ruskin Square Residential D, E&F	2024	2023	2027	No
Barclay Road Annexe : Resi	2023	2022	2026	No
Barclay Road Annexe : Non-Resi	2023	2022	2026	No
Mondial House : Resi	2024	2023	2026	No
Mondial House : Non-Resi	2024	2023	2026	No
Morello Tower: Cherry Orchard Road	2023	2022	2030	No
Morello Tower: Cherry Orchard Garden	2023	2022	2030	No
Wandle Road : Resi	2020	2019	2025	No
Wandle Road : Non-resi	2020	2019	2025	No
Former Essex House, 101 George Street : Resi	2020	2019	2026	No
Former Essex House, 101 George Street : Non-resi	2020	2019	2026	No
28 - 30 Addiscombe Grove CR0 5LP	2023	2022	2030	No
Carolyn House : Resi	2019	2018	2027	No
Carolyn House : Restaurant	2019	2018	2027	No
Queens Square / St George's House : Resi	2021	2020	2026	No
Queens Square / St George's House: Non-resi	2020	2019	2026	No
Taberner House: Resi	2021	2020	2025	No
Taberner House: Non- Resi	2021	2020	2025	No
Addiscombe Square (former Post Office site): Resi	2023	2022	2030	No
Addiscombe Square (former post office site): Non-resi	2023	2022	2030	No
Leon House: Resi	2019	2018	2025	No
Leon House: Non-Resi	2019	2018	2025	No
Job Centre plus site	2022	2021	2027	No
Cambridge House	2023	2022	2030	No
The Edridge resi	2023	2022	2025	No
The Edridge non-resi	2023	2022	2025	No
College Tower resi	2022	2021	2026	No
College Tower non-resi	2022	2021	2026	No

It can be seen that under the timetable agreed for the DEN development to date, that none of the development sites are considered to be in a position to pay a connection charge on the basis of avoided costs.

On this basis, no connection charges have been included in the cashflow model developed for the scheme.

6.10 GRANT SUPPORT

This scheme is a strategically beneficial project, in that it opens up the potential supply of the Croydon town centre from low carbon heat derived from an EfW process. On this basis, and given that the 'waste' heat from the Beddington ERF plant is considered to be very low carbon, it is thought that Government (via the Heat Networks Investment Project (HNIP) would be keen to support the scheme if a base level of financial sustainability can be demonstrated.

Whilst different elements of the project are potentially eligible for different levels of grant support under HNIP, for the purposes of this study, a notional range of support up to 40% is illustrated to demonstrate the impact on overall scheme economics.

6.11 RESULTS

6.11.1. CASHFLOW PERFORMANCE

As a first pass evaluation of the project, the following parameters have been selected:

- No reduction on counterfactual costs (i.e. under the DEN scenario, customers are modelled to pay the same rate as under their counterfactual scenario)
- No grant support
- Flat energy prices through time

Given this set of assumptions, the following overall cashflow position is calculated:

Table 6-13 – Cashflow NPV and IRR results

	25 YEARS	30 YEARS	40 YEARS	60 YEARS
NPV	-£19,254,000	-£18,409,000	-£16,499,000	-£14,024,000
IRR	-5.1%	-3.7%	-1.3%	0.7%

A more detailed set of energy balance figures and operating margin calculations is contained in the appendices to this document to show the derivation of these figures.

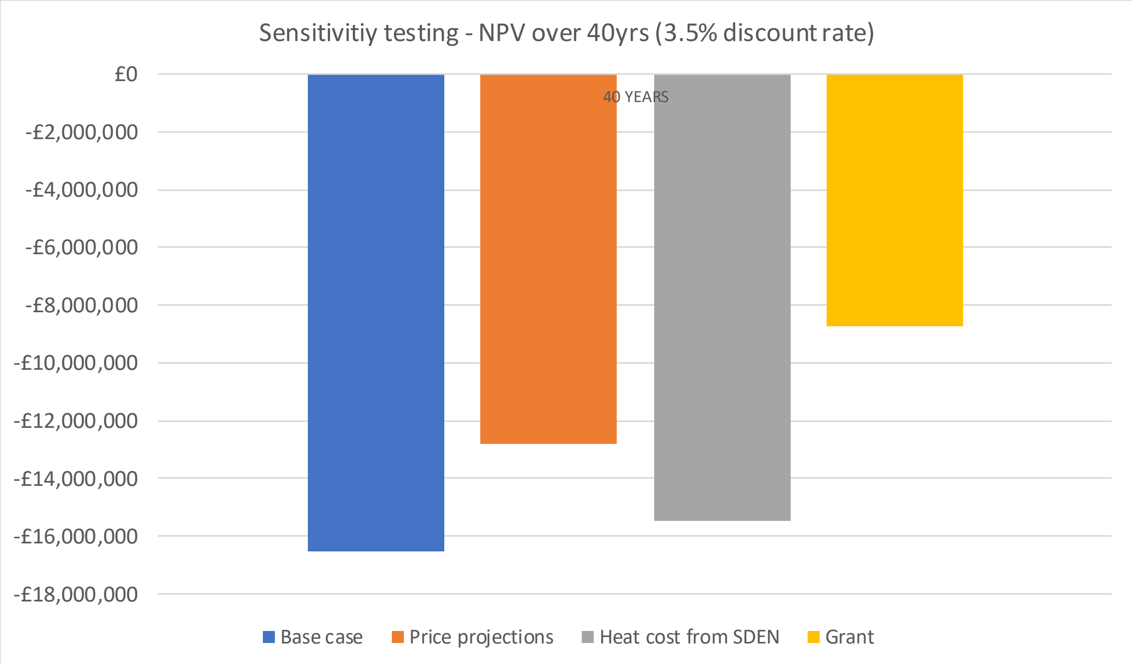
6.11.2. SENSITIVITIES

The following graph shows a small selection of the potential sensitivities that could be presented on the project. Each of the columns on the figure below illustrates NPV result over a 40yr period (3.5% discount rate) given changes in input values as listed below:

Table 6-14 – Sensitivity testing parameters

Base case	Values as outlined above
Price projections	Changes the price projections though time to the BEIS ‘Reference’ case instead of flat prices
Heat cost from SDEN	Changes the assumed heat cost from SDEN from 0.5p/kWh to 0.25p/kWh
Grant	Changes the assumed level of grant support from zero to 40%

Figure 6-4 - Results of sensitivity testing



These sensitivity results illustrate that none of the scheme variants delivers a positive whole life cost.

Potential scheme amendments to improve performance

The results shown above give rise to the question – ‘what could be done to the scheme to improve its whole life cost performance?’. A number of possibilities have been considered. These include:

- Reducing the scale of the network
  - Reducing network scale would also reduce the customer base, and hence would likely negatively impact overall performance, given the large fixed cost element associated with the ERF link and EC building.
- Minimising capital cost required for the scheme

- The intention of this approach would be to eliminate all of the non-essential elements of the scheme in order to reduce capital costs, whilst retaining the operating margin that is anticipated from the resale of ERF heat. I.e. the scheme could be reconfigured to a base-load only supply, where individual customer sites retain their own top-up and standby boilers.

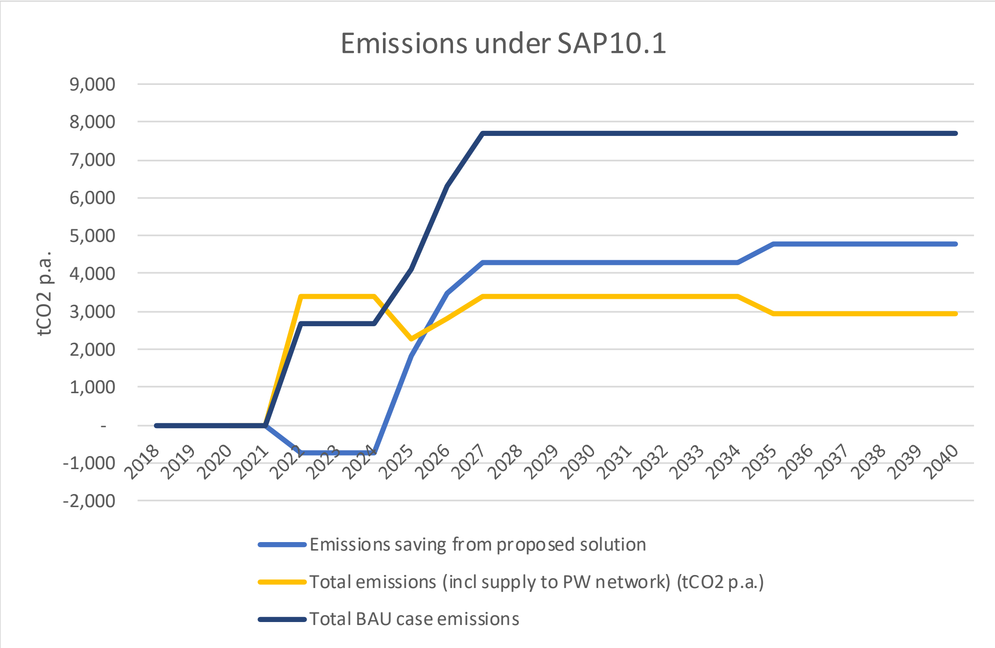
- Increasing the margin on each unit of heat sold
  - Given that the sales value is effectively fixed by the counterfactual cost seen by each connection, it would only through negotiation with SDEN primarily, that a lower heat cost, and therefore greater margin could be generated. However, SDEN will have its own requirement to generate an operational revenue, and there will be limits to the degree that rates can be negotiated down.
- Identifying further customers to increase the heat density of the scheme.
  - This approach would potentially improve the overall scheme economics, by increasing overall scheme income with only a marginal increase in overall capital costs (assuming that additional customers are identified in reasonable proximity).
- Identifying a means to monetise the potential carbon savings that the provision of ERF heat would give to the network customers
  - When planning consent has already been granted, and all S106 obligations discharged, it is anticipated that energy cost will be the primary driver for the majority of development sites. On the basis of the current regulatory framework, it is hard to translate the reduced carbon intensity of the ERF supply into an income stream for the DEN.

6.11.3. CARBON PERFORMANCE

The carbon performance of the scheme has been evaluated against the counterfactual position.

The following graph shows the calculated performance of the scheme when evaluated using the SAP10.1 carbon emissions factors:

Figure 6-5 - Emissions performance of proposed scheme



This graph illustrates that in the initial phase of the project, where CHP is the dominant source of heat for the core scheme, emissions increase above the counterfactual (BAU) case level. However, as the ERF link is put in place and the scheme starts to distribute heat from Beddington ERF, the proposed case emissions are significantly lower than the counterfactual position.

In the phase when the ERF is supplying the full scheme demands, the carbon content of heat is calculated to have an emissions factor of approximately 80gCO_2/kWh. This is significantly lower than a 'typical' figure for a boiler-only heat supply (@ 83% efficiency) of approximately 250gCO_2/kWh.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Over the course of this project a number of tasks have been carried out:

- Confirming the potential customer base for the scheme with Croydon Council
- Identifying metered energy consumption levels for existing customers as far as possible
- Obtaining best available information regarding development site loads.
- Identifying a DH connection route to the ERF plant that is considered to be deliverable with a reasonable level of confidence, including locations for thrust bore crossings of the tram and NR assets
- Identifying customer connection points from site surveys of existing buildings and planning documents for proposed developments
- Identifying a suitable DH network route within the town centre area
- Testing the viability of connections within the town centre area to assess if they would add value to the overall scheme and amending the configuration of scheme to suit
- Carrying out evaluation of potential ERF link capacities to identify a recommended size
- Outline design of the energy centre, including assessment of air quality implications, acoustic breakout, and outline structural approach to the building
- Cashflow analysis of the performance of the scheme, taking capital, replacement, maintenance, operational income and costs into account.
- Carbon performance analysis of the network, based on SAP10.1 carbon factors (consultation version).

The analysis has demonstrated the following:

- The scheme as developed to date has an estimated capital cost of approximately £33m for full build-out
- Counterfactual analysis for the heat loads to be connected shows that at full build out, total annual costs for heat are approximately £1.46m p.a (2018 prices).
- Counterfactual analysis of the private wire system shows that total annual costs for electricity for the core council buildings are approximately £1m p.a. (2018 prices)
- When evaluated under SAP10.1 emissions factors, the scheme is calculated to deliver more than 47,000tonnes CO_2 savings over the first 15 years of operation.
- Individual development sites would be able to receive heat with a significantly lower carbon intensity than they can produce on site.
- The scheme does not show a positive whole life cost performance, and even with when assuming 40% grant funding, the scheme does not deliver a positive IRR over 25 yrs.

7.2 RECOMMENDATIONS

The scheme's cashflow performance is not sufficient in its current configuration allow the capital costs of the scheme to be recovered from project income (even when considering potential grant support). From this perspective, it is recommended that a re-appraisal is carried out of the outline scheme that was put forward as the basis for refinement at the start of this process.

There are a number of fixed elements to the scheme. These include:

- The distance between the ERF and the town centre, and hence the cost of installing a link between the two.
- The quanta, timescales and location of known developments coming forward, and hence the potential income to the DEN project[7].

If these two elements are considered fixed, then the cashflow performance of the scheme can primarily be improved by the following means:

- Reducing the cost of heat purchase to improve operating margins
    - This is primarily within the gift of SDEN (although subject to negotiation), and this report has already assumed a relatively low price for the purchase of heat from SDEN. There is only limited potential to further reduce this.
- Reducing the capital cost of the scheme
    - Buried pipework - Only small savings in the cost of delivering the buried pipework element are considered possible, given the need to cover the distance between the ERF plant and the town centre, and transfer the requisite volumes of heat.
    - Energy Centre – significant cost saving potential here. The structure, flues, utility provision and other aspects of an energy centre with full top-up and standby provision and CHP could be cut back, including eliminating the private wire elements
- Reducing the maintenance cost of the scheme to improve operating margins
    - Maintenance of the buried network (or a 'sinking fund' to cater for major remedial works) will always be required. However, significant savings could be delivered by eliminating elements from the energy centre (e.g. boilers, CHP, etc.), as also noted with regards to capital costs above.

On the basis of the above, it is recommended that a significant departure from the outline designs developed in the 2017 Stage 2 report is considered.

This current report has shown that the scheme, in its configuration as presented in this report, even with aggressive value engineering is highly unlikely to be deliverable on the basis of the project operating margins, given the high capital cost and high risk (in terms of customer connections in particular) that is implicit in this potential investment.

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[7] It is acknowledged that there is some potential to influence the scale of the customer base by considering different pipework routes or attracting new customers, and also that new customers might potentially be attracted to the area given the availability of low-carbon, cost-competitive heat.

It is therefore recommended at this stage that the current scheme configuration is amended to consider:

- Base load heat provision to customers
- Elimination of CHP, private wire, and all top-up and standby boiler elements at the Wandle Road energy centre

Appendix A

AIR QUALITY ANALYSIS

APPENDIX A – AIR QUALITY ASSESSMENT

To:	James Eland Tom Hitchman	**At:**	WSP, London WSP, London
Copy to:		**At:**	
From:	Hongbin Wang Bethan Tuckett-Jones	**At:**	WSP, London WSP, Cardiff
Date:	3rd December 2019	**Ref:**	

Subject: **CROYDON ENERGY CENTRE– FLUE GAS DISPERSION MODELLING / STACK HEIGHT SENSITIVITY TESTING**

Summary

The discharge height of the flues at the Croydon Energy Centre should be a minimum of 87m above ground level. This height is appropriate for the operation of Scenario 1 of the proposed emission rates and this recommendation covers Scenario 2 and Scenario 3 both of which give off less pollutant emissions. For the emission rates meeting GLA criteria, the discharge height should be a minimum of 85m above ground level.

Introduction

There is no statutory guidance available for setting appropriate stack heights. Therefore, the following recommendations are based on the policies set out in the National Planning Policy Framework (NPPF, 2019) and planning guidance provided by Environmental Pollution UK & Institute of Air Quality Management (2017) on the assessment of significance of impacts.

In relation to local air quality, the NPPF states (para 124) that

"*Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas.*"

and (para 120) that

“*To prevent unacceptable risks from pollution …, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account*.”

In 2010 the GLA/Mayor of London published a new Mayor’s Air Quality Strategy for London. This strategy is focused on improving London’s air quality. The Strategy includes a policy which states:

“New developments in London shall as a minimum be ‘air quality neutral’ through the adoption of best practice in the management and mitigation of emissions”.

The London Plan 2016 sets out the new spatial development strategy for Greater London and consolidates all of the alterations to the Plan since 2011. The London Plan sets out an integrated economic, environmental, transport and social framework for the development of London over a 20-25 year period to 2036. The following policies are considered relevant to this assessment: Policy 7.14 is specific to the improvement of air quality and states that development proposals should:

"Minimise increased exposure to existing poor air quality and make provision to address local problems of air quality";

"Promote sustainable design and construction in order to reduce emissions from the demolition and construction of buildings following the best practice guidance in the GLA and London Councils' 'The control of dust and emissions from construction and demolition'";

"Be at least 'air quality neutral' and not lead to further deterioration of existing poor air quality";

"Ensure that where provision needs to be made to reduce emissions from a development, this is usually made on site"; and

"Where the development requires a detailed air quality assessment and biomass boilers are included, the assessment should forecast pollutant concentrations. Permission should only be granted if no adverse air quality impacts from the biomass boiler are identified."

Table 1 shows the significance criteria set by EPUK & IAQM for assessing local air quality impacts. The significance of any impact is determined by both the change in concentration resulting from the scheme being assessed and the total ambient pollution concentration with the scheme in operation.

The table shows that the significance of any given magnitude of impact increases as the total pollution level increases.

In setting an appropriate stack height for the Croydon Energy Centre, it is considered that:

- the impact of the Energy Centre should be imperceptible where concentrations exceed or are at significant risk of exceeding an air quality objective; and
- the significance of the impact should be negligible in general.

That is to say, any impacts should lie within the area shaded in yellow in Table 11.

Table 15 EPUK & IAQM significance criteria for assessing local air quality impacts. Acceptable impacts are shaded in green.

Long term average Concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

AQAL = Air Quality Assessment Level, which may be an air quality objective, EU limit or target value, or an Environment Agency 'Environmental Assessment Level (EAL)'.

In terms of short term impact, the Environment Agency uses a threshold criterion of 10% of the short term AQAL as a screening criterion for the maximum short term, defined in EPUK & IAQM guidance as an impact that is sufficiently small in magnitude to be regarded as having an insignificant effect. Background concentrations are less important in determining the severity of impact for short term concentrations, not least because the peak concentrations attributable to the source and the background are not additive.

The pollutant of greatest concern in relation to the Croydon Energy Centre is nitrogen dioxide. The UK has two ambient air quality objectives for nitrogen dioxide:

- an annual mean concentration of 40μg/m^3, and
- an hourly mean concentration of 200μg/m^3 with 18 exceedences of this level allowed in any calendar year.

Existing Air Quality

Baseline ambient pollutant concentration data have been taken from the 2016 London Atmospheric Emission Inventory (LAEI) models. The LAEI data provide modelled estimates for the whole of London for 2016 on a 20m x 20m basis. These baseline data account for all known pollutant sources within the local and wider areas. The base model in 2016 has been validated against data from LAQN monitoring sites. Future projections are currently not available at the time of writing. The 2016 NO_2 background concentrations for the study area is presented in Figure 15.

The largest NO_2 concentration in the LAEI dataset in the study area is approximately 37.4 µg/m^3 at a grid point which is very close to the A232. Considering pollutant concentrations decrease with height because of ground level traffic emissions being the major emission source for NO_2, the concentration at the grid point with a similar distance to the building height is used as the background concentration at height. The NO_2 concentration is approximately 34 µg/m^3 at the grid point.

The proposed site for the Croydon Energy Centre lies within Croydon AQMA which was declared in 2003 as the whole borough, for the annual and hourly average objective for NO_2. The monitoring data for 2018 showed that NO_2 roadside sites within Croydon continue to exceed the annual mean objective.

Methodology

The impacts of the Croydon Energy Centre have been assessed using detailed dispersion model. The model used was the ADMS v5.2 model. This model has been validated against field studies and is widely used in the UK for stack dispersion modelling. Modelling based on the ADMS model is accepted by the UK's Environment Agency for impact assessments and permitting purposes.

Long term and short term NO_x concentrations have been modelled for three years 2016 to 2018 with respective meteorological data from Heathrow Airport, for 2016 to 2018. This is the closest station to Croydon that records all of the data necessary for dispersion modelling.

The model takes into account the effects of buildings on dispersion, with the proposed residential building, which the stacks of the boilers and CHP are adjacent to, being included in the model inputs. The residential building consist of two parts with the lower part being 72m in height and the higher part 83m in height.

Initial model tests included the two parts were modelled as one whole building of 72m and 83m and two separate parts with the lower part of 72m and the higher part of 83m because in ADMS-5 only one building can be set as the "effective" building. Results of the model of one whole building of 83m presented in the note as the model is considered most fit for the stack height sensitivity test.

Receptors

Receptors in the model are designed to be able to cover those that are likely to experience the impacts from the stack emissions of Croydon Energy Centre. Figure 16 shows horizontal perspective of the modelled receptors. Receptors are spaced around the new proposed residential building at the levels of 1.5m, 73.5m, 79.5m and 82.5m, along the south façade of the two properties on the Scarbrook Road at the levels of 1.5m, 4.5m, 7.5 and 10.5m, and around the buildings at Wandle Road and Whitgift Street at the levels of 1.5m, 37.5m, 40.5m and 43.5m.

The new proposed residential building consists of two adjacent buildings named as Resi1 and Resi2 (see Figure 15). The lower building (Resi1) is 72m in height and the higher (Resi2) is 83m in height. The rooftop of the lower building is proposed to be used as amenity area. Receptors are placed at 1.5m off the rooftop. Those receptors were modelled in the initial tests in the model with parts of building of 72m in height and the model with the lower part of 72m and the higher part of 83m. As they are not the constraining factor in determining the stack heights, they are not presented in this note.

A 10x10m grids are also spread across the model area.

Impacts of the Energy Centre

The following plant are proposed for the Energy Centre:

Scenario 1 – in operation from 2024, the first phase of the project, reflecting the Core scheme loads, and where a 1.2MWe CHP would operate in conjunction with 1 gas boilers for top-up and 1 standby.

Scenario 2 – in operation from 2035, reflecting the interim phase of the project where the primary supply would be heat from the ERF plant, but where the 1.2MWe CHP is retained and additional gas boilers are added in order to provide top-up and standby heat as required (up to 5 no. 6MWth units). Operation of the CHP under this scenario is very limited.

Scenario 3 – in operation from 2040, reflecting the final phase of the project where the ERF is the primary supply, the CHP plant is removed from the scheme, and the only remaining source of emissions from the energy centre is the use of top-up and standby boiler plant (up to 5 no. 6MWth units)

In terms of air quality impacts, Scenario 1 is considered to be the 'worst-case' as even though the customer base of the scheme expands significantly under Scenarios 2 and 3, under these scenarios the vast majority of heat demands are met by the heat supply from the ERF plant, and relatively little operation of the energy centre combustion plant is required. On this basis, this report has focussed on the impacts of Scenario 1. Table 12 shows, for Scenario 1, the emission parameters, relevant to the air quality modelling, for the individual items of plant.

Table 16 Emission parameters per item for Scenario 1.

Parameter	Proposed NO_x emission concentrations[a]		NO_x emission concentrations meeting GLA standards[b]	
	1.2MW CHP	6MW Boiler	1.2MW CHP	6MW Boiler
Stack diameter (m)	0.5	0.7	0.5	0.7
Exit temperature (°C)	120	200	120	200
Exit velocity (m/s)	15	10	15	10
Nitrogen Oxides emission rates[c] (g/s)	0.2228	0.1362	0.0667	0.0847

a. Boiler 70mg/kWh (dry gas and 3% O2), CHP 250mg/Nm3@5%O2. b. Boiler 40mg/kWh (dry gas and 0% O2), CHP 95mg/Nm3@5%O2 c. Emission rates at full load

In the testing, the model results are analysed with the presumption that all plant are to operate continuously at full load for short term (99.79th percentile of hourly average NO_2) analysis and at a scaled-down load for long term (annual average) analysis.

This implies that, from Table 13, that in the short term analysis, the results are conservative i.e. tending to over-estimate impacts. For long term analysis, the scaled-down factor of 40% and 10% are applied for the CHP and boiler respectively, and this may also be a conservative estimate.

Table 17 Annual average operational load.

Parameter	1.2MW CHP	6MW Boiler
Average load	38.6%	4.2%
Average load when operating	97.1%	13.0%
Calculation is based on the estimated the boiler and CHP annual operation pattern provided by WSP design engineers.		

Emissions from the plant occur primarily in the form of nitrogen oxides. Environment Agency guidance is used to estimate the conversion of nitrogen oxides to nitrogen dioxide, with an assumed conversion of 70% in the long term and 35% in the short term.

Results and discussions

Model results indicate that the high impacts occur at the receptors at higher levels of the residential building the stacks are adjacent to. Impacts on those receptors are the major constraints deciding the stack height. Concentrations at ground level are overall much lower than the receptors at heights.

Table 5 and Figure 17 to Figure 20 show the model results at various stack heights for the development for Scenario 1 with 1xCHP and 1xBoiler for the proposed emission rates and the rates that meet GLA standards. The results shown are the maximum predicted concentrations for 2016 to 2018.

Proposed emission rates

Figure 3 show that, as the height of the flues increases, the maximum impacts at relevant receptors decrease rapidly. Table 5 shows that maximum annual mean impacts are of Negligible magnitude (<0.4 $\mu g/m^3$, <1% of objective) at a flue height of 87m or above.

Considering short term impacts, Figure 18 shows that, as the height of the flues increases, maximum impacts at relevant receptors decrease rapidly. Table 5 shows that maximum hourly concentrations are medium in magnitude (<10% of objective, <20$\mu g/m^3$) at a flue height of 87m and above.

Therefore, it is recommended the minimum stack height of the boiler and CHP is 87m.

Emission concentration meeting GLA standards

The stack heights testing for emission concentration meeting GLA have also been carried out. Similar to the case of the proposed emission rates, Figure 19 and Figure 20 as the height of the flues increases, the maximum impacts for both long term and short term at relevant receptors decrease rapidly.

Figure 18 shows that Maximum annual mean impacts are of negligible magnitude (<0.4 µg/m^3, <1% of objective) at a flue height of 85m or above. For short term impacts, maximum hourly concentrations are medium in magnitude (<10% of objective, <20µg/m^3) at a flue height of 84m and above. Therefore, the minimum stack height for the boiler and CHP would be recommended as being 85m.

Summary

The discharge height of the flues at the Croydon Energy Centre should be a minimum of 87m above ground level. This height is appropriate for the operation of Scenario 1 of the proposed emission rates and this recommendation covers Scenario 2 and Scenario 3 both of which give off less pollutant emissions. For the emission rates meeting GLA criteria, it is recommended that the discharge height be a minimum of 85m above ground level.

Hongbin Wang

3rd December 2019

Figure 6 LAEI 20x20m NO_2 Background concentrations

Figure 7 Horizontal view of all modelled receptors and grid points.

Figure 8 Long term NO_2 concentrations (proposed NO_x emission concentrations)

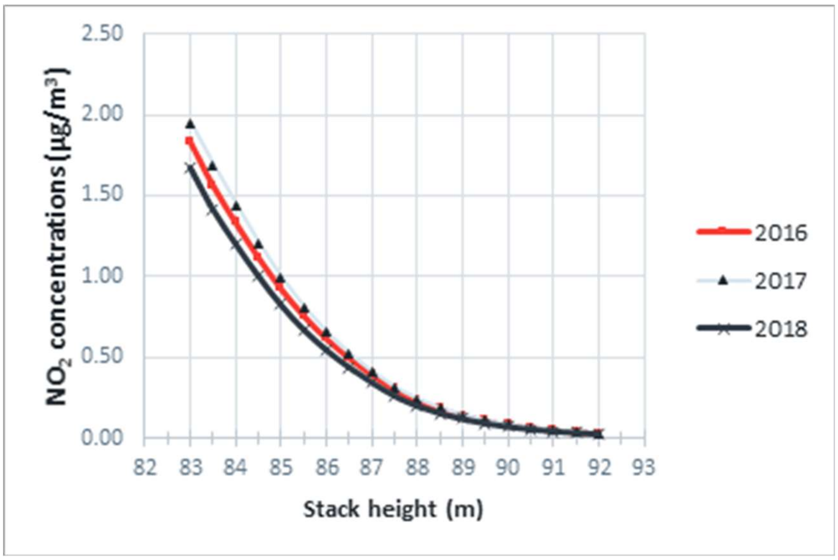

Figure 9 Short term NO_2 concentrations (proposed NO_x emission concentrations)

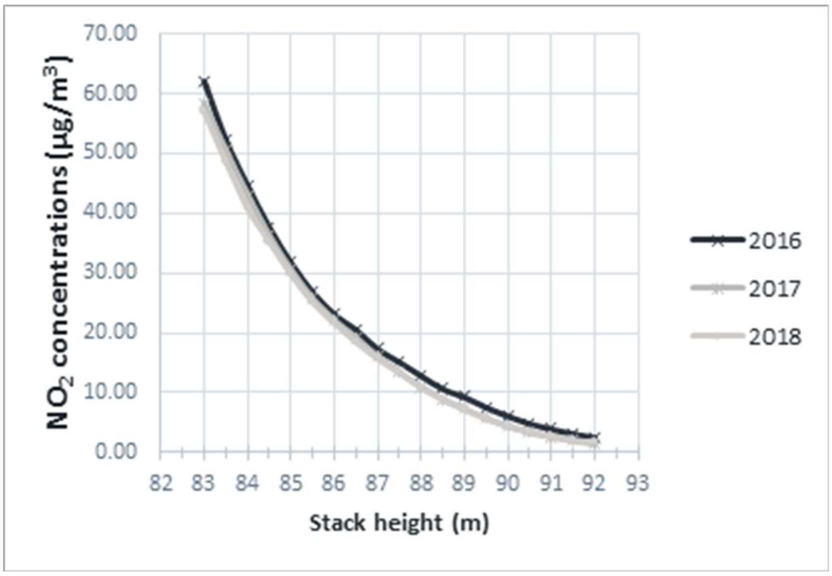

Figure 10 Long term NO_2 concentrations (NOx emission concentrations meeting GLA standards)

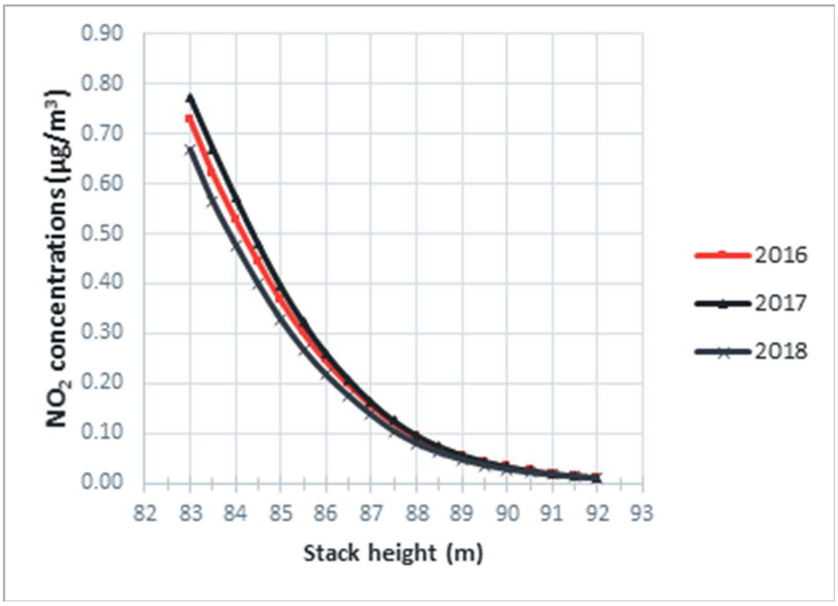

Figure 11 Short term NO_2 concentrations (NO_x emission concentrations meeting GLA standards)

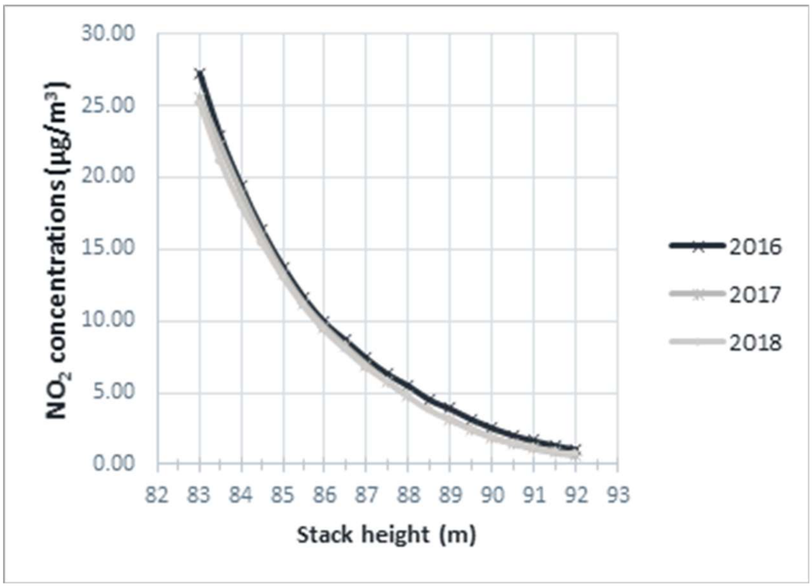

Table 18. Modelled concentrations for Scenario 1 with 1xCHP and 1xBoiler operating continuously. The recommended stack height is highlighted in orange.

Stack Height	Proposed NO_x emission concentrations[a]						NO_x emission concentrations meeting GLA standards[b]					
	Annual Mean Concentration (µg/m³)			Hourly Mean Concentration[c] (µg/m³)			Annual Mean Concentration (µg/m³)			Hourly Mean Concentration[c] (µg/m³)		
	Air Quality Objective = 40µg/m³			Air Quality Objective = 200µg/m³			Air Quality Objective = 40µg/m³			Air Quality Objective = 200µg/m³		
	2016	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
83.0	1.83	1.95	1.68	62.16	58.33	57.12	0.73	0.77	0.67	27.28	25.61	25.19
83.5	1.56	1.69	1.42	52.37	50.55	48.75	0.62	0.67	0.56	22.90	22.24	21.14
84.0	1.33	1.44	1.20	44.71	43.11	40.95	0.53	0.57	0.48	19.41	18.94	17.98
84.5	1.12	1.21	1.01	37.75	36.29	35.40	0.44	0.48	0.40	16.33	15.92	15.42
85.0	0.92	0.99	0.83	31.83	30.61	29.88	0.37	0.39	0.33	13.79	13.36	13.03
85.5	0.76	0.81	0.67	26.90	25.76	25.24	0.30	0.32	0.27	11.64	11.22	11.03
86.0	0.62	0.65	0.55	23.19	22.15	21.74	0.25	0.26	0.22	9.92	9.58	9.33
86.5	0.50	0.52	0.44	20.57	19.06	18.57	0.20	0.21	0.17	8.68	8.23	8.03
87.0	0.39	0.41	0.35	17.37	16.07	15.78	0.16	0.16	0.14	7.42	6.93	6.76
87.5	0.30	0.31	0.26	15.20	13.47	13.47	0.12	0.13	0.10	6.35	5.78	5.80

Stack Height	Proposed NO_x emission concentrations[a]						NO_x emission concentrations meeting GLA standards[b]					
	Annual Mean Concentration (µg/m^3)			Hourly Mean Concentration[c] (µg/m^3)			Annual Mean Concentration (µg/m^3)			Hourly Mean Concentration[c] (µg/m^3)		
	Air Quality Objective = 40µg/m^3			Air Quality Objective = 200µg/m^3			Air Quality Objective = 40µg/m^3			Air Quality Objective = 200µg/m^3		
	2016	2017	2018	2016	2017	2018	2016	2017	2018	2016	2017	2018
88.0	0.23	0.24	0.20	12.90	10.98	10.91	0.09	0.10	0.08	5.52	4.75	4.74
88.5	0.18	0.18	0.15	10.70	8.95	8.95	0.07	0.07	0.06	4.55	0.00	3.80
89.0	0.14	0.14	0.12	9.35	7.32	7.32	0.06	0.06	0.05	3.93	3.18	3.13
89.5	0.11	0.11	0.09	7.62	5.70	5.76	0.04	0.04	0.04	3.20	2.49	2.47
90.0	0.08	0.08	0.07	6.14	4.41	4.52	0.03	0.03	0.03	2.58	1.91	1.91
90.5	0.06	0.06	0.05	4.90	3.36	3.60	0.03	0.03	0.02	2.08	1.46	1.52
91.0	0.05	0.05	0.04	3.99	2.63	2.80	0.02	0.02	0.02	1.70	1.12	1.18
91.5	0.04	0.04	0.03	3.23	1.98	2.15	0.02	0.01	0.01	1.37	0.84	0.90
92.0	0.03	0.03	0.03	2.58	1.48	1.92	0.01	0.01	0.01	1.10	0.63	0.79

a. Boiler 70mg/kWh (dry gas and 3% O_2), CHP 250mg/Nm^3@5%O_2.

b. Boiler 40mg/kWh (dry gas and 0% O_2), CHP 95mg/Nm^3@5%O_2

c. Hourly mean concentrations shown are the 18th highest hourly concentrations over any year. This reflects the UK's air quality objectives which allow 18 exceedences of 200µg/m^3 as an hourly mean in any calendar year.

Appendix B

ACOUSTIC ASSESSMENT

Croydon District Energy Scheme

CROYDON ENERGY CENTRE

Acoustic Design Report

70057109-AR1
DECEMBER 2019

CONFIDENTIAL

Croydon District Energy Scheme

CROYDON ENERGY CENTRE

Acoustic Design Report

REPORT CONFIDENTIAL

PROJECT NO. 70057109

OUR REF. NO. 70057109-AR1

DATE: DECEMBER 2019

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QUALITY CONTROL

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Prepared by	N. Frost	N. Frost		
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Signature		Andrew Jarvis		
Project number	70057109	70057109		
Report number	70057109-AR01	70057109-AR01		
File reference	70057109-AR01	70057109-AR01		

CONTENTS

APPENDICES

1 INTRODUCTION

WSP has been appointed by the London Borough of Croydon Council to provide acoustic engineering services for the construction of a new proposed District Energy Scheme on Scarbrook Road in Croydon, London.

An acoustic assessment has been undertaken to determine the mitigation measures required to ensure that plant noise emissions from the proposed energy centre do not disturb the nearby local residents. The acoustic assessment has been based on the expected criteria of the Local Authority; the London Borough of Croydon Council.

A survey of existing background noise levels was carried out between Wednesday 3rd May and Thursday 4th May 2017. The survey results and procedure are detailed within Section 4 of this report.

The acoustic assessment considers noise emissions from mechanical plant equipment associated with the proposed energy centre. The cumulative noise levels from all plant items have been considered.

This report is technical in nature and to assist the reader a glossary of acoustic terms is included in Appendix A.

2 SITE DESCRIPTION

2.1 EXISTING SITE

The proposed Energy Centre development site is located to the north of the A232 Croydon flyover and adjacent to an approved residential tower development on Wandle Road, which lies to the north-east of the site.

The site is currently occupied by a council-run car park (with car share spaces) for 255 vehicles. Vehicular access is provided via a single access and egress point on Wandle Road located in the northeast of the Site, close to the junction with Whitgift Street. The proposed site is highlighted by the redline boundary as shown in Appendix B.

2.2 SURROUNDING AREA

The Site is bounded by residential properties with private and communal gardens along Scarbrook Road to the north, Wandle Road to the east, Sheldon Street to the south and Salem Place to the west.

The Wandle Road multi-storey car park is located on Wandle Road to the east of the Site. Immediately adjacent to the south of the site is the existing bus stand below the flyover. Croydon Town Centre is located to the north east of the site and East Croydon mainline station is located within walking distance approximately 900 m to the northeast and Church Street Tram stop located 420 m north.

The nearest existing and proposed noise sensitive receptors to the site have been identified to be:

- Noise Sensitive Receptor 1 (NSR1): Existing residential properties on Church Road to the west of the site, approximately 21 m from the site boundary.
- Noise Sensitive Receptor 2 (NSR2): Existing residential properties on Scarbrook Road to the north of the site, approximately 13 m from the site boundary.
- Noise Sensitive Receptor 3 (NSR3): Proposed residential properties part of the approved Wandle Road residential development, located approximately 5 m from the north east of the site boundary.
- Noise Sensitive Receptor 4 (NSR4): Existing residential properties on Sheldon Street to the south of the site, approximately 50m from the site boundary.

The noise sensitive receptors considered in the assessment are shown on the plan in Appendix B.

2.3 PROPOSED ENERGY CENTRE DEVELOPMENT

The proposed development comprises the construction of a two-storey energy centre to house mechanical and electrical plant, along with associated thermal stores, gas kiosk and a substation adjacent to the building.

The heat and power output of the energy centre will serve a district heating network and private wire network providing energy to a number of buildings in the Croydon town centre area.

A district energy centre is a policy aspiration of the Croydon Local Plan 2018 and the Wandle Road surface car park has been identified as the most cost effective and realisable site for its location. District energy networks are most suitable for areas of high urban density like the Croydon

Opportunity Area because of the demand and relatively short distances for the heat or energy to be distributed.

3 PLANNING POLICY AND GUIDANCE

This section outlines the planning policy, British Standards and guidance documents that have been used to assess the impact of noise on residential receptors.

3.1 CONSULTATION WITH THE LOCAL AUTHORITY

As part of the acoustic design work previously undertaken by WSP on the adjacent Wandle Road development, consultation was undertaken with London Borough of Croydon (LBC) to discuss and agree the approach to the noise survey and assessment. Below is a summary of the previously agreed approach, which is also considered to be relevant to this development.

- It was agreed that, due to the site not being adequately secure to leave noise monitoring equipment unattended, shorter term measurements would be used, in conjunction with a 3D acoustic model, to predict noise levels across the site.
- Noise limits for external plant items would be set such that the background noise level, when measured at the nearest noise-sensitive residential premises, is not increased (i.e. noise limits should be at least 10 dB below the existing background noise levels).

3.2 NATIONAL PLANNING POLICY

3.2.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF), 2019

First published in 2012 and most recently updated in February 2019, the NPPF sets out the Government's planning policies for England and how these are expected to be applied. The NPPF superseded Planning Policy Guidance Note (PPG) 24: Planning and Noise amongst other PPG's and Planning Policy Statements (PPS's). In contrast to PPG 24, reference to noise is limited within the NPPF. Noise is referenced within the document as follows:

> *"170. Planning policies and decisions should contribute to and enhance the natural and local environments by:…[a number of points including]…*
>
> *• preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans;"*
>
> and
>
> *"180. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*
>
> *a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life[60];*

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;…"

Reference number 60 of the above quotation points to the Explanatory Note to the Noise Policy Statement for England (NPSE).

3.2.2 THE NOISE POLICY STATEMENT FOR ENGLAND (NPSE), 2010

The NPSE seeks to ensure that noise issues are considered at the right time during the development of policy and decision making, and not in isolation. It highlights the underlying principles on noise management already found in existing legislation and guidance.

The NPSE sets out the long-term vision of Government noise policy as follows:

> *"Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."*

This long-term vision is supported by the following aims:

> *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*
>
> *• avoid significant adverse impacts on health and quality of life;*
>
> *• mitigate and minimise adverse impacts on health and quality of life; and*
>
> *• where possible, contribute to the improvement of health and quality of life."*

To assist in the understanding of the terms 'significant adverse' and 'adverse', the NPSE acknowledges that there are concepts that are currently being applied to noise impacts, for example, by the World Health Organisation (WHO). They are:

> *NOEL* - No Observed Effect Level - This is the level below which no effect can be detected and below which there is no detectable effect on health and quality of life due to noise.
>
> *LOAEL* - Lowest Observable Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected.
>
> *SOAEL* - Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur.

However, the NPSE goes on to state that:

> *"it is acknowledged within the NPSE that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available."*

3.3 BRITISH STANDARDS

3.3.1 BRITISH STANDARD 4142:2014

BS 4142:2014 Methods for rating and assessing industrial and commercial sound contains pertinent guidance relating to the assessment of sounds of an industrial and commercial nature, including sound from:

- industrial and manufacturing processes;
- fixed installations (such as mechanical and electrical plant);
- loading and unloading of goods and materials; and
- mobile plant or vehicles operating on or around an industrial and/or commercial site (where it is an intrinsic part of the overall sound emanating from the site).

It provides a method of determining rating levels for sources of industrial or commercial sound for the purposes of investigating complaints, assessing sound from new, modified, or additional sources, and assessing sound at new residential premises.

The assessor is required to estimate the impact by subtracting the measured background sound level from a rating level, considering the following:

- Typically, the greater the difference, the greater the magnitude of the impact, and the lower the rating level is relative to the background sound level, the less likely it is that the specific sound source will have an adverse impact.
  - A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on context.
  - A difference of around +5 dB is likely to be an indication of an adverse impact, depending on context.
  - Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

The rating level is determined by 'rating' the source by correcting for any acoustic characteristics that may be present, as follows:

- Tonality; +2 dB just perceptible, +4 dB clearly perceptible, +6 dB highly perceptible.
- Impulsivity; +3 dB just perceptible, +6 dB clearly perceptible, +9 dB highly perceptible.
- Intermittency; +3 dB if readily distinctive.
- Other characteristics; +3 dB if readily distinctive.

On the determination of a background sound level, the Standard states that the aim is to present a background sound level, over a suitable time period, which is representative of the typical noise environment, and considers the context of the noise sources affecting that environment. The statistical analysis provided as an example in BS 4142 presents the lowest most commonly occurring L_{A90} value as the typical background sound level.

The importance of 'context' is highlighted in the Standard, as is interpretation by a qualified and experienced assessor. The interpretation of the rating level(s) as quantified above needs to be informed by an understanding of the context within which the sound is experienced.

3.4 LOCAL PLANNING POLICY

3.4.1 LONDON PLAN

The London Plan 2016 sets out the new spatial development strategy for Greater London and consolidates all of the alterations to the Plan since 2011. The London Plan sets out an integrated economic, environmental, transport and social framework for the development of London over a 20-25 year period to 2036. The following policies are considered relevant to this assessment:

- Policy: 7.15 – Reducing and managing noise, improving and enhancing the acoustic environment and promoting appropriate soundscapes;
- Paragraph: 7.52, relating to promoting good health and good quality of life by encouraging the right acoustic environment in the right place at the right time. The Paragraph addresses the control of noise for developments through good acoustic design and points to the guidance provided in BS 8233:2014; and
- Paragraph: 7.53, relating to the control of noise from roads and rail, and noise exposure in urban areas.

3.4.2 THE CROYDON LOCAL PLAN, 2018

The Croydon Local Plan identifies the site (ref. 522: Surface car park, Wandle Road) as being:

- Located within the Croydon Opportunity Area Masterplan in which major growth is expected and a high number of homes are anticipated/predicted. Within this Area objectives include the provision of new homes, bus stands, a district energy centre, retention of car parking and enhanced visual amenity;
- Located within the Old Town Masterplan and is viewed as an Opportunity Site with the car park currently not running at full capacity outside of working hours;
- Situated within the Old Town Eastern Residential Character Area, identified as an area of high-density modern housing; and
- An Area of High Density (Ref. RO12);

3.4.3 POLICY DM23

Paragraphs 8.19, 8.20 and 8.21 of the Croydon Local Plan 2018 relate to the control and assessment of noise for new developments, whereby the aims are to:

- Ensure residents and businesses are protected from the effects of construction noise; and
- Ensure that any proposed development has adequate sound insulation in order to minimise the adverse impact of noise from environmental sources.

4 ENVIRONMENTAL NOISE SURVEY

An environmental noise survey was undertaken between Wednesday 3rd May and Thursday 4th May 2017 in order to establish the prevailing noise levels across the site.

Due to the current occupation of the site, that being a public car park, and an absence of secure places to leave monitoring equipment unattended, data was gathered using primarily short-term attended monitoring at key periods during the day and night in accordance with the approach previously agreed with LBC.

The survey details and results are included in this section.

4.1 SURVEY METHODOLOGY

Table 4-1 details the monitoring locations, which are shown on the plan in Appendix B.

Table 4-1 - Acoustic survey locations

Locations	Description
MP1 (Blue)	Located on the top storey of Wandle Car Park overlooking the flyover. The measurement was undertaken in broad accordance with the Calculation of Road Traffic Noise (CRTN) shortened method. Used to validate the output of the 3D noise model and considered, broadly, representative of noise levels experienced on façades overlooking the flyover.
MP2 (Yellow)	Located at the north-east corner of the existing car park at approximately 5.5 m above ground. Used to validate the output of the 3D noise model.
MP3 (Pink)	Located at the north-west corner of the existing car park at approximately 5.5 m above ground. Used to validate the output of the 3D noise model.
MP4 (Cyan)	Attended measurement location approximately 3 m from the façade of the nearest residential building to the east of Mann Close at 1.2 m above ground. Representative of background noise levels at receptors to the north east of the site.
MP5 (Green)	Attended measurement location approximately 3.5 m from the façade of the nearest residential building to the west of Mann Close at 1.2 m above ground. Representative of background noise levels at receptors to the north west of the site.
MP6 (Orange)	Attended measurement location underneath the north edge of the slip-road up to main flyover at 1.2 m above ground. Indicative of external noise levels incident on areas of the façade of the proposed development that are screened from the flyover by the slip road.

With the exception of MP1, at all measurement locations the microphone was considered to be in free-field conditions, i.e. at least 3.5 m away from any acoustically reflective vertical surfaces.

At location MP1 the microphone was fixed to a fence approximately 2 m above the solid external façade of the car park. Considering the location of the dominant sources of noise relative to the microphone, measurement data are not considered to have been influenced by reflections from this façade.

4.2 EQUIPMENT DETAILS

Details of the equipment used to undertake the environmental noise survey are presented in Table **4-2** below.

Table 4-2 - Equipment details

Noise Measurement Position	Equipment Type	Manufacturer and Model	Serial No.
MP1 and MP4 / MP5 / MP6 (evening)	Meter	01dB-METRAVIB Solo Master	65242
	Pre-amplifier	01dB-Stell PRE 21 S	16781
	Microphone	Microtech Gefell GmbH MCE212	153334
	Calibrator	01dB-Stell Cal 21	35242306
MP2 / MP3	Meter	01dB-METRAVIB Solo Master	10712
	Pre-amplifier	01dB-Stell PRE 21 S	13599
	Microphone	Microtech Gefell GmbH MCE212	94014
	Calibrator	01dB-Metravib Cal 21	51031263
MP4 / MP5 / MP6 (daytime)	Meter	Svantek Type 971	44014
	Pre-amplifier	Svantek Pre-amplifier Type SV18	44336
	Microphone	Svantek Prepolarised Condenser Microphone Model SV22	59572
	Calibrator	NC74	34615221

The sound level meters were field-calibrated before and after measurements using the acoustic calibrators detailed above. No significant drift in calibration level (i.e. no more than 0.5 dB) was recorded. The calibrators and sound level meters had been calibrated by a United Kingdom Accreditation Service (UKAS) accredited calibration laboratory within the preceding 12 months.

Weather conditions throughout the survey were conducive to the measurement of environmental noise, it being dry and clear with low wind speeds (< 5 m/s) throughout.

4.3 SURVEY RESULTS

The survey data can broadly be split into two sets of results:

- Single measurements obtained at MP1, MP2 and MP3; and
- Repeated measurements obtained at MP4, MP5 and MP6.

Table 4-3 overleaf presents the results of measurements taken at locations MP1, MP2 and MP3.

Table 4-3 - Results at locations MP1, MP2 and MP3

Measurement Position	Start Time (hh:mm)	End Time (hh:mm)	dB $L_{Aeq,T}$	dB $L_{A90,T}$
MP1	11:40	14:40	75	67
MP2	12:03	14:00	65	60
MP3	14:05	14:59	66	62

Table 4-4 presents the results of measurements taken at locations MP4, MP5 and MP6.

Table 4-4 - Results at locations MP4, MP5 and MP6

Measurement Position	Start Time (hh:mm)	End Time (hh:mm)	dB $L_{Aeq,T}$	dB $L_{AF90,T}$
MP4	12:12	12:27	63	58
	13:09	13:24	63	58
	21:39	21:54	61	55
	02:51	03:07	50	39
	03:44	03:59	54	41
MP5	12:28	12:43	63	58
	14:08	14:23	65	59
	22:11	22:28	62	55
	03:08	03:23	51	38
	04:00	04:17	54	41
MP6	12:46	13:01	67	62
	14:25	14:45	66	61
	22:30	22:45	63	55
	03:26	03:41	56	43

The site predominantly is affected by road noise from the flyover with distant road traffic also contributing to the ambient noise climate. In the north of the site, local traffic also influences the noise climate.

During attendance it was noted that the sources of noise affecting the site were generally the same throughout the day and night, with a large diurnal variation in the noise climate, as evidenced in the short-term measurement results summarised in Table 4-4 above.

5 PLANT NOISE EMISSION LIMITS

Cumulative plant noise emission limits have been derived for all external sources associated with the development, that fall within the scope of BS 4142 (as summarised in Section 3).

These levels are imposed to limit disturbance to surrounding residents of nearby existing and proposed dwellings, due to noise emitted from plant or services associated with the development.

The limits presented below should be used to inform final plant selections. It is considered likely that LBC would impose a condition upon the development whereby a detailed assessment of noise emissions would be required, with mitigation measures presented where necessary, to demonstrate compliance with these limits.

5.1 NOISE LIMITS

The noise limits have been set in line with guidance presented in BS 4142 and the requirements of LBC.

The results of the attended, short-term monitoring have been used in order to determine appropriate background noise levels from which plant noise limits can be derived.

The nearest existing residential receptors to the north of the flyover (NSR1, NSR2 and NSR3) are considered to have, broadly, the same noise climate and are represented by measurement positions MP4 and MP5.

The nearest existing residential receptors to the south of the flyover (NSR4) are considered to be better represented by noise levels measured at MP6.

Measurements were undertaken at the above locations at, what are considered to be, the quietest daytime and night-time periods.

Table 5-1 below presents plant noise limits at each of the nearest noise sensitive receptors, as described in Section 2.2. The location of these noise sensitive receptors is shown in Appendix B.

Table 5-1 - Noise limits for plant and operations within the scope of BS 4142

Noise Sensitive Receptors	Representative Measurement Location	Period	Typical Background Sound Level (Free-Field, dB $L_{A90,15m}$)	Free-field Cumulative Plant Noise Limit at the Receptor Location (dB $L_{Ar,Tr}$)
Receptors to the flyover, to the west, north, and north-east of the development (NSR1, NSR2 & NSR3)	MP4 / MP5	Daytime (0700 – 2300)	55	45
		Night-time 2300 – 0700)	38	28
Receptors to the south of the Croydon Flyover (NSR4)	MP6	Daytime (0700 – 2300)	55	45
		Night-time 2300 – 0700)	43	33

The above noise limits are expressed in terms of $L_{Ar,Tr}$ (i.e. rating levels), as defined in BS 4142 and explained in Section 3.3 of this report, and are applicable to the cumulative level of all plant and operations as predicted 1 metre from a noise-sensitive element of the residential building(s) in question. As such, individual plant items may need to be designed to achieve a lower level, such that the overall noise limits are achieved.

6 PLANT NOISE ASSESSMENT

Noise emissions from items of plant associated with the proposed development must be assessed in order to determine the mitigation requirements and to ensure acceptable levels of environmental noise are achieved when the project is complete and the equipment is in operation.

6.1 NOISE MODEL

A 3-dimensional digital noise model of the site and its surroundings has been built in the environmental noise propagation prediction software CadnaA. This software allows noise levels to be accurately predicted at surrounding receptors likely to be affected by noise from the proposed energy centre.

The base model has been built using publicly available topographical, building location and road location data. A screenshot of the 3-dimensional noise model is shown in Figure 6-1 below.

Figure 6-1 – Screenshot of the 3-dimensional noise model of the energy centre

6.2 PLANT DETAILS

Table 6-1 below presents the type, location and source noise level of equipment which have been included in the assessment. The assessment is based on a worst-case night-time plant operating scenario.

Table 6-1 - Noise data for plant equipment

Equipment	Number of items	Location	Sound Pressure Level @ 1 metre, dBA
Combined Heat Power (CHP) Container	1	Ground Floor inside Energy Centre	65
CHP Air Intake Louvre	1	First Floor, northern façade of Energy Centre	65
CHP Air Discharge Louvre	1	First Floor, southern façade of Energy Centre	65
CHP Dry Air Cooler	1	Energy Centre Rooftop (East)	65
CHP LTHW Shunt Pump	1	Ground Floor inside Energy Centre	65
CHP Flue Termination	1	3m above parapet of adjacent Wandle Road residential development (approx. total height 86m)	65
Boiler Burner	3	Ground Floor inside Energy Centre	75
Boiler Shunt Pump	3	Ground Floor inside Energy Centre	65
Boiler Flue Termination	3	3m above parapet of adjacent Wandle Road residential development (approx. total height 86m)	94
High Voltage Transformer	1	First Floor inside Energy Centre	60
General Plantroom Noise Level (First Floor)	N/A	First Floor inside Energy Centre	75

6.3 PLANT NOISE RATING CORRECTIONS

The BS 4142 approach is to assess the impact of a noise source(s) by comparing the rating level of a specific source (in this case, new proposed rooftop and basement plant equipment serving the Harrods building), as determined outside the receptor location of interest, to the existing background sound level at the receptor location (in the absence of the source).

The criteria are based on guidance in BS 4142 which requires any sound containing tonality, impulsivity or intermittency to incur an acoustic feature correction.

Based on a review of the initial noise data provided, and the environmental noise survey results, the proposed plant is not expected to contain features that will be distinctive against the residual acoustic environment. Therefore, no acoustic feature correction has been applied to the specific sound levels for this assessment.

6.4 PREDICTED NOISE LEVELS

Noise levels resulting from the energy centre plant have been predicted at 1 m from the façade of the nearest noise sensitive residential receptors and assessed against the proposed noise limits to determine mitigation requirements.

The predicted noise levels are based on the noise data provided, the distance to nearest receptors, and any screening that may be afforded by the existing and proposed building architecture.

The cumulative noise levels from all plant equipment are presented in Table 6-2.

Table 6-2 - Predicted noise levels from energy centre operation at nearest sensitive receptors

NSR	Time Period	Predicted Specific Sound Level, dB	Acoustic Feature Correction, dB	Predicted Rating Level, dB $L_{Ar,Tr}$	Plant Noise Limit, dB L_{A90}	Exceedance, dB
1	Daytime (0700 – 2300)	41	0	41	45	0
	Night-time 2300 – 0700)	41	0	41	28	13
2	Daytime (0700 – 2300)	51	0	51	45	6
	Night-time 2300 – 0700)	51	0	51	28	23
3	Daytime (0700 – 2300)	53	0	53	45	8
	Night-time 2300 – 0700)	53	0	53	28	25
4	Daytime (0700 – 2300)	33	0	33	45	0
	Night-time 2300 – 0700)	33	0	33	33	0

The assessment of noise emissions from the energy centre plant demonstrates that, without mitigation measures, the predicted sound pressure levels are expected to exceed the daytime plant noise limits at NSR2 and NSR3, and exceed the night time plant noise limits at NSR1, NSR2 and NSR3.

Higher exceedances are predicted during the night time periods, due to the lower night time plant noise limits at each receptor. Therefore, mitigation requirements are explored in the following section.

7 MITIGATION REQUIREMENTS

Based on the predicted noise levels in Table 6-2, in order to control noise breakout from the energy centre, the following noise control measures will be required:

- Select quieter boiler burners, to achieve a maximum sound pressure level of 70 dBA at 1 metre.
- Install 4 no. attenuators to the boiler flue exhaust paths.
- Install 1 no. attenuators to the CHP flue exhaust path.
- Install 2 no. attenuators to the CHP air intake and exhaust paths (in addition to the CHP enclosure).
- Install acoustic louvres to all natural ventilation openings on the façade of the energy centre.
- Install an acoustic enclosure to contain noise from the rooftop CHP dry air cooler. The enclosure may be constructed using acoustic louvres achieving the performance provided in Table 7-1.
- Install acoustically absorptive lining (Class A performance) to control the reverberant noise levels within the energy centre. The lining should be applied to the total soffit surface area of both the ground and first floors (approximately 870m^2 total coverage).

The required insertion losses for the attenuators and acoustic louvres are presented in Table 7-1 below.

Table 7-1 - Attenuator and acoustic louvre performance requirements

Description	No.	Required Insertion Loss (dB) At Each Octave Band Centre Frequency (Hz)								Approx. Length (mm)
		63	125	250	500	1000	2000	4000	8000	
CHP air intake and exhaust attenuators	2	7	12	25	40	46	45	33	20	2400
Boiler flue attenuators	4	5	9	17	28	29	30	26	20	1420
CHP flue attenuator	1	4	10	16	26	29	29	29	20	1000
Acoustic louvres. Insertion losses based on Caice CS600 acoustic louvre.	All	7	8	13	23	37	33	29	29	600

The acoustic lining shall comprise acoustically absorptive material (such as Class '0' fire rated open cell foam, mineral fibre or glass fibre) fixed in place with a non-obstructing fixing system. The acoustic lining shall achieve the following minimum sound absorption coefficients.

Table 7-2 - Minimum absorption coefficients for the acoustically absorptive lining

Absorption Coefficient (α) At Each Octave Band Centre Frequency (Hz)					
125	250	500	1000	2000	4000
0.40	0.75	0.90	0.80	0.90	0.85

- Any removable wall sections must be designed so that they do not reduce the overall sound insulation performance of the building envelope.

7.1 RESIDUAL PREDICTED NOISE LEVELS WITH MITIGATION

With the inclusion of the mitigation measures outlined in Section 7, the cumulative noise levels from all plant equipment are presented in Table 7-3.

Table 7-3 - Predicted noise levels from energy centre operation (including mitigation)

NSR	Time Period	Predicted Specific Sound Level, dB	Acoustic Feature Correction, dB	Predicted Rating Level, dB $L_{Ar,Tr}$	Plant Noise Limit, dB L_{A90}	Exceedance, dB
1	Daytime (0700 – 2300)	22	0	22	45	0
	Night-time 2300 – 0700)	22	0	22	28	0
2	Daytime (0700 – 2300)	30	0	30	45	0
	Night-time 2300 – 0700)	30	0	30	28	2
3	Daytime (0700 – 2300)	29	0	29	45	0
	Night-time 2300 – 0700)	29	0	29	28	1
4	Daytime (0700 – 2300)	10	0	10	45	0
	Night-time 2300 – 0700)	10	0	10	33	0

The assessment demonstrates that, with the inclusion of all mitigation measures discussed above, the night time plant noise limits are still exceeded (by 2 dB and 1 dB) at NSR2 and NSR3.

It is therefore recommended that consideration is given to a reduced night time operation of the energy centre, in order that the limits are achieved.

A reduction in the equipment load and number of plant operating would provide respite and serve to lower noise emissions during the more critical and most onerous night time design target at each residential receptor.

As such it is recommended that the energy centre be operational during the daytime period, with limited operating during the more noise sensitive night period.

Further considerations to reduce noise levels include:

- Reducing the louvred area on the northern façade of the energy centre (opposite NSR2).
- Reselecting quieter plant equipment.

8 CONCLUSIONS

WSP has been appointed by Croydon Council to provide acoustic engineering services for the construction of a new proposed District Energy Scheme on Scarbrook Road in Croydon, London.

An acoustic assessment has been undertaken to determine the mitigation measures required to ensure that plant noise emissions from the proposed energy centre do not disturb the nearby local residents.

Previously undertaken noise surveys have been used in conjunction with relevant national and local planning policies, as well as national guidance and standards, to determine plant noise limits at the nearest noise sensitive receptors.

Noise levels have been predicted at nearest residential receptors and assessed against the local planning policy plant noise limits to determine compliance.

The assessment has suggested that, without mitigation, predicted sound pressure levels will exceed the plant noise limits at the closest nearest sensitive receptors.

As such, the following mitigation measures will be required:

- Select quieter boiler burners, to achieve a maximum sound pressure level of 70 dBA at 1 metre.
- Install 4 no. attenuators to the boiler flue exhaust paths.
- Install 1 no. attenuators to the CHP flue exhaust path.
- Install 2 no. attenuators to the CHP air intake and exhaust paths (in addition to the CHP enclosure).
- Install acoustic louvres to all natural ventilation openings on the façade of the energy centre.
- Install an acoustic enclosure to contain noise from the rooftop CHP dry air cooler. The enclosure may be constructed using acoustic louvres achieving the performance provided in Table 7-1.
- Install acoustically absorptive lining (Class A performance) to control the reverberant noise levels within the energy centre. The lining should be applied to the total soffit surface area of both the ground and first floors (approximately $870m^2$ total coverage).

With the inclusion of all mitigation measures outlined above, minor exceedances of the night-time plant noise limits are predicted at two of the closest noise sensitive receptors. It is therefore recommended that consideration is given to restricting the energy centre equipment load and number of plant items operating during the night, to eliminate exceedances of the plant noise limits at these receptors.

Limitations to this report are included within Appendix D.

Appendix A

ACOUSTIC TERMINOLOGY

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

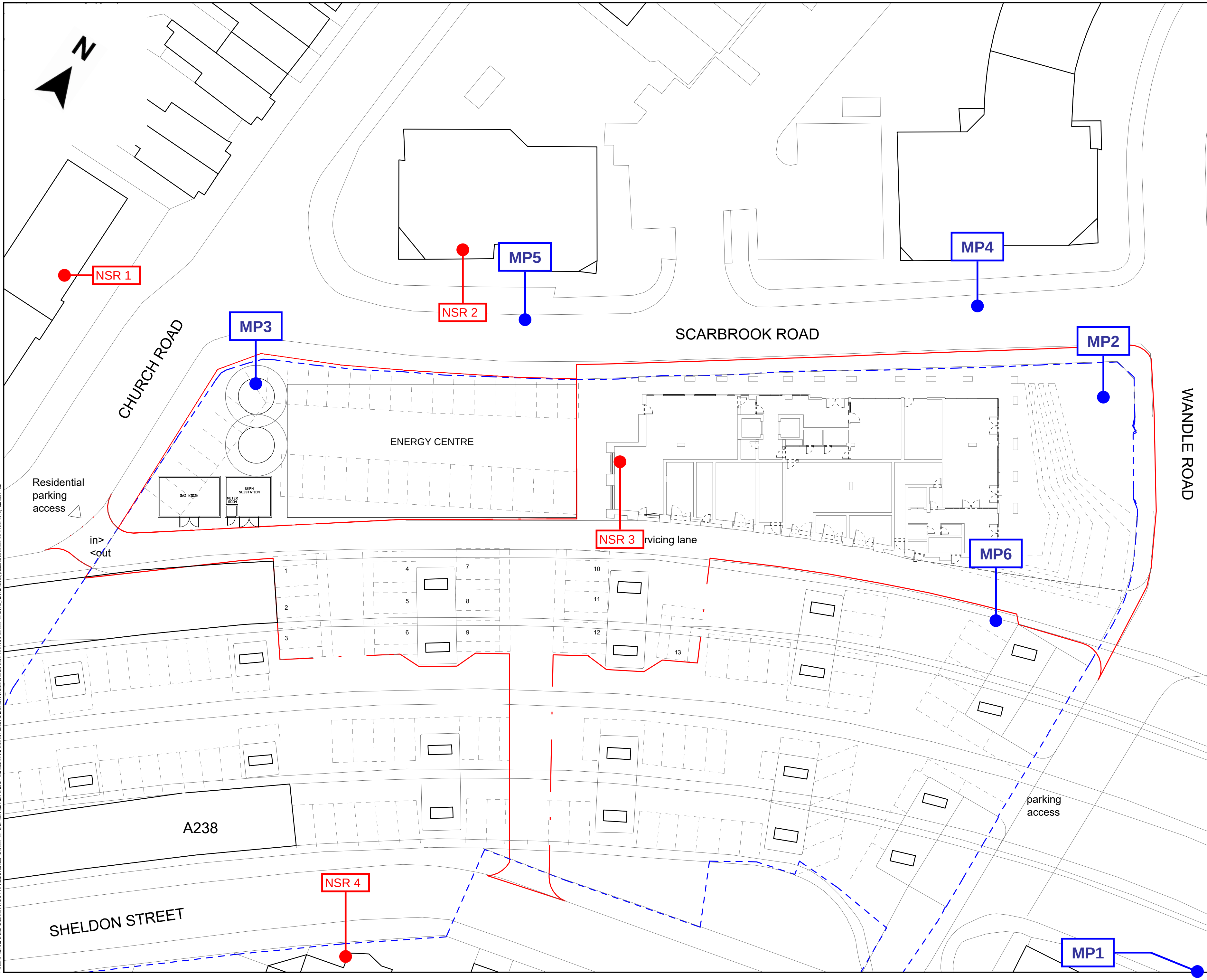
The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

Table A-1: Terminology relating to noise

Terminology	Description
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
Façade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa (20x10-6 Pascals) on a decibel scale.

Appendix B

NOISE MEASUREMENT POSITIONS & NOISE SENSITIVE RECEPTORS



DO NOT SCALE

NOTES:

1. tbc

P0	tbc	TH	DRAFT FOR COMMENT	JE	AG
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DRAWING STATUS: S0 - WORK IN PROGRESS

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CLIENT: CROYDON COUNCIL

PROJECT: CROYDON DISTRICT ENERGY SCHEME

TITLE: ENERGY CENTRE SITE PLAN

SCALE @ A1: 1:200	CHECKED: JE		APPROVED: AJG
PROJECT No: 70057109	DESIGNED: TH	DRAWN: CAD	DATE: 11/10/2019
DRAWING No: M-0100			REV: P0

Appendix C

LIMITATIONS OF THIS REPORT

LIMITATIONS TO THIS REPORT

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The findings and opinions expressed are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. Opinions included therein are based on information gathered during the study and from our experience. If additional information becomes available which may affect our comments, conclusions or recommendations WSP UK Limited reserve the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

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Appendix C

ENERGY BALANCE MODELLING OUTPUTS AND OPERATING MARGIN CALCULATIONS

Energy Balance Outputs

Croydon TEM
Summary outputs

ENERGY BALANCE OUTPUTS kWh p.a. unless otherwise stated	2022	2023	2024	2025	2026	2027	2028	2029
Demands	-	-	-	-	-	-	-	-
Heat demand (LTHW)	5,586,065	5,586,065	5,586,065	10,465,865	18,069,978	27,017,891	27,017,891	27,017,891
Heat losses (LTHW) (Town centre network only)	394,200	394,200	394,200	657,000	1,116,900	1,511,100	1,511,100	1,511,100
Elec demands (before parasitics)	9,138,084	9,138,084	9,138,084	9,138,084	9,138,084	9,138,084	9,138,084	9,138,084
Heat supply	-	-	-	-	-	-	-	-
HS1 - LTHW output (CHP)	4,438,682	4,438,682	4,438,682	1,258,992	1,258,992	1,258,992	1,258,992	1,258,992
HS2 - LTHW output (EfW link output in Town Centre)	-	-	-	8,736,610	15,018,725	22,469,267	22,469,267	22,469,267
HS3 - LTHW output	-	-	-	-	-	-	-	-
Top-up boilers - LTHW output	1,542,530	1,542,530	1,542,530	1,438,365	2,995,775	4,812,955	4,812,955	4,812,955
HS1 - Electricity generation (CHP)	4,264,546	4,264,546	4,264,546	1,209,600	1,209,600	1,209,600	1,209,600	1,209,600
HS2 - Electricity generation	-	-	-	-	-	-	-	-
HS3 - Electricity generation	-	-	-	-	-	-	-	-
HS1 -Fuel input (CHP)	11,062,944	11,062,944	11,062,944	3,137,904	3,137,904	3,137,904	3,137,904	3,137,904
HS2 -Fuel input (heat at EC boundary)	-	-	-	8,736,610	15,018,725	22,469,267	22,469,267	22,469,267
HS3 - Fuel input	-	-	-	-	-	-	-	-
Top-up boilers - Fuel input	1,858,470	1,858,470	1,858,470	1,732,969	3,609,367	5,798,741	5,798,741	5,798,741
EC Parasitic demands	149,507	149,507	149,507	284,237	481,347	713,412	713,412	713,412
Total parasitics	149,507	149,507	149,507	284,237	481,347	713,412	713,412	713,412
Electricity export to grid	628,415	628,415	628,415	106,968	96,140	85,478	85,478	85,478
Electricity import from Grid	5,651,460	5,651,460	5,651,460	8,319,690	8,505,971	8,727,374	8,727,374	8,727,374
Electricity generated and used on site / within PW network	3,636,131	3,636,131	3,636,131	1,102,632	1,113,460	1,124,122	1,124,122	1,124,122
Percentage heat met by low-carbon sources (of heat demand inc Town Centre losses)	74%	74%	74%	90%	85%	83%	83%	83%
Percentage heat met by low-carbon sources (of end-user heat demands only)	79%	79%	79%	96%	90%	88%	88%	88%
Heat top-up and standby supply as LTHW	1,542,530	1,542,530	1,542,530	1,438,365	2,995,775	4,812,955	4,812,955	4,812,955
Fuel input (GCV)	1,858,470	1,858,470	1,858,470	1,732,969	3,609,367	5,798,741	5,798,741	5,798,741
Elec used on site meeting parasitics	114,962	114,962	114,962	48,477	70,469	99,332	99,332	99,332
Run hours	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
HS1	3,692	3,692	3,692	1,008	1,008	1,008	1,008	1,008
HS2	-	-	-	6,265	6,653	6,886	6,886	6,886
HS1 number of starts p.a	484	484	484	336	336	336	336	336
HS2 number of starts p.a	-	-	-	230	243	227	227	227
HS1 Heat rejection	0	0	0	308,292	83,735	9,344	9,344	9,344
Electricity volumes by day / night splits	-	-	-	-	-	-	-	-
IMPORT	kWh p.a.	kWh p.a.	kWh p.a.	kWh p.a.	kWh p.a.	kWh p.a.	kWh p.a.	kWh p.a.
Day (weekday)	2,801,842	3,131,813	3,215,581	4,270,271	4,337,412	4,440,981	4,432,610	5,207,205
Night (weekday)	1,139,466	1,201,886	1,260,038	1,499,532	1,512,571	1,529,295	1,506,953	1,598,578
Day (weekend)	1,195,918	865,946	782,178	1,949,029	2,037,057	2,115,168	2,123,540	1,348,944
Night (weekend)	514,234	451,814	393,662	600,858	618,930	641,930	664,272	572,647
EXPORT	-	-	-	-	-	-	-	-
Day (weekday)	368,024	205,367	177,275	101,481	95,074	84,608	82,662	5,888
Night (weekday)	135,392	113,941	92,614	-	-	-	-	-
Day (weekend)	88,700	251,357	279,449	5,487	1,066	870	2,816	79,589
Night (weekend)	36,298	57,749	79,076	-	-	-	-	-
SOLD TO PRIVATE WIRE DEMANDS (total demands)	-	-	-	-	-	-	-	-
Day (weekday)	4,802,203	5,255,402	5,630,213	4,872,551	4,827,136	4,800,260	4,802,203	5,630,213
Night (weekday)	1,424,457	1,467,608	1,511,906	1,463,127	1,456,094	1,446,062	1,424,457	1,511,906
Day (weekend)	2,284,703	1,831,504	1,456,693	2,214,355	2,259,769	2,286,645	2,284,703	1,456,693
Night (weekend)	626,721	583,571	539,273	588,051	595,084	605,117	626,721	539,273
GENERATED AND USED ON SITE / BY PW NETWORK	-	-	-	-	-	-	-	-
Day (weekday)	2,083,109	2,205,199	2,504,882	776,919	776,126	775,792	781,338	847,312
Night (weekday)	303,811	283,854	269,608	-	-	-	-	-
Day (weekend)	1,129,300	1,007,210	707,527	325,713	337,334	348,330	342,784	276,811
Night (weekend)	119,911	139,868	154,114	-	-	-	-	-
	-	-	-	-	-	-	-	-
HEAT PURCHASE FROM ERF (AT ERF boundary) - e.g. including losses	-	-	-	-	-	-	-	-
Day (weekday)	-	-	-	6,311,013	10,115,108	14,408,992	14,289,728	14,587,220
Night (weekday)	-	-	-	1,404,350	1,688,149	2,303,163	2,291,514	2,417,470
Day (weekend)	-	-	-	2,040,348	3,992,139	6,177,639	6,296,903	5,999,411
Night (weekend)	-	-	-	470,099	712,530	1,068,673	1,080,321	954,365
	-	-	-	-	-	-	-	-
TS imbalance (charge at start of year minus charge at end of year)	- 947	- 947	- 947	- 2,810	- 2,879	- 2,879	- 2,879	- 2,879 -

COST TO CROYDON SPV	TOWN CENTRE SCHEME	FIXED	CAPEX		£ -	£ -	£ 10,611,704	£ -	£ -	£ 2,643,090	£ 3,130,796	£ 1,966,558	£ -	£ -	£ -	£ -
			REPEX		£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
			Maintenance		£ -	£ -	£ -	£ 155,631	£ 155,631	£ 125,082	£ 153,875	£ 202,942	£ 219,330	£ 219,330	£ 219,330	£ 219,330
			Gas Standing Charges	inc in unit price												
			Electricity Standing Charges	inc in unit price												
			Billing and Customer Services	Sales to bulk meters	£ -	£ -	£ -	£ 2,000	£ 2,000	£ 2,000	£ 6,000	£ 12,500	£ 18,000	£ 18,000	£ 18,000	£ 18,000
			Sub-Total		**£ -**	**£ -**	**£ 10,611,704**	**£ 157,631**	**£ 157,631**	**£ 2,770,172**	**£ 3,290,671**	**£ 2,182,000**	**£ 237,330**	**£ 237,330**	**£ 237,330**	**£ 237,330**
		VARIABLE	Gas Import		£ -	£ -	£ -	£ 291,240	£ 291,240	£ 291,240	£ 109,786	£ 152,079	£ 201,426	£ 201,426	£ 201,426	£ 201,426
			Electricity Import		£ -	£ -	£ -	£ 587,434	£ 587,434	£ 587,434	£ 864,779	£ 884,142	£ 907,155	£ 907,155	£ 907,155	£ 907,155
			Other Costs		£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
			Heat Cost from ERF	0.50	£ -	£ -	£ -	£ -	£ -	£ -	£ 51,129	£ 82,540	£ 119,792	£ 119,792	£ 119,792	£ 119,792
			Sub-Total		**£ -**	**£ -**	**£ -**	**£ 878,674**	**£ 878,674**	**£ 878,674**	**£ 1,025,694**	**£ 1,118,761**	**£ 1,228,374**	**£ 1,228,374**	**£ 1,228,374**	**£ 1,228,374**
	ERF LINK	FIXED	CAPEX		£ -	£ -	£ -	£ -	£ -	£ 11,505,562	£ -	£ -	£ -	£ -	£ -	£ -
			REPEX		£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
			Maintenance		£ -	£ -	£ -	£ -	£ -	£ -	£ 101,513	£ 101,513	£ 101,513	£ 101,513	£ 101,513	£ 101,513
			Sub-Total		**£ -**	**£ -**	**£ -**	**£ -**	**£ -**	**£ 11,505,562**	**£ 101,513**	**£ 101,513**	**£ 101,513**	**£ 101,513**	**£ 101,513**	**£ 101,513**
			Total Cost	Cost shown as negative value	**£ -**	**£ -**	**-£ 10,611,704**	**-£ 1,036,305**	**-£ 1,036,305**	**-£ 15,154,408**	**-£ 4,417,878**	**-£ 3,402,274**	**-£ 1,567,216**	**-£ 1,567,216**	**-£ 1,567,216**	**-£ 1,567,216**
INCOME TO CROYDON SPV	TOWN CENTRE EC	OTHER	Heat sales		£ -	£ -	£ -	£ 225,314	£ 225,314	£ 225,314	£ 383,244	£ 628,134	£ 945,242	£ 945,242	£ 945,242	£ 945,242
			Heat - Standing charges		£ -	£ -	£ -	£ 37,122	£ 37,122	£ 37,122	£ 132,113	£ 302,529	£ 514,245	£ 514,245	£ 514,245	£ 514,245
			Heat - Connection Charges		£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
			PW Sales		£ -	£ -	£ -	£ 999,838	£ 999,838	£ 999,838	£ 999,838	£ 999,838	£ 999,838	£ 999,838	£ 999,838	£ 999,838
			PW - Standing charges		£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
			PW - Connection Charges		£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
			Sub-Total		**£ -**	**£ -**	**£ -**	**£ 1,262,274**	**£ 1,262,274**	**£ 1,262,274**	**£ 1,515,195**	**£ 1,930,502**	**£ 2,459,325**	**£ 2,459,325**	**£ 2,459,325**	**£ 2,459,325**
		GENERAL	Electricity Export (from TC EC)		£ -	£ -	£ -	£ 33,050	£ 33,050	£ 33,050	£ 5,626	£ 5,056	£ 4,496	£ 4,496	£ 4,496	£ 4,496
			Other Income		£ -	£ -	£ -	£ 9,600	£ 9,600	£ 9,600	£ 9,600	£ 9,600	£ 9,600	£ 9,600	£ 9,600	£ 9,600
			Sub-Total		£ -	£ -	£ -	£ 42,650	£ 42,650	£ 42,650	£ 15,226	£ 14,656	£ 14,096	£ 14,096	£ 14,096	£ 14,096
			Total Income		**£ -**	**£ -**	**£ -**	**£ 1,304,924**	**£ 1,304,924**	**£ 1,304,924**	**£ 1,530,421**	**£ 1,945,158**	**£ 2,473,420**	**£ 2,473,420**	**£ 2,473,420**	**£ 2,473,420**
			Operanting Margin		**£ -**	**£ -**	**-£ 10,611,704**	**£ 268,619**	**£ 268,619**	**-£ 13,849,484**	**-£ 2,887,457**	**-£ 1,457,115**	**£ 906,204**	**£ 906,204**	**£ 906,204**	**£ 906,204**
			Cumulative Discounted Cashflow				**-£ 10,252,854**	**-£ 10,002,095**	**-£ 9,759,816**	**-£ 21,828,841**	**-£ 24,260,002**	**-£ 25,445,367**	**-£ 24,733,099**	**-£ 24,044,917**	**-£ 23,380,007**	**-£ 22,737,582**
			Operating costs excluding capex & repex					-£1,034,305	-£1,034,305	-£1,003,756	-£1,179,570	-£1,321,703	-£1,447,704	-£1,447,704	-£1,447,704	-£1,447,704
			Operating revenues					£1,304,924	£1,304,924	£1,304,924	£1,530,421	£1,945,158	£2,473,420	£2,473,420	£2,473,420	£2,473,420
			Operating margin net of capex & repex					£270,619	£270,619	£301,169	£350,851	£623,455	£1,025,717	£1,025,717	£1,025,717	£1,025,717
			Discount Rate (%)	3.50%												

		25 YEARS	30 YEARS	40 YEARS
NPV		-£15,637,966	-£14,688,439	-£12,617,555
IRR		-3.9%	-2.6%	-0.4%

Appendix D

ELECTRICAL SURVEY FINDINGS AND PW DESIGN

ELECTRICAL SURVEY FINDINGS AND PW DESIGN

The configuration agreed to be tested as part of this study is based on the assumption that the the economics of the scheme may be significantly improved by supplying the electricity generated by the engine directly to one or more private wire customers rather than exporting it to the grid. The following private wire customers have been considered as part of this study (the Core scheme).

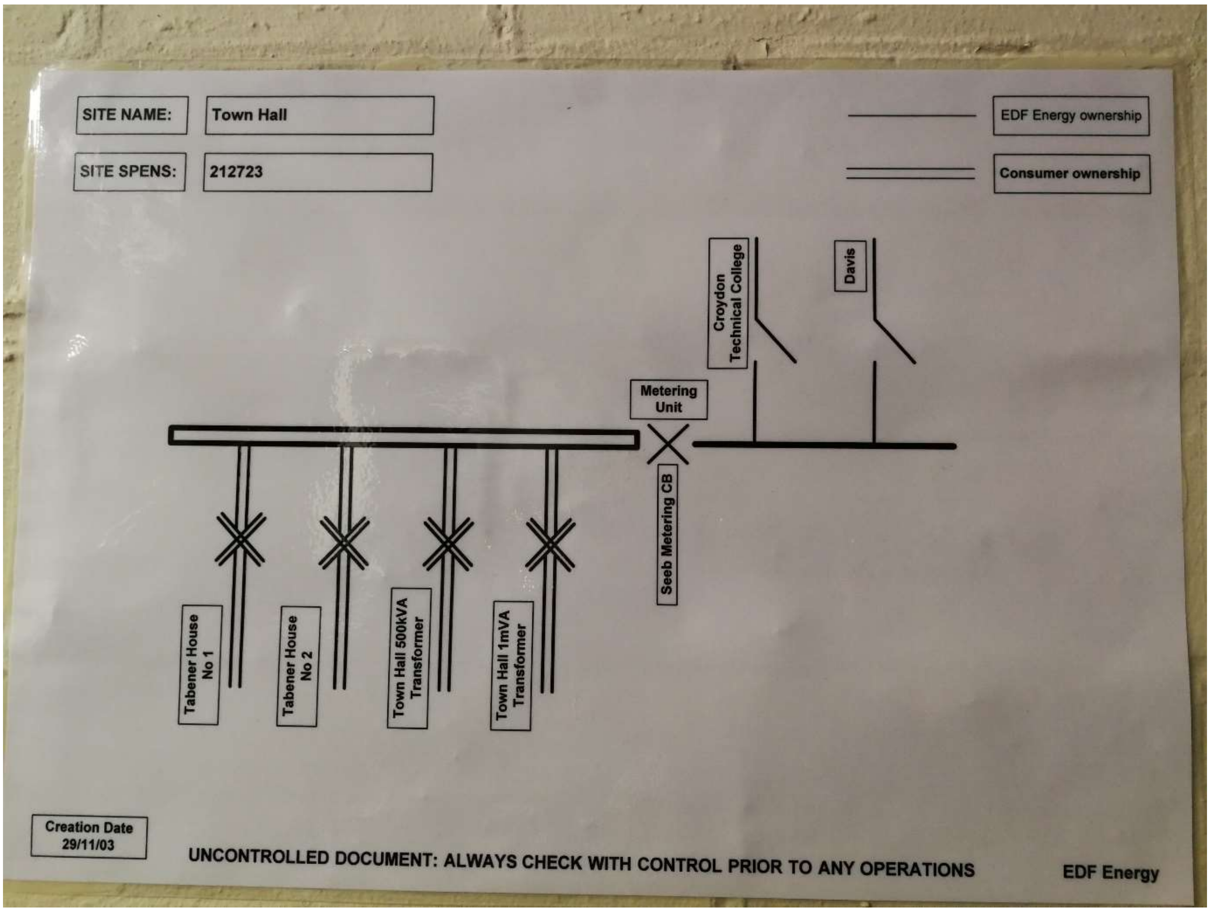
1. Town Hall
2. Library
3. BWH
4. Davis House

WSP visited the potential sites to establish the existing electrical arrangement and to establish the preferred private wire connection arrangement.

Building	**Preferred connection HV/LV**
Town Hall	LV supply
Library	LV supply
BWH	HV supply
Davis House	LV supply

<u>Town Hall & Library</u>

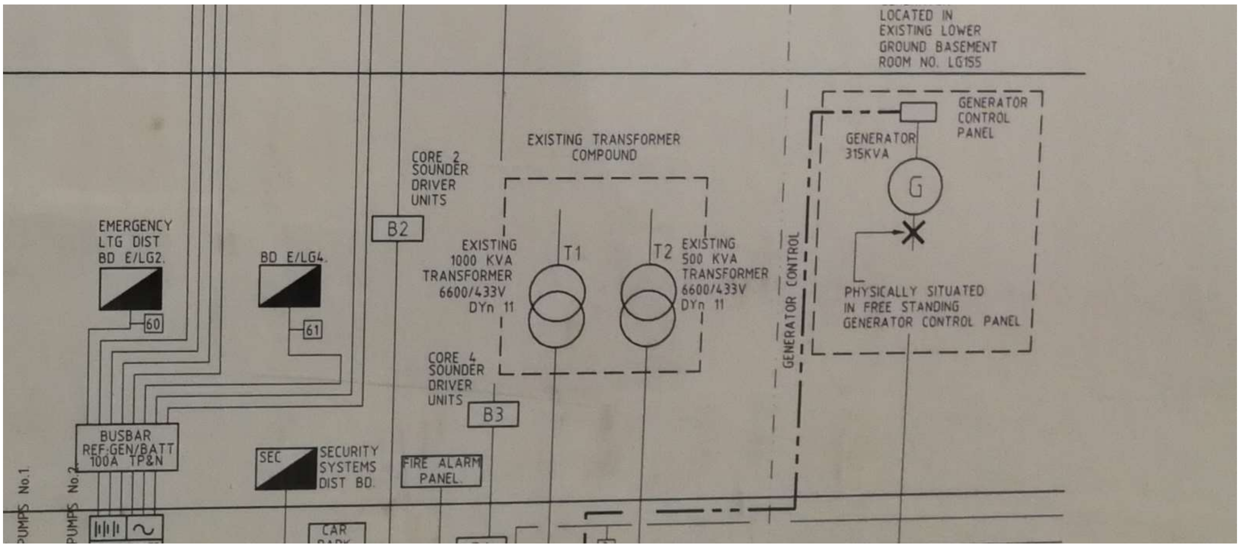
The schematic below illustrates the demarcation between the DNO and customer side installations. As per the pictures below, it is our understanding that the Library and Town hall transformer ratings are 1000kVA and 500kVA respectively.


SITE NAME:
Town Hall
SITE SPENS:
212723
EDF Energy ownership
Consumer ownership
Croydon Technical College
Davis
Metering Unit
Seeb Metering CB
Tabener House No 1
Tabener House No 2
Town Hall 500kVA Transformer
Town Hall 1mVA Transformer
Creation Date 29/11/03
UNCONTROLLED DOCUMENT: ALWAYS CHECK WITH CONTROL PRIOR TO ANY OPERATIONS
EDF Energy


CROYDON LIBRARY
1000kva TRANSFORMER


TOWN HALL
500 KVA TRANSFORMER

Due to access issues on the survey day, we have not surveyed the transformers. However, the as built Single Line Diagram below indicates that the transformers are 6600V/433V. It is therefore proposed that these transformers will have to be replaced with 11kV/417V transformers under the new private wire scheme.

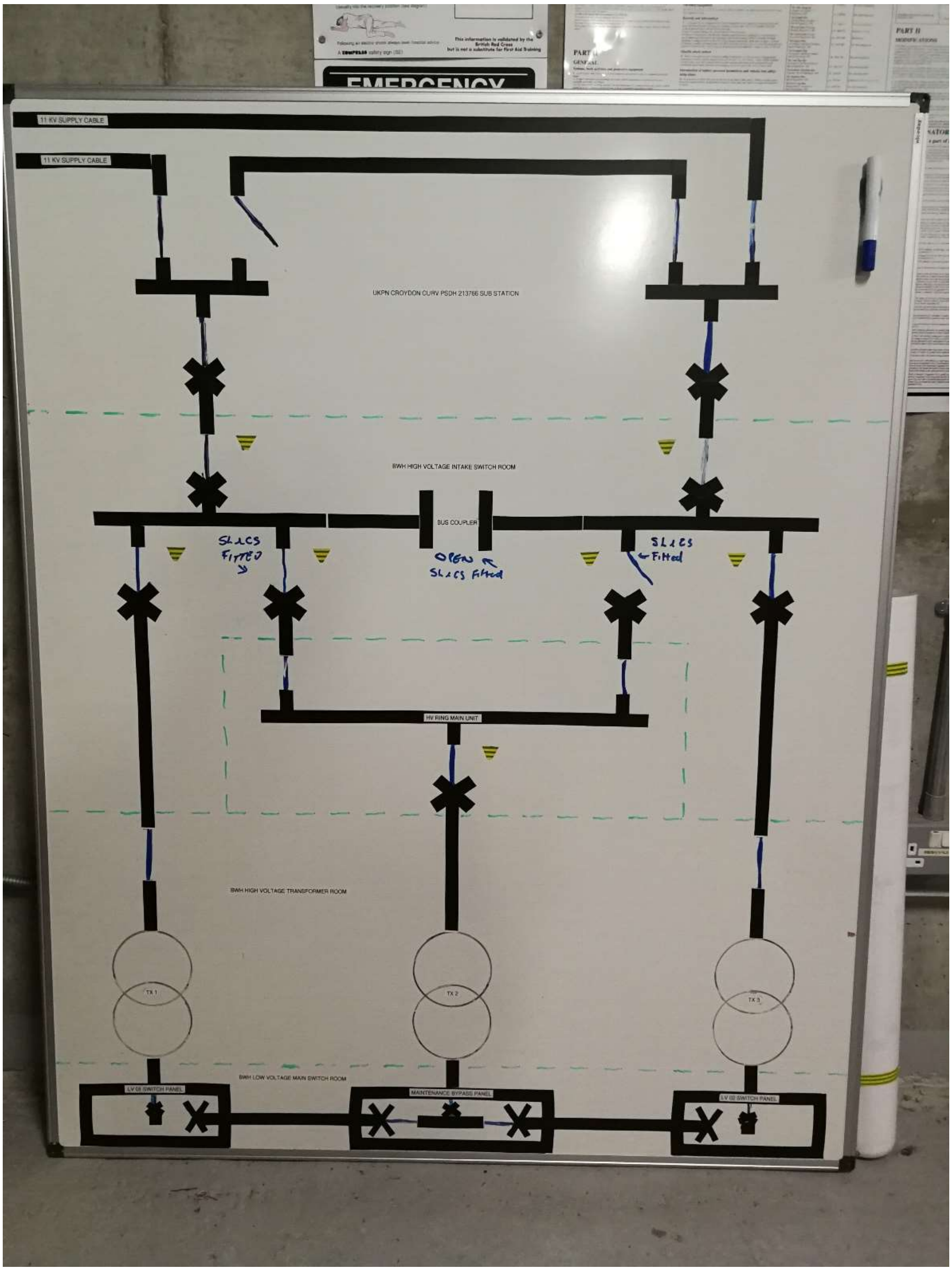


On this basis, we have allowed for two new transformers within the private wire scope to serve these two customers. It is expected that the existing LV distribution will be retained.

Refer to the WSP Single Line Diagram at the end of this Appendix for the proposed private wire connection arrangement.

BWH

The Single Line Diagram below, indicates that there are two 11kV UKPN feeders available via RMUs.

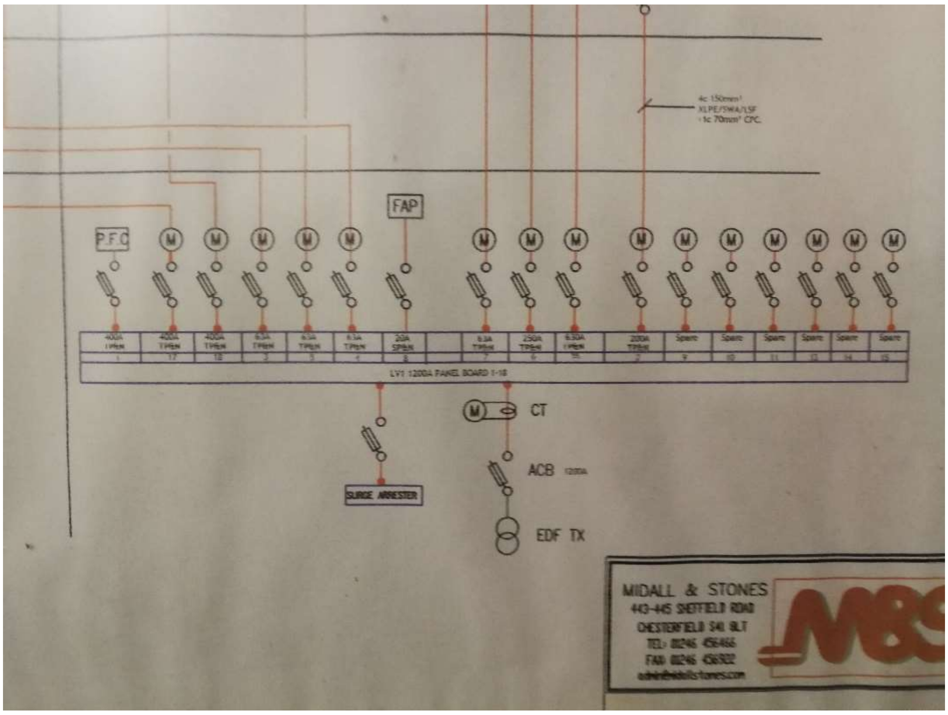


The proposed arrangement therefore includes two private wire RMUs that will replace UKPN's RMUs. Refer to WSP's Single Line Diagram for the proposed 11kV private wire connection arrangement. It is expected that the existing BWH HV intake switchboard will be retained. Two incoming feeders from PW will replace the two existing UKPN's incoming feeders.

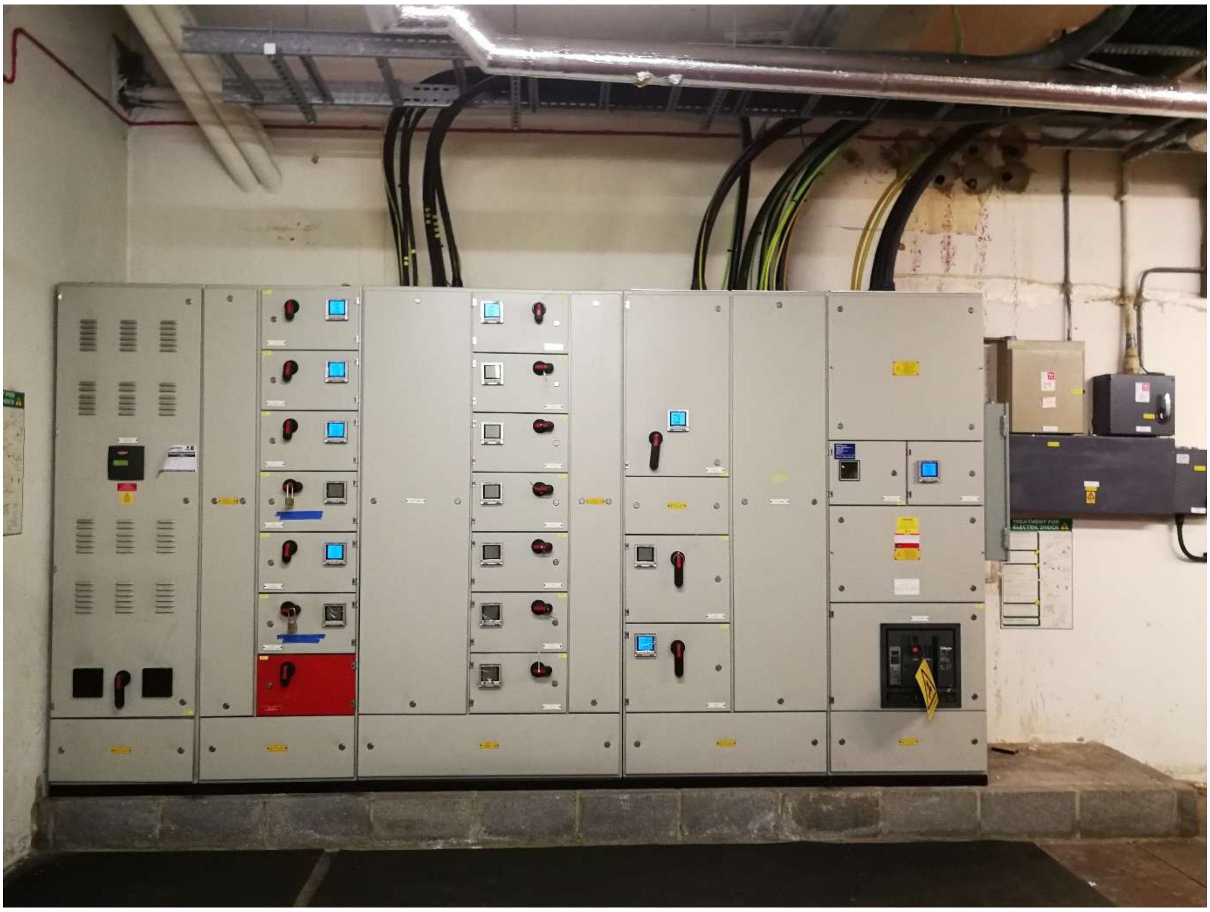
Davies House

The as built Single Line diagram indicates the demarcation between the DNO and customer.

It is our understanding, based on the SLD, that the existing supply to Davies House is Low Voltage.



It is therefore proposed that the private wire will also provide LV supply to this customer. The existing LV distribution shall be therefore retained.



The proposed private wire configuration will include a 11kV RMU and close coupled transformer to provide LV supply to the customer.

Resilience

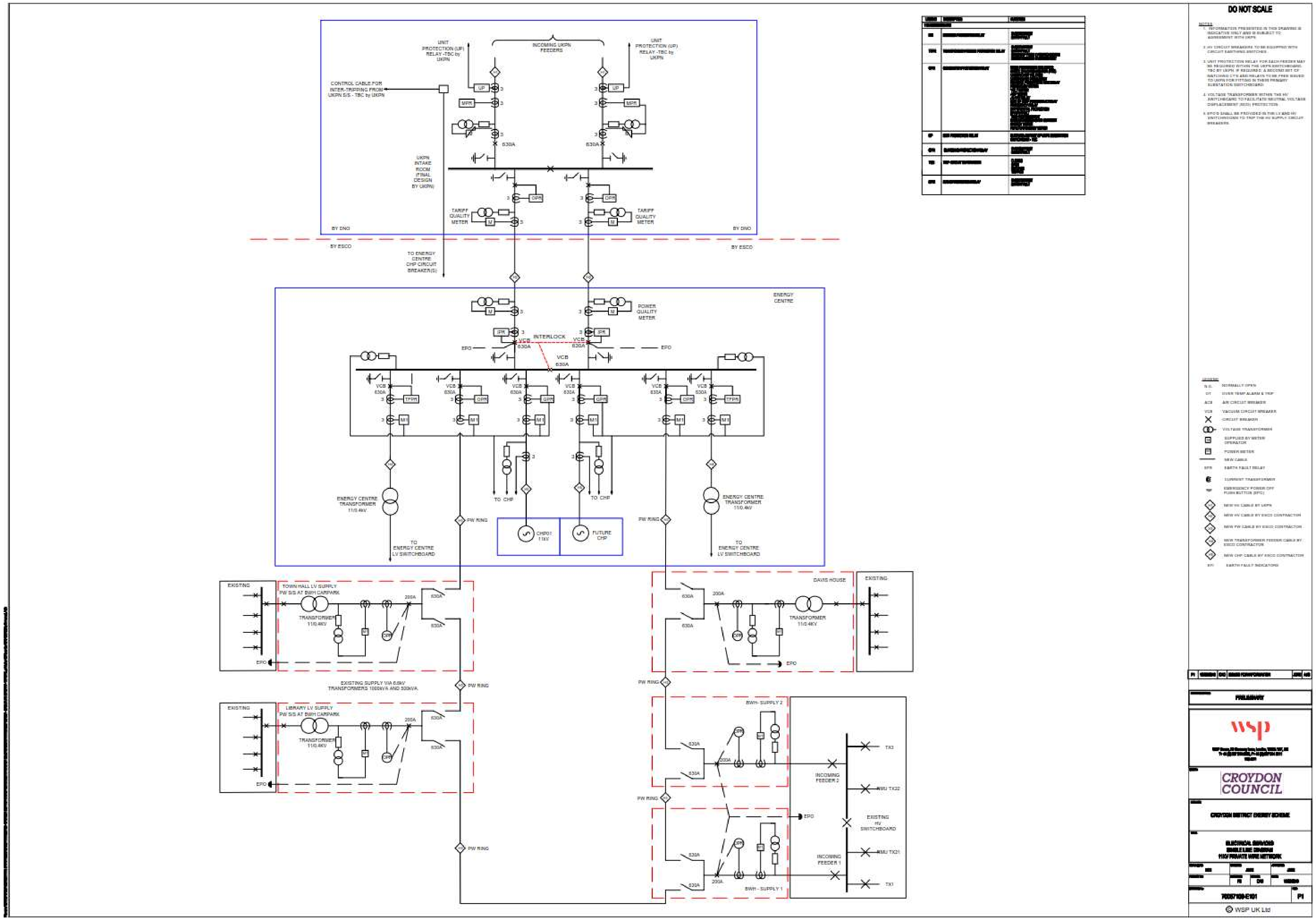
Considering the PW customer supplies and supply security to private customers, we have included two incoming supplies to the energy centre. We have also included a 11kV private wire ring to provide resilient supply to customers.

Decommissioning

The table below includes key electrical items that will be decommissioned to facilitate the PW connection.

Building	**Electrical items decommissioned**
Town Hall	6.6kV transformer
Library	6.6kV transformer
BWH	2 x UKPN RMUs
Davis House	UKPN Assets including transformer

Figure D-1 - Proposed PW SLD



Appendix E

STRUCTURAL PROPOSALS FOR WANDLE RD ENERGY CENTRE

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Croydon District Energy Scheme

STAGE 2 REPORT

Structural Engineering

70057109-REP01
NOVEMBER 2019

CONFIDENTIAL

Croydon District Energy Scheme

STAGE 2 REPORT

Structural Engineering

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70057109

OUR REF. NO. 70057109-REP01

DATE: NOVEMBER 2019

WSP

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WSP.com

QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks				
Date	07/11/2019			
Prepared by	Matthew Fry			
Signature	Fry, Matt Digitally signed by Fry, Matt DN: E=Matthew.Fry@wsp.com, CN="Fry, Matt", OU=Exeter (The Forum), OU=Accounts, OU=UK, OU=EMEA, DC=corp, DC=pbwan, DC=net Reason: I am the author of this document Date: 2019.11.21 13:50:30Z00'00'			
Checked by	Richard Scott			
Signature	Ian Branch Digitally signed by Ian Branch DN: C=GB, E=ian.branch@wsp.com, O=WSP UK Ltd, CN=Ian Branch Reason: I have reviewed this document Date: 2019.11.21 14:39:44Z00'00'			
Authorised by	Richard Scott			
Signature	Ian Branch Digitally signed by Ian Branch DN: C=GB, E=ian.branch@wsp.com, O=WSP UK Ltd, CN=Ian Branch Reason: I have reviewed this document Date: 2019.11.21 14:39:11Z00'00'			
Project number	70057109			
Report number	70057109-REP01			
File reference				

CONTENTS

APPENDICES

1

INTRODUCTION

INTRODUCTION

WSP have been appointed by Croydon Council to provide Engineering Design and Consultancy services for the construction of a new District Energy Scheme on Scarbrook Road in Croydon, London.

The purpose of this report is to communicate the development of the proposed Structural Engineering design up to the end of RIBA Stage 2 together with the criteria on which the next stage of design will be progressed.

The project comprises the construction of a two-storey energy centre to house mechanical and electrical plant, along with associated thermal stores, gas kiosk and a substation adjacent to the building.

PROPOSED SUBSTRUCTURE

There has been no ground investigation carried out specific to the proposed new building, however there has been a previous site investigation carried out within the same site for the construction of a 24-storey mixed commercial and residential building. The proposed substructure solution has been based on the results of that site investigation at this stage, however it is suggested a further ground investigation is undertaken at the next stage, which is specific to the proposed building and its location.

The ground investigation report produced by GEA, report no. J17208, identifies made ground of variable thickness, which was underlain by the Hackney Gravel, over the Lewes Nodular Chalk Formation. The made ground was identified as ranging in depths of between 1.00m and 3.50m and the Hackney Gravel extending to depths of between 3.80m and 6.60m.

A number of different sub-structure solutions were considered to support the building. Ground improvement solutions including vibro-stone columns, vibro-concrete columns and dynamic compaction were considered, however, due to the relatively poor ground conditions beneath the made ground it is recommended piles and a suspended ground floor slab be adopted.

A general plant imposed load of 7.5kN/m^2 may be considered appropriate for the ground floor slab, however specific items of equipment have been specified that exceed this loading – up to 20kN/m^2 locally. To ensure the slab has capacity to support the mechanical and electrical equipment during transport and in their final position, a general imposed load allowance of 20kN/m^2 for the ground floor structure has been considered for the Stage 2 design. Design of the slab will need to account for particularly heavy point loads imposed by the mechanical and electrical equipment, this is to be checked at the next stage when information on loading for the specific equipment is known. A 300mm think Grade RC 28/35 flat slab is recommended, supported on a grid of piles at 5.5m x 3.8m. Confirmation of the most efficient pile layout for the suspended slab is to be confirmed at the next stage. Requirements for enlarged column heads and punching shear reinforcement to suit the proposed loads from mechanical and electrical equipment is to be confirmed at the next stage.

The proposed new building is in close proximity to an existing highway bridge structure. Any works that affect this structure, or its foundations may need Approval in Principle from the local Highways Authority. Further discussions will be required at the next stage of the design to confirm if there are any implications on the foundation design adjacent to the highway bridge structure. Due to the proximity of the highway bridge structure and residential housing in the surrounding area, it is recommended CFA piles are to be used during piling operations to ensure vibration and noise levels are kept to a minimum.

Site specific ground investigation will be required at the next stage of the design to confirm the assumptions that have been made in the substructure design.

PROPOSED SUPERSTRUCTURE

The proposed new building is a two-storey structure to house mechanical and electrical plant and equipment at both ground and first floor levels. A braced steel framed structure has been considered the most efficient structural solution, with a column free area provided throughout the ground floor in order to accommodate specific items of large equipment. Cold rolled purlins and side rails will support a lightweight roof and composite wall panels respectively.

Long span beams, approximately 15.2m in length, are required at first floor to facilitate the column free area at ground floor. Composite 'Westok' cellular beams supporting an in-situ reinforced concrete slab on profiled metal decking has been considered the most efficient structural form at first floor to support the mechanical and electrical equipment. The floor structure is composite between steel beam and concrete with shear forces transferred by in-situ friction welded shear studs. Due to the requirement to allow for flexibility in the position of equipment at this stage, a blanket 10 kN/m^2 imposed load allowance has been made for in the design of the steel structure at first floor. Additional trimming steel may need to be provided under elements of plant to support particularly heavy point loads, an allowance within the steel tonnage estimate has been made for this at this stage. It is recommended any elements of plant likely to vibrate at first floor is positioned as close to supports as possible to ensure there are no effects concerning vibration on the floor plate. Further checks will be required at the next stage once plant positions are finalised to confirm beam sizes specified are acceptable and in particular for vibration performance.

At roof level, long span steel beams supporting cold-rolled steel purlins and a built-up roof system will form a mono-pitch roof. Due to the large amount of services within the building, purlins and steel beams have been designed to support a service load of 1.5 kN/m^2. An allowance has also been provided in the roof design for some acoustic attenuation material to prevent any overspill of noise from the mechanical and electrical equipment to the exterior environment. This needs to be assessed by an acoustic specialist. An air cooler is required at roof level with access from the stair core to be provided to ensure operational and maintenance access. A high-level parapet will be provided around the stairs and air cooler to prevent operatives from falling from the roof, an allowance has been made in the steel tonnage estimate for parapet steelwork at this stage.

Stability of the building frame is provided by a series of vertical and horizontal steel bracing elements distributed throughout the building. Horizontal bracing is provided throughout the roof to ensure loads are distributed around the bays of vertical bracing. Horizontal bracing of the first floor is provided by the composite floor structure acting as a diaphragm. Vertical bracing is provided in each elevation of the building.

The elevation to the north-east of the building has been noted to be in close proximity to a building currently under construction and is considered to be a fire boundary condition. To comply with Building Regulations Part B, consideration to the allowable unprotected area of the wall will need to be given at the next stage as well as the fire resistance of the cladding.

For a building of this nature, an allowance of 75 kg/m^2 (on floor area) of hot rolled steelwork and 10 kg/m^2 (on gross wall and roof area) of cold rolled steelwork should be made. Refer to marked-up drawings in Appendix A and steel estimate spreadsheet in Appendix B for further information.

There is a requirement for two ancillary buildings, separate from the main building, which shall form a Gas Kiosk Enclosure and Substation Enclosure. These are understood to be formed of a GRP housing, provided by a specialist supplier to suit the building requirements. Due to the relatively light loads anticipated within the ancillary buildings two independent raft foundations supported on the made ground is considered a suitable foundation solution to support the enclosures. This is to be confirmed at the next stage when information on specific loading for the buildings is identified.

Thermal stores, which are also separate from the building, are to be supported from a suspended piled ground slab. The superstructure of these thermal stores is to be provided by the specialist thermal store supplier.

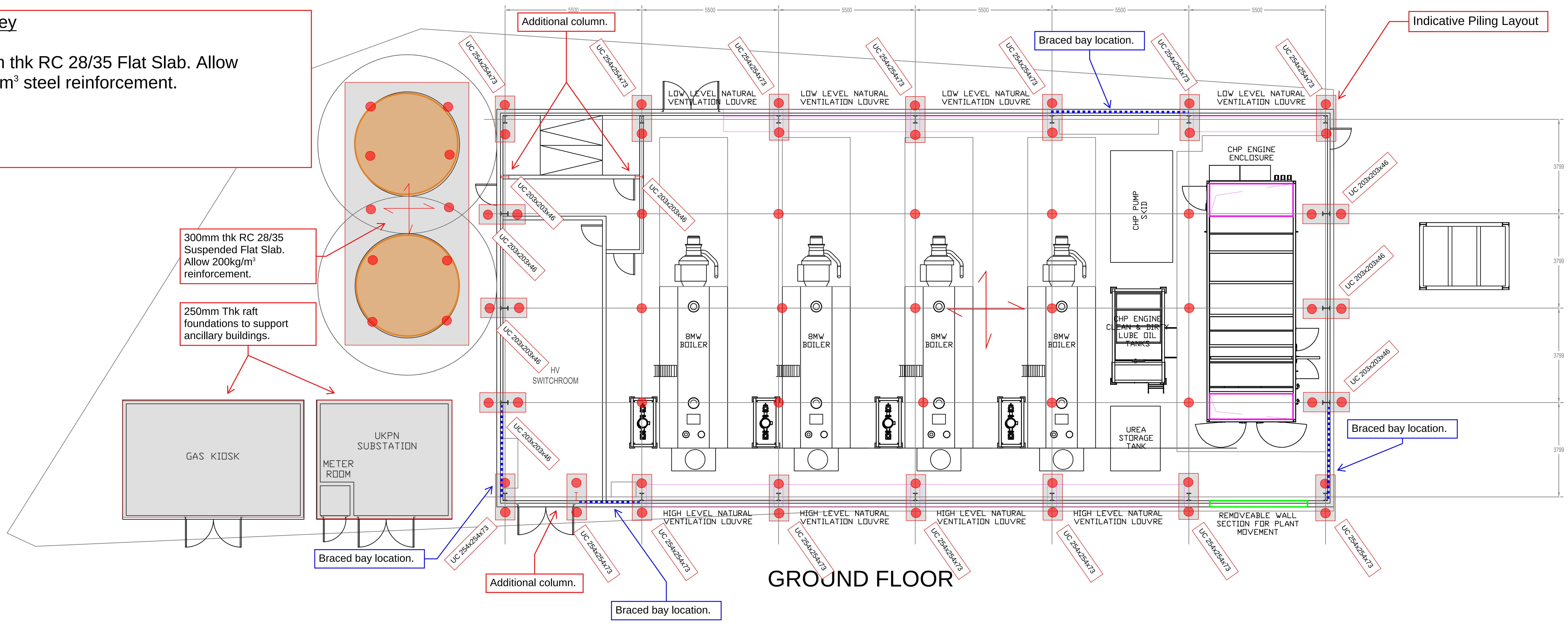
Appendix A

SKETCHES

Ground Floor Key

300mm thk RC 28/35 Flat Slab. Allow 175kg/m³ steel reinforcement.

Pile



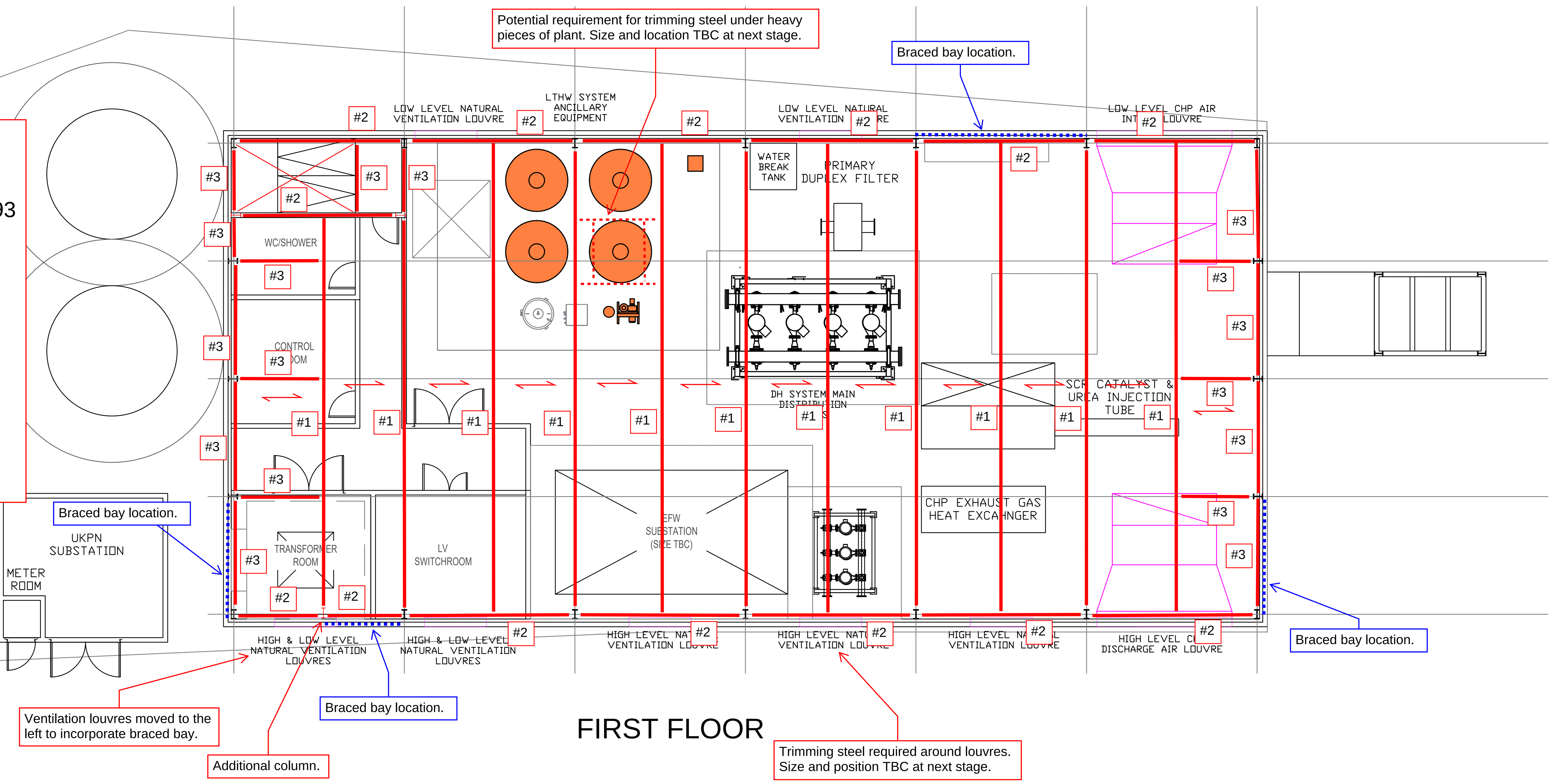
1st Floor Key

130mm RC 28/35 Kingspan Multideck 50 (1.0mm) profiled metal deck with 1 layer A193 mesh

#1 Westok 884x254/254x125 CB 500mm dia cells @ 750mm c/c.

#2 UB 457x191x74

#3 UB 203x133x25



STRUCTURAL MARK-UP

Project: Croydon District Energy Scheme

Job No: 70057109

Date: 19-11-2019

DO NOT SCALE

NOTES:

1. tbc

REV	DATE	BY	DESCRIPTION	CHK	APD
P0	tbc	TH	DRAFT FOR COMMENT	JE	AG

DRAWING STATUS: S0 - WORK IN PROGRESS

wsp

WSP House, 70 Chancery Lane, London, WC2A 1AF, UK
T+ 44 (0) 207 314 5000, F+ 44 (0) 207 314 5111
wsp.com

CLIENT: CROYDON COUNCIL

PROJECT: CROYDON DISTRICT ENERGY SCHEME

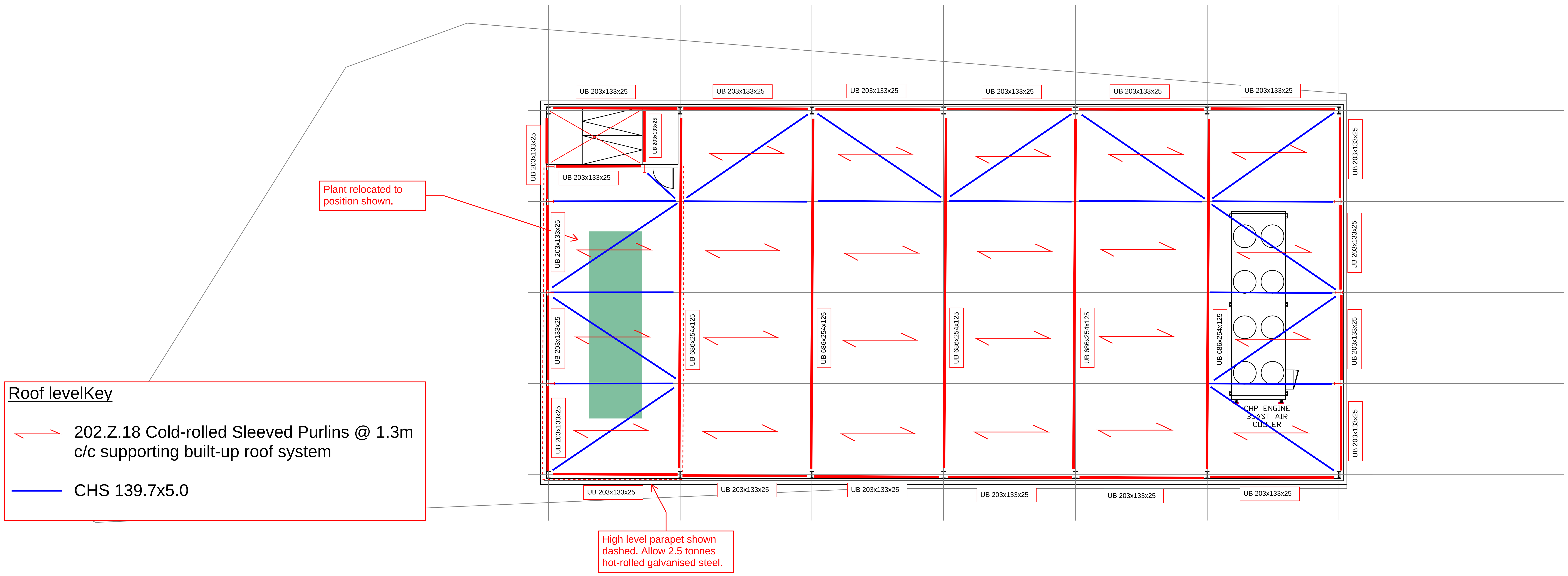
TITLE: ENERGY CENTRE PLANT LAYOUT

SCALE @ A1: 1:100	CHECKED: JE	APPROVED: AJG
PROJECT No: 70057109	DESIGNED: TH / DRAWN: CAD	DATE: 11/10/2019
DRAWING No: M-0100		REV: P0

DO NOT SCALE

NOTES:

1. tbc



P0	tbc	TH	DRAFT FOR COMMENT	JE	AG
REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: S0 - WORK IN PROGRESS

wsp

WSP House, 70 Chancery Lane, London, WC2A 1AF, UK
T+ 44 (0) 207 314 5000, F+ 44 (0) 207 314 5111
wsp.com

CLIENT: CROYDON COUNCIL

PROJECT: CROYDON DISTRICT ENERGY SCHEME

TITLE: ENERGY CENTRE PLANT LAYOUT

SCALE @ A1: 1:100	CHECKED: JE	APPROVED: AJG
PROJECT No: 70057109	DESIGNED: TH / DRAWN: CAD	DATE: 11/10/2019
DRAWING No: M-0101		REV: P0

wsp

STRUCTURAL MARK-UP

Project: Croydon District Energy Scheme

Job No: 70057109

Date: 18-11-2019

Appendix B

STEEL ESTIMATE SPREADSHEET

Croydon District Energy Scheme - Steel Tonnage Estimate

2 Storey Braced Frame Building

Element	Member	Weight - kg/m	No	Length	Total weight-kg	Grade of Steel	
Main Columns	UC 254x254x73	73	15	13.5	14783	S355	
Gable Columns	UC 203x203x46	46	8	13.5	4968	S355	
1st Floor Secondary Composite Beams	Westok 884x254/254x125	125	11	15.2	20900	S355	
1st Floor Primary Composite Beams	UB 457x161x74	74	13	5.5	5291	S355	
1st Floor Gable Beams	UB 203x133x25	25	8	3.8	760	S355	
1st Floor Tie Beams	UB 203x133x25	25	6	2.75	413	S355	
Roof Secondary Beams	UB 686x254x125	125	5	15.2	9500	S355	
Roof Primary Beams	UB 203x133x25	25	12	5.5	1650	S355	
Roof Gable Beams	UB 203x133x25	25	8	3.2	640	S355	
Vertical Bracing	CHS 193.7x8.0	36.6	8	8.3	2430	S355	
Horizontal (Roof) Bracing	CHS 139.7x5.0	16.6	11	6.7	1223	S355	
	CHS 139.7x5.0	16.6	10	5.5	913	S355	
Trimming steel @ 1st floor (heavy points loads)					1500	S355	
Trimming steel around louvres					2000	S355	
Parapet steel					2500	S355	(galvanised)
Total weight hot rolled steel					**69471**	kg	
Allow 10% for plates & bolts					**76418**	kg	
Building Plan Area (1st & Roof)	1003				**76.17**	kg/m^2	
Purlin allowance (1.3m c/c)	202.Z.18	4.88	13	33	2094	kg	
Building Plan Area (Roof)					502	m^2	
					4.17	kg/m^2	
			10% Allowance		4.59	kg/m^2	
Side rail allowance (1.5m c/c)	172.C.14	3.49	10	96.4	3364	kg	
Building Elevation Area					1301	m^2	
					2.59	kg/m^2	
			10% Allowance		2.84	kg/m^2	
Total weight cold rolled rails and purlins					**5458**	kg	
Allow 10% for bolts & cleats					**6004**	kg	

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RISK REGISTER

LA Name: Croydon Council
Opportunity Name: Croydon DEN
Latest update: 29/01/2020
Previous update: n/a

Cells to be completed by the LA or their delegate

Risk Identification			Risk Assessment					Mitigation & Action				
Risk No.	**Risk description**	**Potential impact (including on cost and schedule)**	**Impact (low 1- high 4)**	**Likelihood (low 1- high 4)**	**Current Risk Rating *(auto-calc)***	**Change since previous update**	**Reason for Change**	**Mitigation to date**	**Mitigation Achieved Date**	**Further Action**	**Action Owner**	**Action Target Date**
1	***Technical***				0							
2	*Railway and tram crossings for network route to EfW*	*Liaison with NR can be lengthy and incur design costs. Uncertainty over final approval until BAPA process complete. Railway closures can take time to organise and impact programme*	2	2	4			*Considering potential to integrate project with UKPN reinforcment route*		*Further liaison with UKPN project to evaluate viability of shared approach*		
3	*Integration of EC flue into existing residential building (Wandle Rd) (if preferred option requires it)*	*Must be considered as retrofit measure if required*	2	2	4			*Allowance made structurally for integration within the Wandle Rd development*		*Liaise further with BXB when more detail available.*		
4	*General risks around high-density of buried services in Croydon Town centre*	*Cost impact on network*	2	3	6			*Mitigation depends on network installation procurement route*		*To be determined at procurement stage*		
5	*CHP element of kick-start scheme does not deliver carbon savings under new carbon factors*	*CHP will not be attractive to new development.*	3	3	9			*Ensure connection to EfW plant is in place before new development is connected.*		*Consider alternative models - e.g. circumventing CHP phase.*		
6	*Return temperatures from developments are not as low as expected in modelling phase*	*network capacity reduced / efficiency of operation compromised*	2	3	6			*Refer developments to expectataions of London DH manual*		*Police designs as far as possible within mandate of council involvement in projects.*		
7	*Heat losses on EfW link higher than modelled*	*Increases cost of heat purchased from Sutton*	1	2	2			*Specify appropriate insulation for link taking costs and environmental considerations into account*		*Depends on Sutton heat costs for final design iteration*		
8	*Planning risk surrounding the implementation of the Energy Centre and the addition of flues on the Wandle Rd development*	*adds cost / delay to scheme implementation (if with combustion plant solution)*	2	2	4			*Planners aware of potential flue addition*		*consultation to be carried out sensitively, as required by scheme designs solution*		
9	*Air quality regulation tightens, leading to further cost implications on EC plant to reduce emissions to air.*	*Cost / spatial implications on EC design*	2	1	2			*Keep EC designs flexible as far as possible*		*EC design develpoment when scheme configuration settled*		
10					0							
11	***Customer base / demand***				0							
12	*Phasing of scheme vs development build-out in Croydon town centre*	*Difficulty in securing funding / commitment of customers to allow scheme to progress*	3	3	9			*Engage early - ensure developments are cognizant of their planning obligations, and the environmental benefits of connection*		*Development discussions*		
13	*Timetable of EfW scheme is later than desirable in terms of accessing new developments in their design phase*	*Difficulty in securing funding / commitment of customers to allow scheme to progress*	3	3	9			*Push for development of an EfW-based scheme as early as possible (whilst also being deliverable)*		*General project development planning*		
14	*Developments coming forward are subject to increasingly stringent Building Regulations, reducing the demand density of the network*	*Increased costs per unit of heat delivered.*	1	2	2			*Ensure that potential customer base is kept as wide as possible, and that new opportunities are captured where viable for scheme*		*Development planning discussions*		
15					0							
16	***Commercial***				0							
17	*Scheme in current form does not deliver IRR likely to be attractive to investors.*	*Difficulty in securing funding.*	3	3	9			*Discussions on potential alternative funding routes. Potential to fund network as infrastructure project rather than investment.*		*Internal discussions within Croydon, also linked to outcomes of negotiaions with Sutton in terms of heat price*		
18	*Sutton's cost of heat from EfW plant is too high to allow the Croydon network to operation successfully*	*Prevents the project from securing funding / delivery*	4	3	12			*Early discussion with Sutton. Further negotiation required.*		*Negotiation with Sutton*		
19	*Sutton could only have limited heat capacity available at lower / acceptable price - also subject to whether Sutton finds other heat customers for its heat extract / purchase from Viridor.*	*Prevents the project from securing funding / delivery*	2	2	4			*Early discussion with Sutton. Further negotiation required.*		*Negotiation with Sutton*		
20	*Developments already have contracts for energy supply in place, and are reluctant to form new agreement with Croydon when network is developed*	*Prevents the project from securing funding / delivery*	2	2	4			*Negotiations with developers. Attractiveness of Croydon DEN depends on funding route / grants / heat cost*		*Discussions with developments*		

London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1E)

DECEMBER 2019 (INC MINOR REVS MAY 2020)

CONFIDENTIAL

London Borough of Croydon

CROYDON DISTRICT ENERGY SCHEME

Technical Development (WP1E)

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70057109

DATE: DECEMBER 2019 (INC MINOR REVS MAY 2020)

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Issued for comment	Issue with minor revisions for clarity		
Date	12/12/2019	19/5/2020		
Prepared by	James Eland, Alan Chiu	James Eland, Alan Chiu		
Signature				
Checked by		Bruce Geldard		
Signature				
Authorised by		Bruce Geldard		
Signature				
Project number	70057109	70057109		
Report number		WP1E		
File reference				

CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

This report summarises the capital cost assumptions made for the Croydon DEN study, and includes copies of a number of the quotations received.

Contact name James Eland

Contact details +44 (0) 03 116 9316 | James.Eland@wsp.com

1 INTRODUCTION AND SCOPE

London Borough of Croydon (LBC) is looking to support the growth of Croydon's Metropolitan Centre through an integrated programme of infrastructure development. One element of this is the potential development of a district heating network, where the aspiration would be to provide new and existing buildings a cost-efficient means of moving from natural gas as the dominant fuel, to a lower carbon and renewable fuel mix

A feasibility study was completed in 2017 which indicated that an initial scheme based on new development and existing public-sector buildings was economically viable. The council has allocated a site for the scheme energy centre. With new developments having to meet the London Plan Zero Carbon target, the best longer term low carbon heat supply option would be to connect to the Beddington Energy Recovery Facility (ERF). This commission aims to provide greater confidence in the viability of this supply option, and an alternative based on gas-fired CHP in the identified energy centre.

The objective of the work is to develop a viable scheme that can proceed to procurement.

The scope of the overall commission therefore comprises:

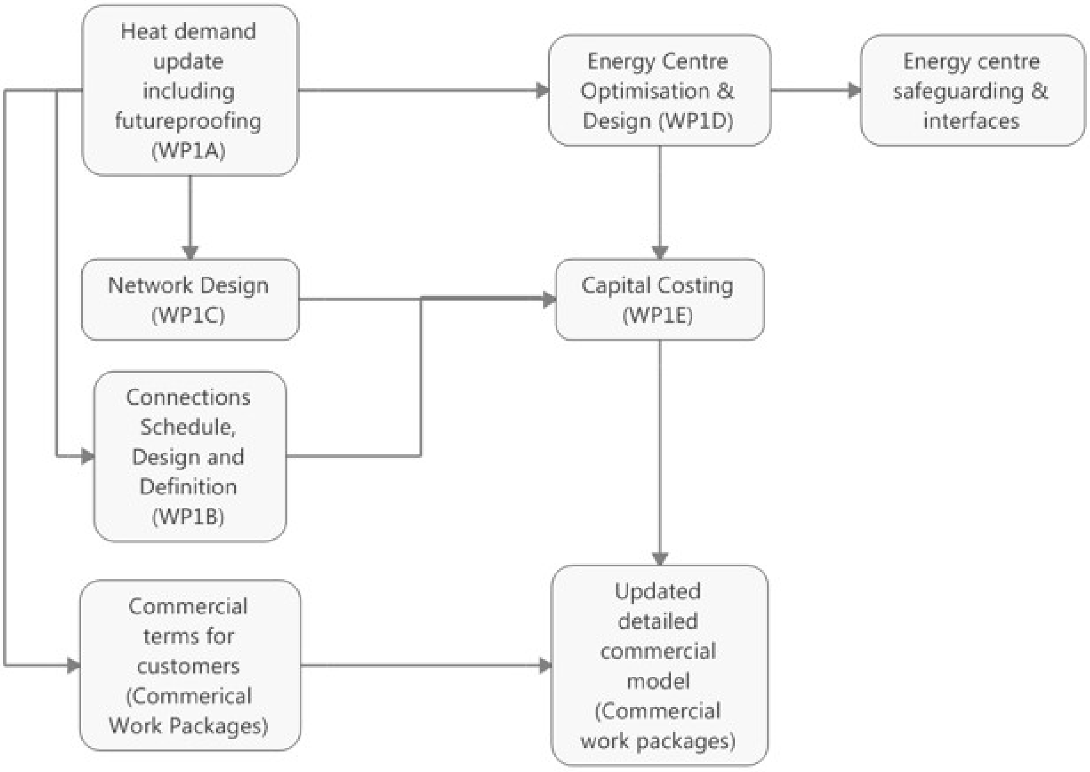
- A review of the 2017 feasibility study
- Updating the heat demands and techno-economics (according to the current phasing of new development)
- Establishing a preliminary system design, along with the capex and opex to a good degree of certainty – including the option of connection to the Beddington ERF plant
- Carrying out a commercial evaluation and identify the business models options that could be taken forward by the Council.

The scope of work is split into five work packages:

- **Work Package 1A:** Heat demands and consumptions. Power demand and consumption for potential 'private wire' supply to civic centre buildings.
- **Work Package 1B:** Distribution and supply to end users
- **Work Package 1C:** Heat network infrastructure
- **Work Package 1D:** Energy Centre
- **Work Package 1E:** Cost schedule for energy centre plant and pipe network

The workflow of the work packages and their relation to the commercial modelling work packages is summarised in Figure 1-1.

Figure 1-1 - Flowchart summarising key outputs of Technical work pages and their relationship to Commercial work packages



This report represents the deliverable **Work Package E,** which presents the assumptions for the cost make-up presented in the cashflow results shown in WP1D**.**

2 KEY PROJECT COSTS

A high-level summary of overall project costs is illustrated below:

Table 2-1 – Headline cost assumptions

	Figures include 10% contingency on non-DH elements, and 5% contingency on DH elements (£,000)
EC Building and Civils	**£2,078**
Energy Centre electrical works	**£1,122**
Energy Centre mechanical plant	**£5,740**
Substations (heat)	**£2,097**
Substations (elec)	**£1,627**
DH network in Town Centre	**£5,789**
Design, prelims, Overhead and profit, PM	**£3,780**
Testing and commissioning	**£330**
Grant support	**£0**
Subtotal	**£22,564**
ERF link costs	**£10,335**
Total with ERF link	**£32,899**

It should be noted that these costs reflect the agreed demarcation with SDEN, as per the correspondence in the notes attached to the end of the Appendices, i.e. that the demarcation should be at the boundary of the SDEN site, and that the SDEN heat cost should include both the cost of pumping and pumps. The costs above therefore do not make any allowance for pumps or other facilities at the SDEN site.

A more detailed breakdown of the estimated costs adopted in the project is included below. A number of the costs have been derived from WSP's experience of other projects, and an overall metric of 'balance of plant' costs has been compared against a selection of three recently tendered projects in order to ensure that these elements are costed in a manner consistent with the recent market.

Budget quotations received are included in the appendices.

ITEM	ITEM NAME	CATEGORY	COST	YEAR SPENT	SENSITIVITY	% CONTINGENCY	Contingency value (£)	VALUE
1	**TC EC**							£ -
2	CHP(s)	EC Mech plant	£ 894,400	2021	100%	10%	£ 89,440	£ 983,840
3	ENERGY CENTRE BUILDING & CIVILS	EC Building and Civils	£ -	2021	100%	10%	£ -	£ -
4	Energy Centre Site - Site Clearance/levelling	EC Building and Civils	£ 50,000	2021	100%	10%	£ 5,000	£ 55,000
5	Energy Centre Compound - Piling	EC Building and Civils	£ 112,000	2021	100%	10%	£ 11,200	£ 123,200
6	Energy Centre Compound - Hardstanding	EC Building and Civils	£ 33,250	2021	100%	10%	£ 3,325	£ 36,575
7	Energy Centre Compound - Thermal Store Base	EC Building and Civils	£ 50,000	2021	100%	10%	£ 5,000	£ 55,000
8	Energy Centre Compound - Thermal Store Access Platform	EC Building and Civils	£ 30,000	2021	100%	10%	£ 3,000	£ 33,000
9	Energy Centre Compound - Security Fencing	EC Building and Civils	£ 20,000	2021	100%	10%	£ 2,000	£ 22,000
10	Energy Centre Building - Shell and Core	EC Building and Civils	£ 1,344,000	2021	100%	10%	£ 134,400	£ 1,478,400
11	Builderswork & Plant Bases	EC Building and Civils	£ 60,000	2021	100%	10%	£ 6,000	£ 66,000
12	Acoustic Natural Ventilation Louvres	EC Building and Civils	£ 100,000	2021	100%	10%	£ 10,000	£ 110,000
13	Gas Enclosure Slab	EC Building and Civils	£ 25,000	2021	100%	10%	£ 2,500	£ 27,500
14	Gas Enclosure	EC Building and Civils	£ 25,000	2021	100%	10%	£ 2,500	£ 27,500
15	UKPN enclosure slab	EC Building and Civils	£ 15,000	2021	100%	10%	£ 1,500	£ 16,500
16	UKPN Enclosure	EC Building and Civils	£ 25,000	2021	100%	10%	£ 2,500	£ 27,500
17	ENERGY CENTRE MECHANICAL SERVICES		£ -		100%	10%	£ -	£ -
18					100%	10%	£ -	£ -
19	CHP Selective Catalytic Reduction	EC Mech plant	£ 162,500	2021	100%	10%	£ 16,250	£ 178,750
20	Natural Gas Boilers (initial phase))	EC Mech plant	£ 432,986	2021	100%	10%	£ 43,299	£ 476,284
21	Natural Gas Boilers (mid phase))	EC Mech plant	£ 216,493	2024	100%	10%	£ 21,649	£ 238,142
22	Natural Gas Boilers (final phase))	EC Mech plant	£ 216,493	2025	100%	10%	£ 21,649	£ 238,142
23	Energy from Waste Heat Interface	EC Mech plant	£ 120,000	2024	100%	10%	£ 12,000	£ 132,000
24	Thermal Store (initial phase)	EC Mech plant	£ 100,000	2021	100%	10%	£ 10,000	£ 110,000
25	Thermal Store (ERF phase)	EC Mech plant	£ 100,000	2024	100%	10%	£ 10,000	£ 110,000
26	Flues	EC Mech plant	£ 700,000	2021	100%	10%	£ 70,000	£ 770,000
27	Chimney	EC Mech plant	£ -	2021	100%	10%	£ -	£ -
28	District Heating Pumps	EC Mech plant	£ 120,000	2021	100%	10%	£ 12,000	£ 132,000
29	CHP LTHW Shunt Pump	EC Mech plant	£ 10,000	2021	100%	10%	£ 1,000	£ 11,000
30	Boiler LTHW Shunt Pumps	EC Mech plant	£ 40,000	2021	100%	10%	£ 4,000	£ 44,000
31	Energy from Waste Heat Interface Shunt Pumps	EC Mech plant	£ 40,000	2024	100%	10%	£ 4,000	£ 44,000
32	Variable Temperature Blending Pumps	EC Mech plant	£ 20,000	2021	100%	10%	£ 2,000	£ 22,000
33	Expansion and pressurisation unit(s)	EC Mech plant	£ 100,000	2021	100%	10%	£ 10,000	£ 110,000
34	Water Treatment	EC Mech plant	£ 20,000	2021	100%	10%	£ 2,000	£ 22,000
35	Dirt Separators	EC Mech plant	£ 30,000	2021	100%	10%	£ 3,000	£ 33,000
36	Degassing/ deaerators	EC Mech plant	£ 10,000	2021	100%	10%	£ 1,000	£ 11,000
37	LTHW Pipework & Ancillaries - Day 1	EC Mech plant	£ 400,000	2021	100%	10%	£ 40,000	£ 440,000
38	LTHW Pipework & Ancillaries - Future (EfW supply)	EC Mech plant	£ 50,000	2024	100%	10%	£ 5,000	£ 55,000
39	Gas Pipework & Ancillaries	EC Mech plant	£ 200,000	2021	100%	10%	£ 20,000	£ 220,000
40	CWS Pipework & Ancillaries	EC Mech plant	£ 50,000	2021	100%	10%	£ 5,000	£ 55,000
41	Above Ground Drainage Pipework & Ancillaries	EC Mech plant	£ 20,000	2021	100%	10%	£ 2,000	£ 22,000
42	Below Ground Drainage Pipework within site compound	EC Mech plant	£ 15,000	2021	100%	10%	£ 1,500	£ 16,500
43	Energy Centre Controls - Day 1	EC Mech plant	£ 350,000	2021	100%	10%	£ 35,000	£ 385,000
44	Energy Centre Controls - Future	EC Mech plant	£ 30,000	2024	100%	10%	£ 3,000	£ 33,000
45	Welfare Facilities	EC Mech plant	£ 20,000	2021	100%	10%	£ 2,000	£ 22,000
46	**ENERGY CENTRE ELECTRICAL SERVICES**	EC ELEC	£ -	2021	100%	10%	£ -	£ -
47	Energy Centre HV	EC ELEC	£ 300,000	2021	100%	10%	£ 30,000	£ 330,000
48	Electrical Services Balance of plant - Day 1	EC ELEC	£ 700,000	2021	100%	10%	£ 70,000	£ 770,000
49	Electrical Services Balance of plant - Future	EC ELEC	£ 20,000	2024	100%	10%	£ 2,000	£ 22,000
50	**TESTING & COMMISSIONING**	EC ELEC	£ -	2021	100%	10%	£ -	£ -
51	Testing and commissioning - Day 1	EC Testing and commissioning	£ 250,000	2021	100%	10%	£ 25,000	£ 275,000
52	Testing and commissioning - Future	EC Testing and commissioning	£ 50,000	2024	100%	10%	£ 5,000	£ 55,000
53	**ENERGY CENTRE UTILITY CONNECTIONS**	EC Mech plant	£ -	2021	100%	10%	£ -	£ -
54	Gas Connection	EC Mech plant	£ 400,000	2021	100%	10%	£ 40,000	£ 440,000
55	Foul Drainage Connection	EC Mech plant	£ 30,000	2021	100%	10%	£ 3,000	£ 33,000
56	Electrical Connection	EC Mech plant	£ 290,000	2021	100%	10%	£ 29,000	£ 319,000
57	Mains Cold Water Supply	EC Mech plant	£ 30,000	2021	100%	10%	£ 3,000	£ 33,000

70	**CUSTOMER CONNECTIONS HEAT**					100%	10%	£	-	£	-
71	Bernard Weatherill House Heating	Substations (heat)	£	53,000	2021	100%	10%	£	5,300	£	**58,300**
72	Bernard Weatherill House Hot Water	Substations (heat)	£	43,000	2021	100%	10%	£	4,300	£	**47,300**
73	Town Hall Heating	Substations (heat)	£	56,500	2021	100%	10%	£	5,650	£	**62,150**
74	Central Library Heating	Substations (heat)	£	129,500	2021	100%	10%	£	12,950	£	**142,450**
75	Davis House Heating	Substations (heat)	£	79,500	2021	100%	10%	£	7,950	£	**87,450**
76	Davis House Hot Water	Substations (heat)	£	39,500	2021	100%	10%	£	3,950	£	**43,450**
77	Croydon Combined Court Heating	Substations (heat)			9999	100%	10%	£	-	£	-
78	Magistrates Court Heating	Substations (heat)			9999	100%	10%	£	-	£	-
79	Croydon College Heating	Substations (heat)	£	117,000	2025	100%	10%	£	11,700	£	**128,700**
80	Croydon Park Hotel Heating	Substations (heat)			9999	100%	10%	£	-	£	-
81	Croydon Park Hotel Hot Water	Substations (heat)			9999	100%	10%	£	-	£	-
82	101 George Street Heating	Substations (heat)	£	84,000	2025	100%	10%	£	8,400	£	**92,400**
83	Barclay Annexe Heating	Substations (heat)	£	48,500	2025	100%	10%	£	4,850	£	**53,350**
84	Fairfield Halls 01 Heating	Substations (heat)	£	80,000	2025	100%	10%	£	8,000	£	**88,000**
85	Fairfield Halls 02 Heating	Substations (heat)	£	80,000	2025	100%	10%	£	8,000	£	**88,000**
86	Leon House Heating	Substations (heat)	£	80,000	2024	100%	10%	£	8,000	£	**88,000**
87	Mondial House Heating	Substations (heat)	£	71,000	2025	100%	10%	£	7,100	£	**78,100**
88	Nestle Heating	Substations (heat)	£	71,000	2025	100%	10%	£	7,100	£	**78,100**
89	Taberner House Heating	Substations (heat)	£	84,000	2024	100%	10%	£	8,400	£	**92,400**
90	Wandle Road Heating	Substations (heat)	£	68,500	2024	100%	10%	£	6,850	£	**75,350**
91	Ruskin Square B01 Heating	Substations (heat)	£	71,000	2026	100%	10%	£	7,100	£	**78,100**
92	Ruskin Square B02 Heating	Substations (heat)	£	80,000	2026	100%	10%	£	8,000	£	**88,000**
93	Ruskin Square B03 Heating	Substations (heat)	£	84,000	2026	100%	10%	£	8,400	£	**92,400**
94	Ruskin Square B04 Heating	Substations (heat)	£	84,000	2026	100%	10%	£	8,400	£	**92,400**
95	Ruskin Square B05 Heating	Substations (heat)	£	84,000	2026	100%	10%	£	8,400	£	**92,400**
96	Cambridge House Heating	Substations (heat)			9999	100%	10%	£	-	£	-
97	Carolyn House Heating	Substations (heat)	£	54,500	2026	100%	10%	£	5,450	£	**59,950**
98	Job Centre Heating	Substations (heat)	£	54,500	2026	100%	10%	£	5,450	£	**59,950**
99	Ruskin Square R01 Heating	Substations (heat)	£	84,000	2026	100%	10%	£	8,400	£	**92,400**
100	Addiscombe Grove Heating	Substations (heat)			9999	100%	10%	£	-	£	-
101	Addiscombe Square Heating	Substations (heat)			9999	100%	10%	£	-	£	-
102	Morrello Tower Cherry Orchard Gardens Heating	Substations (heat)			9999	100%	10%	£	-	£	-
103	Morrello Tower Cheerry Orchard Road Heating	Substations (heat)			9999	100%	10%	£	-	£	-
104	College Tower Heating	Substations (heat)	£	54,500	2025	100%	10%	£	5,450	£	**59,950**
105	The Edridge Heating	Substations (heat)	£	71,000	2024	100%	10%	£	7,100	£	**78,100**
106					2021	100%	10%	£	-	£	-
107					2021	100%	10%	£	-	£	-
108	**CUSTOMER CONNECTIONS POWER (including cabling)**				2021	100%	10%	£	-	£	-
109	1 - DAVIS HOUSE	Substations (elec)	£	345,500	2021	100%	10%	£	34,550	£	**380,050**
110	2 BHW	Substations (elec)	£	233,000	2025	100%	10%	£	23,300	£	**256,300**
111	3 TOWN HALL	Substations (elec)	£	375,500	2025	100%	10%	£	37,550	£	**413,050**
112	4 LIBRARY	Substations (elec)	£	525,500	2025	100%	10%	£	52,550	£	**578,050**
113							10%	£	-	£	-
114							10%	£	-	£	-
115								£	-	£	-
116								£	-	£	-
117	**TOWN CENTRE DISTRIBUTION SYSTEMS (note column H figures here include % contingency figure)**							£	-	£	-
118	Town centre DH Core	DH NETWORK TC	£	1,111,075	2021	100%	0%	£	-	£	**1,111,075**
119	Town centre DH Core Extension	DH NETWORK TC	£	1,763,767	2024	100%	0%	£	-	£	**1,763,767**
120	Town centre DH Ext 1	DH NETWORK TC	£	1,085,249	2025	100%	0%	£	-	£	**1,085,249**
121	Town centre DH Ext 2	DH NETWORK TC	£	1,829,383	2026	100%	0%	£	-	£	**1,829,383**
122	**DESIGN AND PRELIMS**							£	-	£	-
123	Professional fees	DESIGN AND PRELIMS TC	£	590,656	2021	100%	0%	£	-	£	**590,656**
124	Project management - phase 1	DESIGN AND PRELIMS TC	£	189,293	2021	100%	0%	£	-	£	**189,293**
125	Project management - later phases	DESIGN AND PRELIMS TC	£	46,970	2025	100%	0%	£	-	£	**46,970**
126	Prelims (15% on EC elements)- phase 1	DESIGN AND PRELIMS TC	£	1,419,695	2021	100%	0%	£	-	£	**1,419,695**
127	Main contractor overhead and profit (10% on EC element)- Pha	DESIGN AND PRELIMS TC	£	946,464	2025	100%	0%	£	-	£	**946,464**
128	Prelims (15% on EC elements) - later phases	DESIGN AND PRELIMS TC	£	352,273	2021	100%	0%	£	-	£	**352,273**
129	Main contractor overhead and profit 10% on EC elements)- late	DESIGN AND PRELIMS TC	£	234,849	2025	100%	0%	£	-	£	**234,849**
130	GRANT ASSUMPTION	GRANT	£	-	2021	100%	0%	£	-	£	-
131	System management / operation		£	50,000	2021	100%	0%	£	-	£	**50,000**

NB there are no cost items on numbered lines 58 to 69 – hence these are not included here to make the table more legible.

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Appendix A

BUDGET QUOTATIONS RECEIVED

This section contains quotations received for:

CHP (Edina)

Boilers (Bosch)

Interface Substation (heat)

Electrical substation

Utilities

Eland, James

From: Adam Bloom <adam-bloom@edina.eu>
Sent: 11 October 2019 14:43
To: Eland, James
Cc: Hitchman, Tom; Theo Labuschagne; Paul O'Neill
Subject: RE: 1.2MWe Croydon

Hi James, yes your correct £125,000 for SCR.
Regards

Adam Bloom
Head of Sales UK
www.edina.eu

Main: +44 (0) 161 432 8833
Mobile: +44 (0) 75 5785 3571
Email: adam-bloom@edina.eu

Edina UK Ltd (Manchester)
12 & 13 Rugby Park
Bletchley Road
Stockport
SK4 3EJ
T: +44 (0) 161 432 8833

Edina UK Ltd (Lisburn)
Edina Power Ltd
Lissue Industrial Estate (West)
Lisburn, Co. Antrim
BT28 2RE
T: +44 (0) 28 9262 2122

Edina Ltd (Dublin)
Delaire House
Unit 4, Swords Business Park
Co. Dublin
K67 HN56
T: +353 (0) 1 882 4800

Edina Ltd (Cork)
Rockgrove Industrial Estate
Little Island
Co. Cork
T45 CA26
T: +353 (0) 21 435 1396

Edina Group | Edina UK Ltd | Edina Power Ltd | Edina Ltd

From: Eland, James <james.eland@wsp.com>
Sent: 11 October 2019 10:38
To: Adam Bloom <adam-bloom@edina.eu>
Cc: Hitchman, Tom <Tom.Hitchman@wsp.com>; Theo Labuschagne <theo-labuschagne@edina.eu>
Subject: RE: 1.2MWe Croydon

Many thanks Adam,

The swift response much appreciated. Can I just double check in your costs below that the SCR cost is £125k? I assume this was just a slip-of-the-shift-key, but just to be sure…

Kind regards,
James

From: Adam Bloom [mailto:adam-bloom@edina.eu]
Sent: 11 October 2019 09:39
To: Eland, James <james.eland@wsp.com>

Cc: Hitchman, Tom <Tom.Hitchman@wsp.com>; Theo Labuschagne <theo-labuschagne@edina.eu>
Subject: RE: 1.2MWe Croydon

Hi James, good to hear from you again.
Regarding below, I think we can cover off most of the points below (in red) and attached, let me know if you need anything else.

Regards

Adam Bloom
Head of Sales UK
www.edina.eu

Main: +44 (0) 161 432 8833
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Edina Group | Edina UK Ltd | Edina Power Ltd | Edina Ltd

From: Eland, James <james.eland@wsp.com>
Sent: 10 October 2019 14:03
To: Adam Bloom <adam-bloom@edina.eu>
Cc: Hitchman, Tom <Tom.Hitchman@wsp.com>
Subject: 1.2MWe Croydon

Dear Adam,

How's things? It has been a while! I hope that you are keeping well.

Could I please request some data and budget quotation for a CHP selection, please?

We are currently working on a job in Croydon, where the Council is keen to pursue a centralised energy centre supply solution for a town centre district heating scheme. We are currently trying to get through outline business case stage so that the scheme can move ahead. It would be great if you could assist with this by providing some data for the selection that we are looking at:

Gas-fired CHP unit, 1.2MWe output, 250mg NOX, 65 dBA, HV

This selection is for a kick-start phase of the scheme, after which the primary supply should transition to the supply of heat from an EfW plant. The initial CHP phase will provide greater cashflow margin in operation than the later EFW phase, and hence should serve to de-risk the scheme and increase the overall deliverability of the project.

During the initial CHP phase, we would be looking to operate the system on a variable flow / variable flow temperature basis, reducing operating temperatures during off-peak times (down to an estimated 80 deg C).

Might you be able to provide a project-specific budget quotation, based on the following parameters:

1.2MWe unit
95 deg C flow (anticipated peak flow temp during winter conditions)
65 deg C return
65 dBA acoustic performance
HV supply
SCR equipment to take emissions down to London-plan level – e.g. 95mgNOx / Nm3? (is this something that you are able to provide a cost estimate / tech details for?)
Supply, deliver, install, commission

Budget Price for standard indoor CHP at 95/65c, 400v generation, full packaged unit as per attached: £590,000.00
Extra cost for 65dBa/1m: £42,000.00
Extra for HV: £56,000.00
Extra for SCR to achieve circa 50mg/nm3 at 5% O2: £!25,000.00
O&M rate for 15 years (based on fully inclusive package) 1.0p/kWh

We will need the usual type of information – e.g. the inputs / outputs, air quality information, acoustic information, layouts, connections, weights, etc...

Attachments:

Data Sheet
Scope Document
Layout drawing

The project will require a new energy centre to be built, so there should be a 'clean' environment for the install.

It would be great if you were able to provide a project-specific capital cost quote and also an on-going fully comprehensive maintenance offering, preferably over different periods, but certainly for a 10 yr period.

There is probably lots of detail that I have failed to include here, but I hope that either Tom H (cc'd) or I will be able to address any queries you have on this.

Many thanks,
Kind regards,
James

James Eland
Associate

wsp
M +44 (0) 753 098 2142

WSP House, 70 Chancery Lane
London

WC2A 1AF

Thermotechnology

Bosch Thermotechnology Ltd.
Cotswold Way, Warndon
Worcester
WR4 9SW
UNITED KINGDOM

Bosch Industriekessel GmbH
TT-INB/SOP2
Nürnberger Str. 73
91710 Gunzenhausen
www.bosch-industrial.com

Ralf Frisch, TT-CH/PAI
Phone +49(9831)56-244, PCFax +49(9831)56-92244
ralf.frisch@de.bosch.com, Our ref.: 32MW Option

10/18/2019

Thank you for your Enquiry

Customer number:	5023703
Our Project No.:	205412/2; 77
Our Offer No.:	1169069225-77

Dear Sir or Madam,

With reference to your inquiry, please find enclosed our detailed quotation.

Our quotation is based on the attached Sales and Delivery Conditions and is without obligation until final confirmation.
For detailed information on the special advantages of the design and equipment of our boiler systems and boiler house components, please refer to the detailed description as well as the enclosed leaflets.

Technical details such as capacity rates, consumption values and dimensions are available in the technical data sheets and specification sheets.

Should you require further explanations and expert technical advice, please do not hesitate to contact us.

Yours sincerely,

Bosch Industriekessel GmbH
TT-INB/SOP2

This document is valid without signature.

Enclosures
Price Summary
Technical Data
Description and Scope of Delivery
Sales and Delivery Conditions
Leaflets and Specification Sheets
Directive water conditions

Price Summary

Position	Description	Amount	Unit price	Total net price
01	Hot water boiler -plant	1		
01.01	UNIMAT Hot water boiler UT-M	1	155,266.12	155,266.12
01.01.01	Boiler and equipment	1	112,546.82	
01.01.02	Boiler control panel	1	11,772.67	
01.01.03	Burner available at site	1	8,551.79	
01.01.04	Safety equipment	1	9,785.90	
01.01.05	Return flow temperature safeguard RTS(temperature boosting)	1	12,608.93	
01.02	UNIMAT Hot water boiler UT-M	1	155,387.78	155,387.78
01.02.01	Boiler and equipment	1	112,546.82	
01.02.02	Boiler control panel	1	11,894.33	
01.02.03	Burner available at site	1	8,551.79	
01.02.04	Safety equipment	1	9,785.90	
01.02.05	Return flow temperature safeguard RTS(temperature boosting)	1	12,608.93	
01.03	UNIMAT Hot water boiler UT-M	1	155,387.78	155,387.78
01.03.01	Boiler and equipment	1	112,546.82	
01.03.02	Boiler control panel	1	11,894.33	
01.03.03	Burner available at site	1	8,551.79	
01.03.04	Safety equipment	1	9,785.90	
01.03.05	Return flow temperature safeguard RTS(temperature boosting)	1	12,608.93	
01.04	UNIMAT Hot water boiler UT-M	1	155,387.78	155,387.78
01.04.01	Boiler and equipment	1	112,546.82	
01.04.02	Boiler control panel	1	11,894.33	
01.04.03	Burner available at site	1	8,551.79	
01.04.04	Safety equipment	1	9,785.90	
01.04.05	Return flow temperature safeguard RTS(temperature boosting)	1	12,608.93	
01.07	Documentation, extended version	1	1,448.26	1,448.26
01.07.01	Piping diagram	1	122.00	
01.07.02	2D symbols for the scope of delivery	1	169.00	
01.07.03	Data medium for Documentation, extended version	1	112.67	
01.07.04	Labeling of loosely delivered parts	1	1,014.00	
01.07.05	3.1 certificate for safety valve	1	30.59	
02	MEC Remote	1	953.96	953.96

Technical data

Position	Description		
	Attribute	Unit	Value
	General Data		
	Country of destination	-	Great Britain
	Location	-	indoors
	Assembly and operating conditions	-	free of frost, dust as well as dripping water
	Erection altitude max. about sea level	m	60
	Ambient temperature min.	°C	10
	Ambient temperature max.	°C	40
	Voltage	V	400
	Voltage fluctuations max. (+/-)	%	5
	Neutral conductor	-	yes
	Earth connection	-	yes
	Frequency	Hz	50
	Max. frequency fluctuations (+/-)	%	1
	Direct switching up to	kW	5.5

Position	Description		
	Attribute	Unit	Value
01	Hot water boiler -plant		
	Power output system boundary	kW	32,000
	Trip temperature for the safety limiter	°C	120
	Trip pressure safety valve	bar	10.00
	Av. supply flow temperature	°C	105
	Av. return flow temperature	°C	65
	Water quality	-	acc. to Operating Manual "Directive water condition" B004
	Max. allowable geodetic height difference	m	64.24
	Fuel	-	Gas / Natural Gas H
	Fuel standard	-	DVGW G260
	Net calorific value (rated to 0 °C / 1013 mbar) (gas)	kWh/Nm³	10.35
	Gas flow pressure on gas regulation module inlet (+ 5% / - 0%)	mbar	150
	gas temperature	°C	15.00
	All details ref. to the O2-contents in the dry smoke gas of	%	2.10
01.01	UNIMAT Hot water boiler UT-M		
	Nominal capacity	kW	8,000
	Cold water test pressure	bar	18.50
	Door hinge	-	left
	Response pressure safety pressure limiter min. related to a geodetic height of 0 m	bar	1.19
	Category (DGRL)	-	IV
	Max. adm. temperature difference supply flow / return flow	K	50.00
	Min. permitted return flow temperature	°C	50.00
	Min. permitted supply flow temperature	°C	70.00
01.01.01	Boiler and equipment		
	Nominal capacity	kW	8,000
	Boiler type	-	UT-M 48
	Max. design pressure	bar	10.0
	Trip pressure safety valve	bar	10.00
	Nominal size safety valve socket	DN	80
	Nominal pressure stage safety valve socket	PN	40
	Number of safety valve sockets	-	1.00
	Nominal size supply flow socket	DN	200
	Nominal pressure stage supply flow socket	PN	25

Position	Description		
	Attribute	**Unit**	**Value**
	Nominal size return flow socket	DN	200
	Nominal pressure stage return flow socket	PN	25
	Water-side resistance boiler	mbar	40.58
	Nominal diameter flue gas connection (DIN24151, DIN24154)	DN	630
	Insulation thickness min.	mm	100.00
	Thickness of insulation cladding	mm	0.60
	Ascent side maintenance platform on boiler top	-	right
	Mounting place terminal box	-	Boiler front - top left (10 o'clock position)
	Efficiency gas	%	93.1
	calculation of efficiency (gas)	-	in accordance with the basic principles of EN 12953 part 11 – indirect method
	Efficiency (gas) at 75% load	%	93.9
	Efficiency (gas) at 50% load	%	94.6
	Efficiency (gas) at 25% load	%	95.1
	Total burner capacity (gas)	kW	8,595
	Norm volume flow fuel (gas)	m^3/h	830
	Radiation loss gas (TI 005/01)	%	0.16
	Norm volume flow moist smoke gas (gas)	m^3/h	9,883
	Mass flow moist smoke gas (gas)	kg/h	12,270
	Flue gas loss approx. (in accordance with the basic principles of EN 12953 Part 11) (gas)	%	6.8
	Flue gas temperature approx. (gas)	°C	179
	Furnace volume load (gas)	MW/m^3	1.0
	Heating surface on burner side	m^2	244.7
	Maximum permissible local flue gas pressure at the limit of supply	mbar	0.00
	Minimum permissible local flue gas pressure at the limit of supply	mbar	-1.00
	Water volume flow	m^3/h	177.5
	Volume on flue gas side (single value)	m^3	14.86
	Water content full	l	13,080
	Total resistance on heating gas side of boiler in operation with gas (based on altitude)	mbar	7.88
	Total resistance on heating gas side includes	-	Boiler
	Total volume on flue gas side	m^3	14.86

Position	Description		
	Attribute	**Unit**	**Value**
	Heating surface - boiler	m²	244.7
	Transportation weight boiler body approx.	kg	20,800
	Total weight boiler body (full) approx. +/- 2%	kg	35,300
	Transportation weight (complete with burner and all mounted parts)	kg	20,800
	Operating weight boiler (complete with all mounted parts)	kg	35,300
01.01.02	Boiler control panel		
	Extra space in the boiler control panel	%	20
	Width control panel	mm	800
	Height control panel	mm	1,800
	Depth control panel	mm	400
	Installed load	kW	31.82
	Base height	mm	200
	Maximum site protection must be	A	100.00
	Display size Touch Panel	-	9"
	Mounting place control panel	-	Standing control panel
	Cable harness feeder at the boiler (o´clock)	-	12
	Cable harness length	m	10.00
01.01.03	Burner available at site		
	Type of control of burner(gas)	-	continuously via constant signal (4-20mA)
	Total nominal load firing (electric)	kW	28.50
	Assembly side of gas fitting	-	left
	Power supply	-	three-phase a.c. current
	Scope of delivery mating connector for cable harness to burner	-	0
01.01.04	Safety equipment		
	Design	-	Hot water
	Nominal diameter	DN	200
	Nominal pressure	PN	25
	Manufacturer safety valve	-	ARI
01.01.05	Return flow temperature safeguard RTS(temperature boosting)		
	Min. necessary residual feed pressure	mbar	50.00
	min. return flow temperature	°C	45.00
	admixing water flow	m³/h	60.0
	Nominal diameter admixing line	DN	100
	nominal pressure admixing line	PN	16

Position	Description		
	Attribute	**Unit**	**Value**
	Nominal diameter	DN	200
	Nominal pressure	PN	25
	Transportation weight return flow temperature safeguard	kg	190.00
01.02	UNIMAT Hot water boiler UT-M		
	refer to item 01.01		
01.02.01	Boiler and equipment		
	refer to item 01.01.01		
01.02.02	Boiler control panel		
	refer to item 01.01.02		
01.02.03	Burner available at site		
	refer to item 01.01.03		
01.02.04	Safety equipment		
	refer to item 01.01.04		
01.02.05	Return flow temperature safeguard RTS(temperature boosting)		
	refer to item 01.01.05		
01.03	UNIMAT Hot water boiler UT-M		
	refer to item 01.01		
01.03.01	Boiler and equipment		
	refer to item 01.01.01		
01.03.02	Boiler control panel		
	refer to item 01.01.02		
01.03.03	Burner available at site		
	refer to item 01.01.03		
01.03.04	Safety equipment		
	refer to item 01.01.04		
01.03.05	Return flow temperature safeguard RTS(temperature boosting)		
	refer to item 01.01.05		
01.04	UNIMAT Hot water boiler UT-M		
	refer to item 01.01		
01.04.01	Boiler and equipment		
	refer to item 01.01.01		
01.04.02	Boiler control panel		
	refer to item 01.01.02		
01.04.03	Burner available at site		
	refer to item 01.01.03		
01.04.04	Safety equipment		

Position	Description		
	Attribute	Unit	Value
	refer to item 01.01.04		
01.04.05	Return flow temperature safeguard RTS(temperature boosting)		
	refer to item 01.01.05		
02	MEC Remote		
	Type of connection MEC Remote	-	LAN (DSL)
03	Connection of control to control system at site		
	Type of data transfer	-	Modbus RTU

Description of delivery scope

01	Hot water boiler -plant
01.01	**UNIMAT Hot water boiler UT-M** for the generation of **hot water.** For **technical data**, please refer to the attached technical data sheets, for further information to the current leaflets and specification sheets.
01.01.01	**Boiler Pressure Vessel**, consisting of the cylindrical boiler shell, front and rear boiler ends, centric flame tube with annularly arranged smoke tubes of the 2nd and 3rd pass, completely water-cooled reversion of the flue gases from the flame tube in the first smoke tube pass. Connection for supply flow, return flow, excess pressure safeguard and drain, two transportation lugs and a boiler rating plate. Injector device for internal return flow temperature boosting. The boiler pressure vessel is fully electrically welded, material and welding seams are controlled by X-ray or ultra-sonic testing in accordance with the European Pressure Equipment Directive PED (2014/68/EU). **Acceptance of the Pressure Vessel:** Acceptance at the workshop acc. to the European Pressure Equipment Directive PED (2014/68/EU). **CE-Marking of the Pressure Vessel:** acc. to the European Pressure Equipment Directive PED (2014/68/EU). **Mounting parts:** **Boiler Base Frame**, sturdy profile steel construction, for even distribution of load and easy transportation, suitable for the placement of sound absorbing pads. The boiler body is positioned on the base frame by supports. **Corrosion Protection Paint** of those parts which are not covered by the insulation. 2 coats of paint with one component lead- and chromate-free paint based on modified polymer dispersions. The portion of organic solvents is below 5 weight percent. **1 Set of Operation and Instruction Labels** **Flue Gas Chamber** with flue gas condensate connection and inspection opening on flue gas side. **Flue gas connection socket** DN 630 with counterflange, packing, nuts and bolts. **Boiler Front Door** with thermal insulation and adjustable locking device, as inspection opening for the furnace, for cleaning and revision on flue-gas side and for fastening of the burner. The door opens acc. to the attached technical data sheet. **1 Burner brick lining(s),** corresponding to our technical information TI036 design as a straight, cast brick lining **1 Flame sight hole(s)** for viewing of the flame, with sight glass clear Ø 32 mm, protective cover, connection for cooling air and measurement.

Documentation, consisting of:
Operating manual
Operating manual acc. to European regulations for the scope of delivery.
Quantity: 1
Language: English
Design: print-out
Deadline: with delivery
Additional set of documents:
Quantity: 1
Language: English
Design: CD-ROM
Deadline: with delivery
Operation log
Operation log acc. to European regulations for the scope of delivery.
Quantity: 1
Language: English
Deadline: with delivery
Additional set of documents:
Quantity:
1
Language:
English
Deadline:
with delivery

Acceptance documentation
Acceptance documentation in accordance with European directives as far as required for the supply of the boiler plant, respectively for the part concerning the delivery scope, however without assembly drawing and PI-diagram.
Quantity: 3
Language: English
Deadline: 2 weeks after delivery date
Additional set of documents:
Quantity:
1
Language:
English
Deadline:
2 weeks after delivery date

Insulation of boiler shell and boiler ends with mineral wool mats and protective cladding of structured aluminium.
Maintenance platform on boiler top (boiler centre); installation of rail, ladder and connection between boilers possible.

Rail for maintenance platform on boiler top
delivery in bulk for assembly on site
Ladder for maintenance platform.
The ladder is designed for installation on the same height level as the boiler base frame.

Set of vibration damper for reduction of vibration transmission on the basement through calculated, vibration insulated bedding. The vibration dampers were put under the base frame.

Shrink-Wrapping for Transportation
All weather-sensitive parts shrink-wrapped or packed in plastic wrapping. Loose parts - if necessary - to be packed in cases, cartons or other suitable type of packing. Disposal of packing material at site.

Hoisting jacks (4 pieces), welded to the boiler frame, suitable for applying lifting equipment (e.g. lifting cylinder, jacks). The boiler can be conveniently lifted by means of the hoisting jacks during bringing in, placement and leveling of the boiler, e.g. in order to slide transport devices below the boiler supports or to remove the same.

Flue gas temperature display device
for display of the flue gas temperature downstream of the boiler in the Boiler control BCO, consisting of:
- Temperature transducer for proportional provision of signal 0/4-20 mA
with welded sleeve R 1/2" (installated in flue gas chamber).
Terminal Box
Protection class IP54, of steel sheet, powder-coating grey/structure, galvanized assembly plate, cable entry from below. Control design in accordance with DIN-/EN-standards. Connection of the control devices and the control panel via terminal strips in the terminal box. Terminal box is function-tested, 1 set of wiring diagrams inside the terminal box.
Advantages
Reading of the instruments and operating of the plant is facilitated by individual mounting or installation of the boiler control panel. Easy and mix-up proof connection to the terminal box by means of individually customized, coded and marked cable bundles with plug connections on both sides.

Boundary conditions for the indication of max. possible geodetic net height difference:
You have chosen, for the boiler, a safety valve trigger pressure of 10.00bar and a trigger temperature for the safety temperature limiter of 120°C. The saturated steam pressure belonging to this temperature is 0.99bar.
Taking into account the surcharges (distance safety valve to pressure limiter max. of 10.00% of safety valve pressure or at least 0,5 bar, safety margin pressure limiter max. to pressure maintenance device of 0,5 bar, an assumed workspace pressure holding device of 1.00 bar and safety margin pressure limiter min (0,3 bar)and a safety margin to the highest point of the system (0,2bar), remain for the geodetic net height (maximum

permissible highest point of the hot water system) 64.24 m (6.01 bar).
For **technical data**, please refer to the attached technical data sheets, for further information to the current leaflets and specification sheets.

01.01.02 **Boiler Control Panel for Boiler control BCO**

Enclosure type IP 54, made of steel sheet, powder coated grey structure, galvanized mounting plate, cable ducting from below. The switching and control devices are assembled on a mounting plate and inside the control panel door. Wiring in the control panel is executed by means of flexible cables in sufficiently dimensioned cable ducts. The control devices are designed in accordance with DIN-/EN- standards. The control devices are connected on terminal strips inside the control panel. The control panel is function-tested, 1 set of wiring diagrams is provided inside the panel.
The marking of the electrical operating equipment in the wiring diagrams is made in accordance with DIN EN 81346- 2.
Control Panel Lighting incl. door position switch and safety plug for freestanding control panels.
Assemblies:
·Main switch with locking device

Automation device BCO with touch-sensitive touchscreen colour display
Industrially proven hardware from the range of stored-program controls are applied in the Boiler Control BCO. The complete control software is stored on a memory card provided with the device. A graphic TFT-display with touch-sensitive interface serves as display and operating unit. Operating signals and process value archive are stored on a multi-media card included in the delivery scope.

Basic functions:
·Load control

·Low load control
·Boiler operation hours meter
·Burner operation hours meter
·Registration of number of burner starts
·Clear text display of operation and fault signals, signal history on 500 signals with time recording (Coming, Going, Acknowledging) and all relevant operation data at the time
·Intuitive, menu-driven operation by means of the touch-sensitive graphic display
·Display of all operation-relevant measured values and conditions
MODBUS RTU Connection, consisting of
1 communication processor with link-up possibility to a superior plant control (not in scope of supply) via a 9-pin SUB-D-connector, configurated as MODBUS-RTU-Slave, with RS485 and RS232 interface.

Condition Monitoring basic
CMbasic is an analysis and evaluation system integrated in the BCO boiler control. It gathers, analyses and evaluates system operating statistics and parameters, consumption

values, and measurements, and uses a traffic light-style display to clearly show the results. It detects, evaluates and notifies the user, in good time, of increased wear or uneconomical operation of the boiler system.

Scope of delivery:

Temperature-recording device at boiler outlet on flue gas side

Software module integrated in boiler control

Scope of functions

-Displays operating hours; frequency of starts; cold starts as a function of time

-Detects unfavourable start-up conditions

-Detects contamination on water and flue gas side

-Detects unwanted condensation

-Generates service notifications

-Displays boiler load profiles as a function of time

-In steam boilers where the fittings are controlled electrically, highlights energy losses from blow-down and desalting

-Displays measurements as actual values at time of delivery and as a function of time

-Representation of the digital volume meters with additional reset function, which are includedin the scope of deliveryand displayed in the control panel

Intended use

CMbasic gives customers the option of monitoring the efficiency and correct operation of their system. In this way CMbasic makes a positive contribution to system availability and to ensuring consistently high system efficiency.

Emergency off switch for control panel

External start-up and shut-down control

With two potential-free contacts the boiler can be automatically started and shut-down. Potential-free contact established by existing regulation or control units in the control panel. Wiring up to the terminals in the control panel for external signaling and control function. Contact load max. 5 A.

MEC Remote

- key switch for disrupting the internet connection of MEC Remote

Wiring diagrams for the scope of delivery.

Quantity: 5

Language: English

Design: print-out

Deadline: with delivery

Additional set of documents:

Quantity:

1

Language:

English

Design:
print-out
Deadline:
with delivery

01.01.03 **Integration of locally supplied and mounted burner into the boiler control**

The requirements for the locally supplied burner are specified in our Technical Information Sheet TI030:
- Design of the electrical interface boiler control - burner control
- Safeguarding of the power supply of the local burner
- Burner load control from the boiler control panel.

Latest 10 working days after placing of order, the following data have to be provided to us:
- Burner manufacturer's specification for the burner plate (hole pattern)
- Burner manufacturer's specification for the bricklining

Please use the enclosed Technical Information Sheet TI036.

Load Control, consisting of:
- Temperature transducer for proportional provision of signal 0/4-20 mA
- Screw-in protective shell for the installation of the temperature sensor in order to guarantee that the sensor is replaced without draining the system.

External set-point adjustment 4-20mA

The set point for the boiler supply flow temperature can be specified externally by means of an analog signal. This signal is isolated electrically from the boiler control by an isolation amplifier.

Workshop assembly of burner, mechanical (assembly to the boiler), including the required assembly material as well as the assembly and installation engineering.
Dismantling of those parts which have to be delivered separately for transport reasons.
Output data which are affected by locally supplied components are not guaranteed. The warranty applies only to parts supplied by Bosch Industriekessel GmbH.
Wiring of the burner provided by the customer with cable harness from the control panel to the boiler with foolproof connection plugs up to a rated current of 35 A (design of plugs acc. to technical information TI030).

Lenght of the cable harness 10.00 from outlet of boiler to control panel. Outlet of cable harness on 12 o'clock-position at the boiler.
The mating connector at the burner has to be provided by the customer.

Wiring diagram check of the burner provided by the customer

The supplier checks the compatibility of the boiler control with the electronic interface of the burner provided by the customer. Deviations from the interface definition of technical information TI030 are documented. The burner wiring diagram and maybe required changement of the burner interface has to be provided by the customer.

01.01.04 **Safety Equipment** (boiler part)

for high-pressure hot water boiler for integration into closed
systems acc. to EN 12953, part 6, pic. 4.2 resp. 4.4, for operation
without permanent supervision, consisting of:

Supply flow adapter piece SP DN200 PN25, length 700.00 mm with connection sockets for:
pressure gauge manostat pipe
temperature transducer G 1/2 inch
flow limiter
safety temperature limiter
low water cut off probe
filling test equipment
Pressure gauge manostat pipe with 5 connections G 1/2 inch A, acc. to ISO 228/1.
Pressure gauge-manostat pipe shut-off valve, consisting of:
- shut-off valve, maintenance-free with bellow seal and limit switch, DN20 PN40
Pressure gauge device, consisting of:
- Pressure gauge
- Pressure gauge shut-off valve
Pressure safeguard, each consisting of:
- full-stroke corner safety valve, type-accepted, DN 80 PN 40
- 3.1 certificate for safety valve
Low water cut-off, self-monitoring, EC-/TÜV-tested, electronic**,** for limitation of min. water level for boiler water conductivity at 25 °C > = 30 μS/cm
- limiter probe with permanent isolation supervision
- electronic switching unit to switch off burner and alarm notification. Installed in control panel if control panel is in our scope of delivery. The electronic system is designed for installation in a control panel with protection level IP54.
Safety Temperature Limiter, design as surface-mounting thermostat
Safety pressure limiter max., consisting of:
- safety pressure limiter, CE examined
for merging into the safety chain
Safety pressure limiting device min., consisting of:
- safety pressure limiter, CE examined

Second Safety pressure limiting device max., consisting of:
- safety pressure limiter, CE examined
for merging into the safety chain

Flow limiter
for monitoring the boiler water flow.
The switching point of the flow limiter is preadjusted. If the control panel is delivered by us, the burner will be reliably switched off and blocked when falling short of the preset water flow.
If the supply flow adapter pieces are included in the delivery, the flow limiter will be

installed there.
- Flow rate monitor, 1"
In case of falling below the adjusted flow the burner will be switched off and locked reliably.
Return flow temperatur indication
for indication of the boiler return flow temperature in control cabinet, consisting of:
- Temperature transducer for proportional provision of signal 0/4-20 mA
- Screw-in protective shell for the installation of the temperature sensor in order to guarantee that the sensor is replaced without draining the system.
bleeding equipment consisting of:
- shut-off valve, maintenance-free with bellow seal DN20 PN40

Mounting form: corner valve

Assembly of all afore-mentioned components at the factory. Dismantling of those parts which have to be delivered separately for transport reasons.

01.01.05 **Return Temperature Boosting Equipment**, consisting of:
Set of fittings, consisting of:
- 1 butterfly valve(s) with manual actuation, DN100 PN16
- disc non-return valve DN100 PN40
- 1 admixing pump DN100 PN16
Version as inline pump for installation in the pipeline
- 1 butterfly valve(s) with manual actuation, DN100 PN16
Thermostat incl. sensor for control of the admixing pump. Safeguarding of the minimum required flow to be provided at site.
If the workshop piping of the return temperature boosting device is included in the scope of supply, the thermostat will be installed and the electrical connection by means of cable loop will be prepared.
Dismantling of those parts which have to be delivered separately for transport reasons.
- Temperature transducer for proportional provision of signal 0/4-20 mA
- Screw-in protective shell for the installation of the temperature sensor in order to guarantee that the sensor is replaced without draining the system.
1 motorized return shut off valve, consisting of:
- Shut-off valve with built-on servo drive DN200 PN25
Potential-free contact for shut-off valve open, for network pump supplied by the builder , is made available by the installation of additional control devices and electrical linking in the control panel.
Function in operating current principle as operating or fault alarm. Wiring as far as the terminals in the switchgear cabinet for external messaging and control function. Contact load max. 5 A.
1 supply flow shut off valve, consisting of:
- 1 butterfly valve(s) with manual actuation, DN200 PN25
Electrical Wiring prepared for connection of the admixing pump by means of cable loop.

	Dismantling of those parts which have to be delivered separately for transport reasons.
01.02	refer to item 01.01
01.02.01	**Boiler Pressure Vessel**, consisting of the cylindrical boiler shell, front and rear boiler ends, centric flame tube with annularly arranged smoke tubes of the 2nd and 3rd pass, completely water-cooled reversion of the flue gases from the flame tube in the first smoke tube pass. Connection for supply flow, return flow, excess pressure safeguard and drain, two transportation lugs and a boiler rating plate. Injector device for internal return flow temperature boosting. The boiler pressure vessel is fully electrically welded, material and welding seams are controlled by X-ray or ultra-sonic testing in accordance with the European Pressure Equipment Directive PED (2014/68/EU). **Acceptance of the Pressure Vessel:** Acceptance at the workshop acc. to the European Pressure Equipment Directive PED (2014/68/EU). **CE-Marking of the Pressure Vessel:** acc. to the European Pressure Equipment Directive PED (2014/68/EU). **Mounting parts:** **Boiler Base Frame**, sturdy profile steel construction, for even distribution of load and easy transportation, suitable for the placement of sound absorbing pads. The boiler body is positioned on the base frame by supports. **Corrosion Protection Paint** of those parts which are not covered by the insulation. 2 coats of paint with one component lead- and chromate-free paint based on modified polymer dispersions. The portion of organic solvents is below 5 weight percent. **1 Set of Operation and Instruction Labels** **Flue Gas Chamber** with flue gas condensate connection and inspection opening on flue gas side. **Flue gas connection socket** DN 630 with counterflange, packing, nuts and bolts. **Boiler Front Door** with thermal insulation and adjustable locking device, as inspection opening for the furnace, for cleaning and revision on flue-gas side and for fastening of the burner. The door opens acc. to the attached technical data sheet. **1 Burner brick lining(s),** corresponding to our technical information TI036 design as a straight, cast brick lining **1 Flame sight hole(s)** for viewing of the flame, with sight glass clear Ø 32 mm, protective cover, connection for cooling air and measurement. **Documentation,** consisting of: Additional set of documents: Quantity: 1 Language: English Design: CD-ROM

Deadline: with delivery

Operation log

Operation log acc. to European regulations for the scope of delivery.
Quantity: 1
Language: English
Deadline: with delivery
Additional set of documents:
Quantity:
1
Language:
English
Deadline:
with delivery

Acceptance documentation

Acceptance documentation in accordance with European directives as far as required for the supply of the boiler plant, respectively for the part concerning the delivery scope, however without assembly drawing and PI-diagram.
Quantity: 3
Language: English
Deadline: 2 weeks after delivery date
Additional set of documents:
Quantity:
1
Language:
English
Deadline:
2 weeks after delivery date

Insulation of boiler shell and boiler ends with mineral wool mats and protective cladding of structured aluminium.
Maintenance platform on boiler top (boiler centre); installation of rail, ladder and connection between boilers possible.
Rail for maintenance platform on boiler top
delivery in bulk for assembly on site
Ladder for maintenance platform.
The ladder is designed for installation on the same height level as the boiler base frame.

Set of vibration damper for reduction of vibration transmission on the basement through calculated, vibration insulated bedding. The vibration dampers were put under the base frame.

Shrink-Wrapping for Transportation
All weather-sensitive parts shrink-wrapped or packed in plastic wrapping. Loose parts - if

necessary - to be packed in cases, cartons or other suitable type of packing. Disposal of packing material at site.

Hoisting jacks (4 pieces), welded to the boiler frame, suitable for applying lifting equipment (e.g. lifting cylinder, jacks). The boiler can be conveniently lifted by means of the hoisting jacks during bringing in, placement and leveling of the boiler, e.g. in order to slide transport devices below the boiler supports or to remove the same.

Flue gas temperature display device
for display of the flue gas temperature downstream of the boiler in the Boiler control BCO, consisting of:
- Temperature transducer for proportional provision of signal 0/4-20 mA
with welded sleeve R 1/2" (installated in flue gas chamber).

Terminal Box
Protection class IP54, of steel sheet, powder-coating grey/structure, galvanized assembly plate, cable entry from below. Control design in accordance with DIN-/EN-standards. Connection of the control devices and the control panel via terminal strips in the terminal box. Terminal box is function-tested, 1 set of wiring diagrams inside the terminal box.

Advantages
Reading of the instruments and operating of the plant is facilitated by individual mounting or installation of the boiler control panel. Easy and mix-up proof connection to the terminal box by means of individually customized, coded and marked cable bundles with plug connections on both sides.

Boundary conditions for the indication of max. possible geodetic net height difference:
You have chosen, for the boiler, a safety valve trigger pressure of 10.00bar and a trigger temperature for the safety temperature limiter of 120°C. The saturated steam pressure belonging to this temperature is 0.99bar.
Taking into account the surcharges (distance safety valve to pressure limiter max. of 10.00% of safety valve pressure or at least 0,5 bar, safety margin pressure limiter max. to pressure maintenance device of 0,5 bar, an assumed workspace pressure holding device of 1.00 bar and safety margin pressure limiter min (0,3 bar)and a safety margin to the highest point of the system (0,2bar), remain for the geodetic net height (maximum permissible highest point of the hot water system) 64.24 m (6.01 bar).
For **technical data**, please refer to the attached technical data sheets, for further information to the current leaflets and specification sheets.

01.02.02 **Boiler Control Panel for Boiler control BCO**
Enclosure type IP 54, made of steel sheet, powder coated grey structure, galvanized mounting plate, cable ducting from below. The switching and control devices are assembled on a mounting plate and inside the control panel door. Wiring in the control panel is executed by means of flexible cables in sufficiently dimensioned cable ducts. The control devices are designed in accordance with DIN-/EN- standards. The control devices are connected on terminal strips inside the control panel. The control panel is function-tested, 1 set of wiring diagrams is provided inside the panel.

The marking of the electrical operating equipment in the wiring diagrams is made in accordance with DIN EN 81346- 2.

Control Panel Lighting incl. door position switch and safety plug for freestanding control panels.

Assemblies:

·Main switch with locking device

Automation device BCO with touch-sensitive touchscreen colour display
Industrially proven hardware from the range of stored-program controls are applied in the Boiler Control BCO. The complete control software is stored on a memory card provided with the device. A graphic TFT-display with touch-sensitive interface serves as display and operating unit. Operating signals and process value archive are stored on a multi-media card included in the delivery scope.

Basic functions:

·Load control

·Low load control
·Boiler operation hours meter
·Burner operation hours meter
·Registration of number of burner starts
·Clear text display of operation and fault signals, signal history on 500 signals with time recording (Coming, Going, Acknowledging) and all relevant operation data at the time
·Intuitive, menu-driven operation by means of the touch-sensitive graphic display
·Display of all operation-relevant measured values and conditions

MODBUS RTU Connection, consisting of
1 communication processor with link-up possibility to a superior plant control (not in scope of supply) via a 9-pin SUB-D-connector, configurated as MODBUS-RTU-Slave, with RS485 and RS232 interface.

Condition Monitoring basic
CMbasic is an analysis and evaluation system integrated in the BCO boiler control. It gathers, analyses and evaluates system operating statistics and parameters, consumption values, and measurements, and uses a traffic light-style display to clearly show the results. It detects, evaluates and notifies the user, in good time, of increased wear or uneconomical operation of the boiler system.

Scope of delivery:
Temperature-recording device at boiler outlet on flue gas side
Software module integrated in boiler control

Scope of functions
-Displays operating hours; frequency of starts; cold starts as a function of time
-Detects unfavourable start-up conditions
-Detects contamination on water and flue gas side
-Detects unwanted condensation

-Generates service notifications
-Displays boiler load profiles as a function of time
-In steam boilers where the fittings are controlled electrically, highlights energy losses from blow-down and desalting
-Displays measurements as actual values at time of delivery and as a function of time
-Representation of the digital volume meters with additional reset function, which are includedin the scope of deliveryand displayed in the control panel

Intended use

CMbasic gives customers the option of monitoring the efficiency and correct operation of their system. In this way CMbasic makes a positive contribution to system availability and to ensuring consistently high system efficiency.

Bus connection cable with plug (plugs delivered separately) for connection of Boiler control BCO boiler control panels. Cable length between connection points 10.00 m.
Emergency off switch for control panel

External start-up and shut-down control
With two potential-free contacts the boiler can be automatically started and shut-down. Potential-free contact established by existing regulation or control units in the control panel. Wiring up to the terminals in the control panel for external signaling and control function. Contact load max. 5 A.

Wiring diagrams for the scope of delivery.
Quantity: 5
Language: English
Design: print-out
Deadline: with delivery
Additional set of documents:

Quantity:
1
Language:
English
Design:
print-out
Deadline:
with delivery

01.02.03	refer to item 01.01.03
01.02.04	refer to item 01.01.04
01.02.05	refer to item 01.01.05
01.03	refer to item 01.01
01.03.01	refer to item 01.02.01

01.03.02	refer to item 01.02.02
01.03.03	refer to item 01.01.03
01.03.04	refer to item 01.01.04
01.03.05	refer to item 01.01.05
01.04	refer to item 01.01
01.04.01	refer to item 01.02.01
01.04.02	refer to item 01.02.02
01.04.03	refer to item 01.01.03
01.04.04	refer to item 01.01.04
01.04.05	refer to item 01.01.05
01.05	**Functions of connection of boiler plant to superior control technology**
01.07.01	**Piping Diagram** The piping diagram is designed acc. to EN ISO 10628 and is limited to our scope of supply. Quantity: 1 Language: English Deadline: 3 weeks within order confirmation Execution: one PDF-file (black/white), one PDF-file (coloured, in delivery scope characteristics) and onepacked DXF-file (ZIP file format) compliant to ACAD 2000 - Drawing Exchange Format (coloured, in delivery scope characteristics) dispatch on CD-ROM A non-dimensioned key for all fittings, MSR devices and piping is included. Additional set of documents: Quantity: 1 Language: English Deadline: 3 weeks within order confirmation Execution: one PDF-file (black/white), one PDF-file (coloured, in delivery scope characteristics) and onepacked DXF-file (ZIP file format) compliant to ACAD 2000 - Drawing Exchange Format (coloured, in delivery scope characteristics) dispatch on CD-ROM Additional set of documents: Quantity: 1 Language: English Deadline: 3 weeks within order confirmation Execution: one PDF-file (black/white), one PDF-file (coloured, in delivery scope characteristics) and onepacked DXF-file (ZIP file format) compliant to ACAD 2000 - Drawing Exchange Format (coloured, in delivery scope characteristics) dispatch by eMail
01.07.02	2D symbols 2D symbols for all main components. Sent by email; one PDF file, symbols in DXF or DWG format.
01.07.04	**Labelling of loose delivered parts**

Temporary labelling of loose delivered parts for clear identification of the components according to the delivery note. Designed as PE-label with delivery note number, item number and material number.
With metal tags fixed to the respective component.

02 **MEC Remote**
for remote access to the boiler control panel or system control panel via the internet.
Router for MEC Remote
VPN router for remote access to boiler control panel BCO / system control panel SCO via the internet portal www.mec-remote.com, parameterized and installed in a control panel in order to be connected to a internet connection on site or a customer network via DSL Router or dial-up in a mobile phone network via the optional available UMTS radio module. Costs of connection for data transmission are not included in the price of the device. We recommend the acquisition of an unlimited plan.
Scope of delivery router
- VPN router ERT50
- microSD card incl. router software
- implementation of plant data into MEC portal

If MEC Remote will be connected to a customer network, the router's IP address in the network needs to be indicated to the responsible project officer at the latest 10 working days after the order confirmation arrival. Otherwise the router will be configured with DHCP on the WAN side. The connection to the internet needs to be established according to TI043.
Function
In order to successfully set up a data connection to the MEC Remote portal (www.mec-remote.com), an online registration needs to be completed. This way you acquire the customer's access to the MEC Remote portal including remote access to all connected plants, server provision to visualize the connected boiler control panels and system control panels and automatic software and security updates for the VPN router. After the successful registration you furthermore gain the option to receive fast and professional help by BOSCH specialized staff - irrespective of the plant location. In case of incidents, extensive remote diagnosis can be created, parameter can be adjusted end even errors in the program sequence of the control can be identified and cleared.

The online registration can be found here:
http://www.bosch-industrial.com/mec-registration.

03 **Connection of the boiler plant** to a superior control technology.
via **MODBUS RTU**, consisting of
Communication processor(s) with link-up possibility to superior control technology (superior control technology is not included in this scope of supply) for transmission of operating signals, actual process data of the boiler control and control possibilities from the superior control technology.

The presettings are noted in the technical information TI034
- default Modbus-address(es), baud-rate, parity und stop-bits

	The exact functions can be found in the section **Functions of connection of boiler plant to superior control technology** of this description. **Note:** If for the data transmission at site an Engineer is needed, the occuring costs will be invoiced acc. to our conditions for delegation of personnel.
08	**Delivery FCA** Gunzenhausen / Bischofshofen Transportation of delivery scope to loading site in manufacturers workshop, loading onto truck or railway waggon with manufacturers crane and personnel.

CONDITIONS OF SALE AND DELIVERY

All delivers and services, assembly work and repairs are governed by these conditions and by any separate contractual agreements. Any terms of purchase of the buyer which deviate from these shall not become part of the contract even on acceptance of the order. Unless otherwise agreed, a contract comes about when the order is confirmed in writing by the seller.

Validity of the offer

Our offer and the prices in our offer are valid for a period of 3 months, calculated from the date of the offer. After this date, a probable price increment of 6 % for the following year is to be considered.

Object of the delivery and performance

The object of the delivery and performance according to the specification described in this offer.
The scope of our delivery and performance is completely and finally specified in this offer.
Further details and delivery limitations will become clear from these Conditions of Sale and Delivery.

Method of payment

Total amount of order by a divisible and irrevocable letter of credit, opened through and confirmed by one of the below mentioned banks and free of any charges for the seller:
- HypoVereinsbank AG - account no. 2906880, bank code: 765 200 71,
 IBAN: DE70765200710002906880, BIC: HYVEDEMM406
- Commerzbank AG - account no. 119675300, bank code: 760 800 40,
IBAN: DE73760800400119675300, BIC: DRESDEFF760

The L/C must be payable in Germany at sight against presentation of the usual shipping documents or a warehouse receipt to the bank. The letter of credit must be in accordance with UCP 2006, ICC-publication no. 600. The validity period of the L/C must exceed the delivery time by one month for shipping plus 21 days for negotiation.

Conditions of delivery

The delivery will be FCA Gunzenhausen / Bischofshofen.

Transport conditions

If transport is included in the order, this will be carried out solely in accordance with the general conditions of carriage valid at the time, such as the General German Conditions of Carriage (ADSp, publ. 2003) issued by Bundesverband Spedition und Logistik e.V..

Any claims by the seller against the dispatch company are assigned to the buyer, who accepts this assignment.

Delivery time ex works

Our standard delivery times apply. For the current delivery time please contact your personal contact person.

Storage and maintenance costs

If the customer defaults on acceptance, the customer shall bear the costs incurred by us, in particular for storage (also by third parties). For each day of delay, the customer shall reimburse us for lump-sum costs amounting to 0.025% of the net order value as well as a one-off lump-sum expense amounting to 1% of the net order value, unless we can prove to the customer that we incurred higher actual costs.

HRS PACKAGED PLATE HEAT EXCHANGER QUOTATION

Package Reference:	**HS-01**
Package Type:	AMX2667/3
Quantity	1
Description:	3-off Duty/Duty/Duty Plate Heat Exchangers Mounted on a Common Mild Steel Skid Base c/w Interconnecting Pipework & equipment as listed below
Design Specification (Per Heat Exchanger)	
Unit Duty 33% (100%):	2,667 kW (100% Duty - 8,000 kW Total)
Primary Circuit 33% (100%):	95/70°C at 25.5 Litres/Second (100% - 76.4 Litres/Second Total)
Secondary Circuit 33% (100%):	65/90°C at 25.5 Litres/Second (100% - 76.4 Litres/Second Total)
Maximum Substation Pressure Drop (Pri/Sec):	100 kPa / 100 kPa
Maximum Pri/Sec Working Pressure:	16.0/10.0 BarG (24.0/15.0 BarG Hydraulic Test Pressure)
Maximum Working Temperature:	110°C
Constituent Component Details	
Control Panel:	NONE - ½" BSP Sockets provided within the Pipework Wiring to be done by others
Primary Heat Meter:	1 x Kamstrup w/ 603 Integrator or equivalent
Primary Differential Pressure Control Valve :	1 x Samson 42-24 Differential Pressure Regulator or equivalent
Primary Thermo Bypass Valve:	1 x Danfoss AVTB
Primary Control Valve :	3 x 2-Port Valve c/w Spring-Return Modulating Actuator
Secondary Control Valve :	3 x 2-Port Valve c/w Spring-Return Modulating Actuator (On/Off)
Secondary Safety Valve:	3 x Bailey Birkett / Nabic Pressure Relief Valve
Other Ancillaries & Valves:	Arrangement based on: **'Typical Heat Substation Schematic' Based on 3 x PHE's and not 2** **Black Demarcation Box Labelled 'Packaged Heat Substation'** Valves are Crane / Hattersley
Plate Heat Exchangers:	3 x SE, 316L Plates with EPDM PRX Gaskets Insulation Jacket Included
Primary & Secondary Pipework:	Carbon Steel BS3602 HFS 430 / API5L / BS1387, Screwed up to & including DN40/DN50 & Flanged Above
End Connection Sizes:	8,000kW Primary: DN200 BS EN1092-1:2002 PN16 2,667kW Primary: DN125 BS EN1092-1:2002 PN16 8,000kW Secondary: DN200 BS EN1092-1:2002 PN16 2,667kW Secondary: DN125 BS EN1092-1:2002 PN16
Pipework Insulation:	NONE
Skid Base:	Mild Steel Painted Matt Black *(Split into 2 or 3 Sections due to the Size)*
PRICE PER PACKAGE:	**£99,225 EACH NETT DELIVERED***
DELIVERY (see Extras):	10 - 16 WORKING WEEKS (FROM DRAWING APPROVAL) (*Subject to change based on production & material availability*)
QUOTE VALIDITY:	30 DAYS
PAYMENT TERMS:	STRICTLY 30 DAYS NETT

Any Equipment not mentioned within this quotation has not been included

winder power
power & distribution transformers

winder power limited
Grangefield House, Richardshaw Road
Pudsey, Leeds, LS28 6QS
E-mail: donna.pinkney@winder.co.uk
Domain: www.winderelectrical.co.uk
Direct Tel No: 0113 2180741
Fax No: 0113 2572206

EMAIL QUOTATION

To:	[redacted]
Company:	
Email Address:	
From:	*Donna Pinkney*
Date / Ref:	*9 January 2017 DP/54620*
No of Pages	*Three*
Subject:	[redacted]

Dear Dave

Further to your recent enquiry, we take pleasure in offering the following quotation for your consideration.

- Supply one – new Winder, UK manufactured, 1000kVA, 11000/417V no load (ie output volts will drop once load is applied), 3 phase, 50Hz, KNAN, midel cooled transformer, connected Delta Star to Vector Group Reference Dyn11, complete with:
    - 40°C ambient temperature design. 60/65°C temperature rise
    - 4.75% design Impedance, +/- 10% IEC tolerances
    - EcoDesign losses – Fe = 770W, Copper = 10500W
    - Off circuit tapchanger, HV for HV variation, +5 to -5%, in 4 steps of 2.5%
    - HV Insulation levels – 12kV, BIL 75kV, pf 28kV
    - LV insulation levels – 1.1kV, BIL N/A, pf 3kV
    - Copper HV and LV windings
    - Generator fed design
    - Hermetically sealed, with welded on lid and nitrogen cushion
    - Midel 7131
    - Liquid temperature indicator, complete with 4 x standard alarm and trip contacts
    - Winding temperature indicator, complete with 4 x standard alarm and trip contacts
    - Liquid level indicator, complete with alarm and trip contacts
    - Pressure relief device, complete with trip contact
    - Liquid deflector shield and pipework, vented to ground
    - Mild steel cooling radiators
    - HV – 3P, 1G, IP54, top entry cable box, complete with standard porcelain bushings and undrilled (pilot holes only) steel cable box
    - LV – 4P, 16G, IP54, top entry cable box, complete with standard monobloc and undrilled (pilot holes only) aluminium gland plate, suitable for 4 x 1C cables per phase and 4 x 1C cables for the neutral
    - Fully rated neutral
    - LV cable cleats
    - LV neutral CT, located on the neutral of the LV cable box (ratio, Class etc to be provided by client)

- Standard fittings, including filler, lifting and jacking lugs, skid base, thermometer pocket, 2 x earthing terminals, prismatic liquid level gauge and name, rating and tap connection plate.
- Standard UK environment paint finish in Dark Admiralty Grey, 150 microns

PRICE EACH EX WORKS **£33,525.00 NETT**

NOTES ON OFFER

- We have not included for any transportation to site. A hiab vehicle to the London area, would be an **additional £1,500.00 nett**, assuming delivery during normal working hours, Monday to Friday and offloading based on a a maximum straight 4 metre reach being required.
- We have included for standard routine tests in strict accordance with BS EN 60076. No allowance for type or special tests has been included for. A temperature rise test would be an **additional £1,500.00 nett.** A leak pressure test would be an **additional £1,000.00 nett.**
- The transformers will be manufactured and tested in accordance with BS EN 60076.
- We have included for standard mild steel radiators and a standard UK environment paint finish.
- We have assumed that the transformer will not contain any large motor loadings. Please advise if this is not the case.
- We have included for 1 x CT, located on the neutral within the LV cable box. Full CT details would be required within
- We have not included for any cable terminations, nuts, bolts, glands etc.
- As of July 2015, any new transformer put into service within the European Union, will be subject to the mandatory EU Regulation for EcoDesign transformers. Our current offer assumes that the transformer will be purchased, manufactured and energised before end of June 2021 and therefore, fully complies with Tier 1 levels.

Delivery
Due to our current workload the delivery period on the above would be approximately 16-18 working weeks from date of order, however, this is subject to factory loadings at time of order.

Quality Assurance
All work/process activities will comply with the requirements of ISO 9001:2008, OHSAS 18001:2007 and ISO 14001:2004.

Value Added Tax
Our quotation is exclusive of any value added tax properly chargeable which would be added to our final account.

Working Hours
In the compilation of our quotation we have assumed that the whole of the electrical works can be carried out during normal working hours, ie Monday to Friday, based on an 8 hour day.

Testing
We have included for an unwitnessed routine tests.

Payments
30 days from date of invoice, subject to credit clearance.

Validity
Valid for 30 days from the date shown above and fixed except for copper, which is subject to adjustment calculation (+/-) for LME ruling at time of order. Based on copper LME of £4,400,00 per tonne.

Storage
In the event of a purchase order the goods would be manufactured and stored one month free of charge from date of invoice. Storage rates will be charged thereafter (amount to be agreed).

Site Safety
So that we can accommodate safety requirements that may be needed on your site we would be pleased to receive your advise about any hazardous areas, processes or situations likely to be in the proximity of our operations. Please contact the writer to arrange any special permits or instruction regarding the above.

Documentation
Our price is inclusive of one set of documentation ie test certificate, general arrangement/schematic drawing and standard Operation and Maintenance manual (if applicable). We reserve the right to charge for additional copies - details on request. All documentation will be supplied in English.

Consequential Losses
We do not accept any form of direct, incidental or consequential losses whatsoever.

Terms and Conditions
All quotations are subject to our standard terms and conditions, a full copy of which is available on request.

We trust the above is in line with your requirements, but should you require further information or clarification, please do not hesitate to contact the undersigned.

Yours sincerely
For Winder Electrical

DONNA PINKNEY
Sales Manager

Eland, James

From: Chris Wright <chriswright@hartwellmanufacturing.co.uk>
Sent: 25 October 2019 14:27
To: Hitchman, Tom; Paul Tomlinson
Cc: Eland, James; Robert Tomlinson
Subject: RE: Croydon Energy Centre - ~80m Flue Stack

Tom,

Doing some basic calcs we would estimate a total mast weight of circa 82 tonnes, so approx. 20.5 tonnes per leg, alternatively we could look to support off a structural base plate 2.8 x 2.9m giving 11m2 which then spreads the load at 7.5t/m2. These are only provisional calcs so you may want to add a decent contingency, consider 100 tonnes.

In terms of cranage it obviously depends at what stage the build is when it comes the installation and where we can put the crane and available reach, if we consider a 500 tonne crane, typical costs for this would be as below so you can see if we can take advantage of erecting the mast at the earlier build stage it would significantly reduce the crane cost.

500t crane
Day 1 – set up
Fixed fly - £18,400 + vat
Luffer - £23,000+ vat
£10,500.00 + vat- each day thereafter for say 3 to 4 days
Total - £ 73,000 to £80,000

If you can provide a layout of the plant room we can look at putting together some budget pricing for you, the special cladding may skew the costs. As a very high level indication, typical projects of this size are in the region of £400k to £500k but I wouldn't want to commit to this without all the details.

If you need anything else please let us know.

Kind Regards,

Chris Wright
Sales Manager

01924 262226
07534 216594
chriswright@hartwellmanufacturing.co.uk
www.hartwellmanufacturing.co.uk **NEW WEBSITE LAUNCHED!!!**

From: Hitchman, Tom <Tom.Hitchman@wsp.com>
Sent: 21 October 2019 16:34

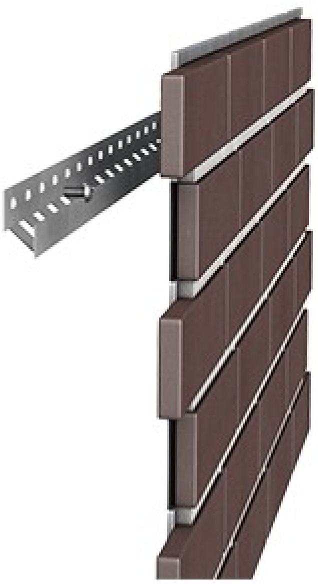
To: Chris Wright <chriswright@hartwellmanufacturing.co.uk>; Paul Tomlinson <paul@hartwellmanufacturing.co.uk>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Croydon Energy Centre - ~80m Flue Stack

Hi Chris and Paul,

Thank you very much for the information you provided on Friday, this was very useful for the meeting with the residential building developer.

The residential developer is due to commence the groundworks for the construction of the residential building. They have requested further details of the likely loading of the flue stack imposed on the ground slab to allow the piling design to be finalised. Do you think you would be able to assist in determining a likely load for this structure?

I have attached a more detailed sketch of the flue arrangement. The flue height is ~86m from ground level. The top ~12.4m extends beyond the adjacent roof level to achieve a flue termination level +3m above the parapet of the highest roof section. It is likely that the flue steelwork will need to be clad. The architect suggested an appearance to match the brickwork of the residential building, which could be perhaps a prefabricated brick-effect panel such as below. Is this something you have done before?



Technical Information

Stofix brick facade	Kiln-fired brick
Brick colours and textures	Any colour and texture available from reputable brick manufacturers
Mortar colours	Colours as per Stofix mortar colour chart
Brick slip dimensions	Any standard brick size can be used
Joint surface material	Micro-stone (crushed stone)
Stofix cladding panel dimensions	Approx. 1200 x 600 mm (0,72 m²)
Weight	Approx. 35-40 kg / m² (approx. 25–29 kg / panel)
Bonding	Standard ½ brick, ⅓brick, stack bond. Special bond can be used.
Thermal expansion	0.5 mm / m (-20°C – +50°C)
Ventilation cavity	From 15 mm
Expansion joints	At 7.5 m intervals when length / height exceeds 12 m
Additional insulation capacity	0–300 mm
Mounting structure	Hot dip galvanized steel 600 g/m², thickness 0,7-2 mm

If you are also able to advise a very high level budget price estimate, including crane hire, that would also be very helpful.

If you require any further information please let me know.

Regards,

Tom Hitchman
Principal Engineer

wsp

T +44 (0)203 116 9321

WSP House, 70 Chancery Lane
London
WC2A 1AF

wsp.com

From: Chris Wright <chriswright@hartwellmanufacturing.co.uk>
Sent: 18 October 2019 13:14
To: Hitchman, Tom <Tom.Hitchman@wsp.com>
Cc: Eland, James <james.eland@wsp.com>; Paul Tomlinson <paul@hartwellmanufacturing.co.uk>
Subject: RE: Croydon Energy Centre - 80m Flue Stack

Tom,

Attached you'll find some photos of typical projects

In terms of pre-assembly we would manufacture as much within the shop structure and flues as possible, the limiting factor is normally the crane and its available capacity, if you are on a greenfield site and you can get full access with the a mobile crane then we can manufacture as full 12m module sections steel and flues and install, if crane access is limited it would be sectional to suit capacity.

In terms of scaffolding Paul T will elaborate but its not normally required as we have full ladder access and deck out within each section so as the next section is lowered the guys affix at the transition.

Kind Regards,

Chris Wright
Sales Manager

Hartwell
MANUFACTURING & MECHANICAL SERVICES

☎ 01924 262226
☎ 07534 216594
✉ chriswright@hartwellmanufacturing.co.uk
www.hartwellmanufacturing.co.uk **NEW WEBSITE LAUNCHED!!!**

From: Hitchman, Tom <Tom.Hitchman@wsp.com>
Sent: 18 October 2019 13:07
To: Chris Wright <chriswright@hartwellmanufacturing.co.uk>
Cc: Eland, James <james.eland@wsp.com>; Paul Tomlinson <paul@hartwellmanufacturing.co.uk>
Subject: RE: Croydon Energy Centre - 80m Flue Stack

Hi Chris,

Thanks very much.

Any thoughts on install method and whether you would need to scaffold up the outside of the building?

Regards,

Tom Hitchman
Principal Engineer

wsp

T +44 (0)203 116 9321

WSP House, 70 Chancery Lane
London
WC2A 1AF

wsp.com

From: Chris Wright <chriswright@hartwellmanufacturing.co.uk>
Sent: 18 October 2019 13:03
To: Hitchman, Tom <Tom.Hitchman@wsp.com>
Cc: Eland, James <james.eland@wsp.com>; Paul Tomlinson <paul@hartwellmanufacturing.co.uk>
Subject: RE: Croydon Energy Centre - 80m Flue Stack

Tom,

Attached you can see a model of an 80 structural mast with 6 flue cores, these we re all preassembled in 12m modular section flues and structure and erected on site, I'm looking for some photos and hopefully will send on subsequent mails.

Kind Regards,

Chris Wright
Sales Manager

01924 262226
07534 216594
chriswright@hartwellmanufacturing.co.uk
www.hartwellmanufacturing.co.uk **NEW WEBSITE LAUNCHED!!!**

From: Hitchman, Tom <Tom.Hitchman@wsp.com>
Sent: 18 October 2019 10:31
To: Chris Wright <chriswright@hartwellmanufacturing.co.uk>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Croydon Energy Centre - 80m Flue Stack

Hi Chris,

Tony also mentioned you had recently worked on a similar project with a ~90m flue stack. If you are able to share any drawings / photos this would be very helpful.

Regards,

Tom Hitchman
Principal Engineer

T +44 (0)203 116 9321

WSP House, 70 Chancery Lane
London
WC2A 1AF

wsp.com

From: Hitchman, Tom
Sent: 16 October 2019 17:25
To: 'chriswright@hartwellmanufacturing.co.uk' <chriswright@hartwellmanufacturing.co.uk>

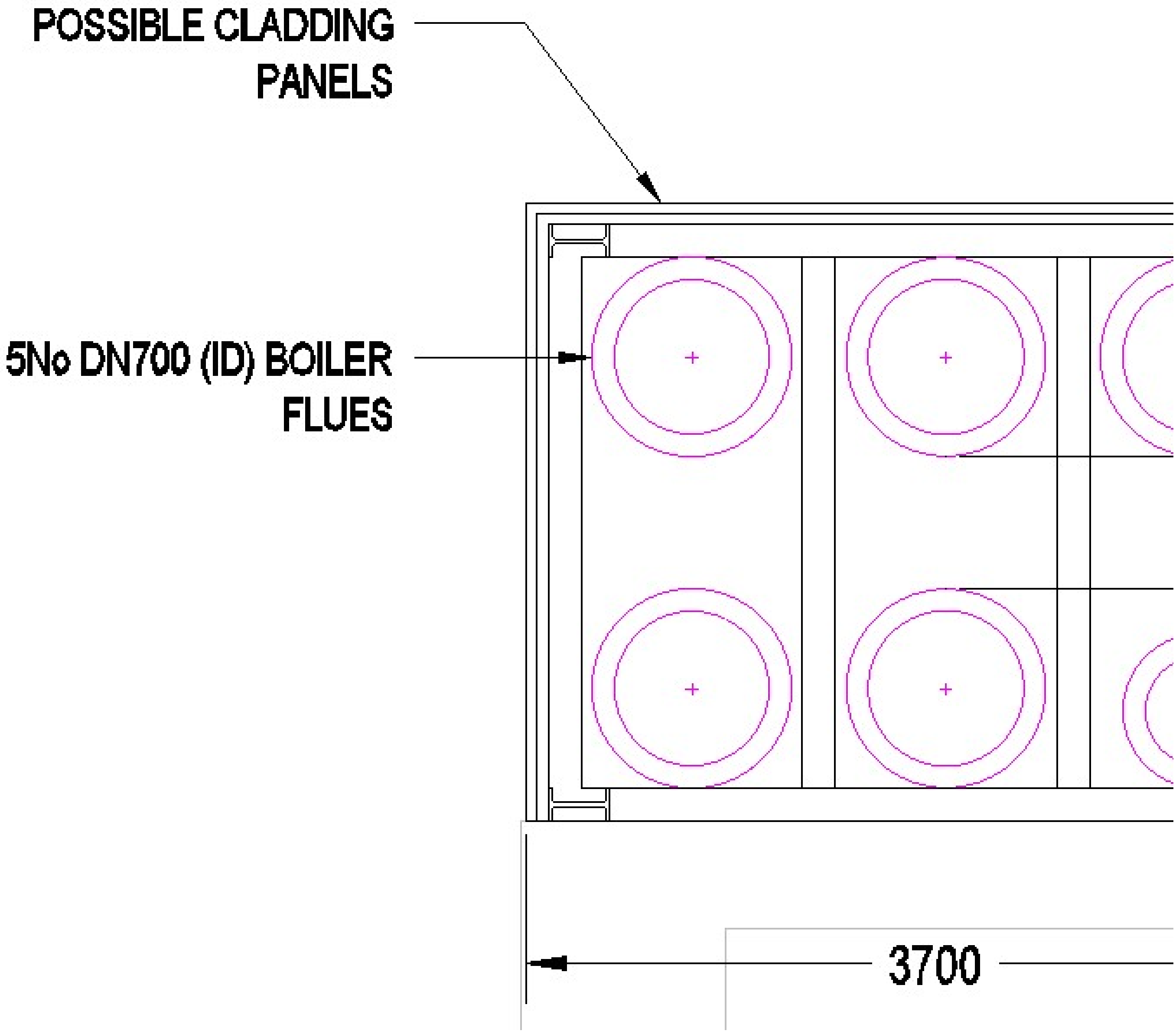
Cc: Eland, James <james.eland@wsp.com>
Subject: Croydon Energy Centre - 80m Flue Stack

Hi Chris,

Tony passed on your contact details to discuss flue options for the Croydon Energy Centre project.

We are looking at routing flues from a new energy centre up the side of a new residential tower block. The stack height will be nominally 80m + up to ~30m of horizontal flue run to the specific pieces of equipment. See attached early stage site plan and elevation showing the indicative flue route.

We are at an early stage with plant selections and flue sizing but this will indicatively be 5No 700mm ID flues for 6MW boiler modules and 1No 500mm ID flue for a CHP unit. Indicative arrangement shown below. CHP flue to be rated for 6bar and 450°C (normal operating conditions would be 60mbar, 120°C) All flues to be insulated and clad. Currently shown with 100mm of insulation, final requirement to be agreed.



What would you recommend in terms of flue construction and future access requirements? Tony suggested that fully welded would be your preference for reduced maintenance with external access for inspection. I have currently allowed for 600mm clearance between the flues. Would this be sufficient for internal access if preferable? The architect may require cladding around the flues that may make external access difficult.

Your thoughts on the above would be much appreciated. And if you can provide a high level budget price for this arrangement that would be very helpful. If you require any further information then please let me know.

Regards,

Tom Hitchman
Principal Engineer

T +44 (0)203 116 9321

WSP House, 70 Chancery Lane
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WC2A 1AF

wsp.com

Registered Office
Newington House
237 Southwark Bridge Road
London SE1 6NP

Company:
UK Power Networks
(Operations) Limited

Registered in England and Wales No: 3870728

Mr. Jason Rive
WSP
The Forum
Barnfield Road
EXETER
EX1 1QR

Date: 11 November 2019

Our Ref: 8500131506 / QID 3000022888

Dear Mr. Rive

Site Address: Church Road / CROYDON CR0 1SE

Thank you for your recent enquiry regarding the above premises. I am writing to you on behalf of South Eastern Power Networks plc the licensed distributor of electricity for the above address trading as UK Power Networks.

I am pleased to be able to provide you with a budget estimate for the work.

It is important to note that this budget estimate is intended as a guide only. It may have been prepared without carrying out a site visit or system studies. No enquiry has been made as to the availability of consents or the existence of any ground conditions that may affect the ground works. It is not an offer to provide the connection and nor does it reserve any capacity on UK Power Networks electricity distribution system.

Budget estimate:

The budget estimation for this work is:

Description

Budget estimate for the connection of a 2800kVA HV supply for a District Heating Energy Centre

High Voltage Point Of Connection

£290,000 (exclusive of VAT) if the Point Of Connection (POC) is to our High Voltage network along Church Road

Additional costs may be required for off-site reinforcement. This will be decided by the results of a network study, which will be carried out during preparation of the formal quotation.

All load requests in this area may be subject to interactivity at the primary substation.

It will be necessary to establish a new totally enclosed substation on the development site, in situations where a standard GRP substation enclosure can be used, an area of land of at least 4m x 4m will be required. If, however, you prefer to construct a brick substation then an area of land of at least 5m x 5m will be required. Planning Permission, although not required for a GRP substation, will be required for a brick built enclosure, and it will be your responsibility to obtain this.

The substation must be located such as to minimise the need for the manual handling of heavy plant. The Manual Handling Operations Regulations 1992 require the use of mechanical handling whenever this reasonably practicable. To meet these regulations we use a lorry mounted crane to deliver substation plant. The project must therefore be planned to ensure that it is suitable for the delivery of plant from a large vehicle. The Construction (Design and Management) Regulations 2015 also require that consideration be given to the safe installation, maintenance and eventual removal of equipment. To comply with this legislation we need to be able to gain access with a suitable vehicle throughout the life of the project.

Assumptions

This budget estimate is based on the following assumptions:

- The most appropriate Point of Connection (POC) is as described above.
- A viable cable or overhead line route exists along the route we have assumed between the Point of Connection (POC) and your site.
- In cases where the Point of Connection (POC) is to be at High Voltage, that a substation can be located on your premises at or close to the position we have assumed.
- Where electric lines are to be installed in private land UK Power Networks will require an easement in perpetuity for its electric lines and in the case of electrical plant the freehold interest in the substation site, on UK Power Networks terms, without charge and before any work commences.
- You will carry out, at no charge to UK Power Networks, all the civil works within the site boundary, including substation bases, substation buildings where applicable and the excavation/reinstatement of cable trenches.
- Unless stated in your application, all loads are assumed to be of a resistive nature. Should you intend to install equipment that may cause disturbances on UK Power Networks' electricity distribution system (e.g. motors; welders; etc.) this may affect the estimate considerably.
- All UK Power Networks' work is to be carried out as a continuous programme of work that can be completed substantially within 12 months from the acceptance of the formal offer.

Please note that if any of the assumptions prove to be incorrect, this may have a significant impact on the price in any subsequent quotation. You should note also that UK Power Networks' formal connection offer may vary considerably from the budget estimate. If you place reliance upon the budget estimate for budgeting or other planning purposes, you do so at your own risk.

Post estimate call

I will contact you within the next few days to discuss your estimate, to ensure you understand the work we will do for the estimated price, your responsibilities, any dependencies and the likely timescales for the work. UK Power Networks are always looking to improve our service offering and as such, the post estimate call may be recorded for training purposes. We will not share the recorded call with anyone outside of our connections business and it will be deleted as soon as we have completed the training review. However, if you do not want us to record the call please let me know at the beginning of the call.

If you would like to proceed

If you would like to proceed to a formal offer of connection then you should apply for a quotation. Please refer to our website click here for `The connection process' which details our application process.

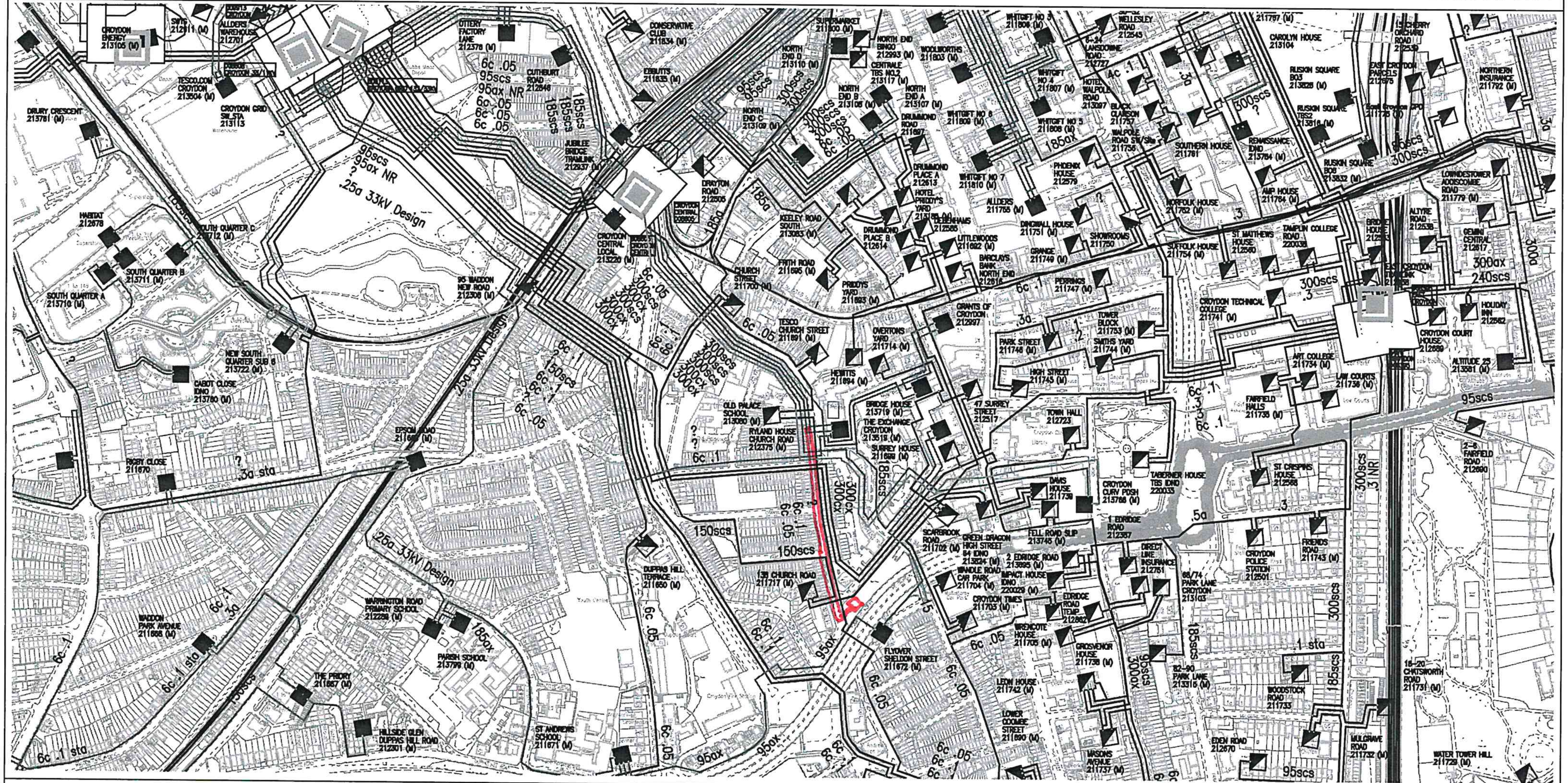
To help us progress any future enquiry as quickly as possible please quote the UK Power Networks Reference Number from this letter on all correspondence.

If you have any questions about your budget estimate or need more information, please do not hesitate to contact me. The best time to call is between the hours of 9am and 4pm, Monday to Friday. If the person you need to speak to is unavailable or engaged on another call when you ring, you may like to leave a message or call back later.

Yours sincerely

Mr. Robert Burke
PARKWOOD INDUSTRIAL ESTATE
Kent, MAIDSTONE
ME15 9XH
01622 352 396
rob.burke@ukpowernetworks.co.uk

Title: JOB NO: STANDARD PLOT



0m 100m 200m 300m 400m 500m 600m 700m

The quality and accuracy of any print will depend on your printer, your computer and its print settings. Measurements scaled from this plan may not match measurements between the same points on the ground.

Legend	
LV Cable or Line	
HV Cable or Line	
EHV Cable or Line Approx. position	
Ductline	[ ]
Pole & Street Furniture	● ○
Substation & Link Box	

1. The position of the apparatus shown on this drawing is believed to be correct but the original landmarks may have been altered since the apparatus was installed.
2. The exact position of the apparatus should be verified – use approved cable avoidance tools prior to excavation using suitable hand tools.
3. It is essential that trial holes are carefully made avoiding the use of mechanical tools or picks until the exact location of all cables have been determined.
4. It must be assumed that each property and item of street furniture has an electricity supply. Service cables shown only where known.
5. All cables must be treated as being live unless proved otherwise by UK Power Networks.
6. The information provided must be given to all people working near UK Power Networks plant & equipment. Do not use plans more than 3 months after the issue date for excavation purposes.
7. Please be aware that electric cables/lines belonging to other owners of licensed electricity distribution systems may be present and it is your responsibility to identify their location.

VISITING AN OPEN POINT? Please mark on this plan all locations visited and open points as found, then return updated map to your Business Unit – Thank You.

1. UK Power Networks does not warrant that the information provided to you is correct. You rely upon it at your own risk.
2. UK Power Networks does not exclude or limit its liability if it causes the death of any person or causes personal injury to a person where such death or personal injury is caused by its negligence.
3. Subject to paragraph 2 UK Power Networks has no liability to you in contract, in tort (including negligence), for breach of statutory duty or otherwise for any loss, damage, cost, claims, demands, or expenses that you or any third party may suffer or incur as a result of using the information provided whether for physical damage to property or for any economic loss (including without limitation loss of profit, loss of opportunity, loss of savings, loss of goodwill, loss of business, loss of use) or any special or consequential loss or damage whatsoever.
4. This plan has been provided to you on the basis of the terms of use set out in the covering letter that accompanies this plan. If you do not accept and/or do not understand the terms of use set out in the covering letter you must not use the plan and you must return it to the sender of the letter.
5. You are responsible for the security of the information provided to you. It must not be given, sold or made available upon payment of a fee to a third party.

Contact UK Power Networks on 0800 056 5866 for details of EHV Cable routes before commencing work.

Grid Ref: TQ 32054 65423
Map Centre: TQ3265SW
Scale: 1:5000
(when Plotted at A3)
Plotted on: 11/11/2019
Plotted by: Burke, Robert

UK Power Networks

Plan Provision

CHECK IT OUT BEFORE YOU DIG IT OUT
CALL 0800 056 5866
EMERGENCY– If you damage a cable or line
Phone 0800 096 3766 (24hrs) URGENTLY

LOOK OUT LOOK UP

ALWAYS LOOK UP BEFORE YOU START WORK
Refer to HSE Guidance note GS6

Maps produced at 1:2500 scale are LV Geo-Schematics which show LV mains cables and overhead lines (in some cases all voltages). Prior to carrying out excavations you must refer to the 1:500 records to determine the location of all known underground plant and equipment.

Eland, James

From: Rive, Jason
Sent: 22 November 2019 09:11
To: WILLIAMS Andy
Cc: Eland, James; WINDLE Jonathan
Subject: RE: 5097016 Connection application for Croydon DH Energy Centre

Good morning Andy,

I've spoken with colleagues and we wish to keep pursuing the option of a medium pressure connection, as a LP connection is not really ideal for this size energy centre. Hope to hear back soon on the reinforcement costs.

Many thanks,
Jason

Jason Rive ***MEng AMIMechE***
Project Engineer
Energy Solutions

T+ 44 (0)1392 267 588
M+ 44 (0)789 669 1662

The Forum, Barnfield Rd, Exeter EX1 1QR

wsp.com

From: Rive, Jason
Sent: 19 November 2019 20:49
To: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Cc: Eland, James <james.eland@wsp.com>; WINDLE Jonathan <Jonathan.Windle@fulcrum.co.uk>
Subject: RE: 5097016 Connection application for Croydon DH Energy Centre

Hi Andy,

Not the outcome from the RWC that I was hoping for, but ultimately it was a great tournament and we got to see some pretty good play!

Thanks for the information on the gas connection. I will pass this on to a colleague to advise.

I have attached the response from UKPN, and redacted the costs as requested. Let me know if you need more info on this in order to work up a budget quotation.

Many thanks,
Jason

Jason Rive ***MEng AMIMechE***
Project Engineer
Energy Solutions

T+ 44 (0)1392 267 588
M+ 44 (0)789 669 1662

The Forum, Barnfield Rd, Exeter EX1 1QR

wsp.com

From: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Sent: 19 November 2019 15:15
To: Rive, Jason <Jason.Rive@wsp.com>
Cc: Eland, James <james.eland@wsp.com>; WINDLE Jonathan <Jonathan.Windle@fulcrum.co.uk>
Subject: FW: 5097016 Connection application for Croydon DH Energy Centre
Importance: High

Hi Jason,

Trust all's well ,

Since we last spoke the RWC didn't quite go to plan for both our teams, hopefully we'll see some more of Japanese team in future tournaments though,

RE: Gas update as below email really from my colleague in design, we would like to get your thoughts please.

There is an LP option to supply immediately at the site. SGN have initially advised reinforcement is needed are now working on their network analysis to confirm the extent and costs.
With it being LP and them wanting 150mbar they would need to arrange boosters for this.

Jason any info back from UKPN for the electric POC non –cons?

Jon,
Can I check have you look further afield for MP gas connection, please?

Kind Regards

ANDY WILLIAMS | Business Development Manager
Mobile: 07557 233 025 |
Email: andy.williams@fulcrum.co.uk | Web: www.fulcrum.co.uk

FULCRUM Address: Fulcrum, 2 Europa View, Sheffield Business Park, Sheffield, S9 1XH. Tel: 03330 146 466

From: WINDLE Jonathan <Jonathan.Windle@fulcrum.co.uk>
Sent: 19 November 2019 14:01
To: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Subject: 5097016 Connection application for Croydon DH Energy Centre

Andy, to give you an update on this if you need to update the customer
There is an LP option to supply immediately at the site. SGN have initially advised reinforcement is needed are now working on their network analysis to confirm the extent and costs.
With it being LP and them wanting 150mbar they would need to arrange boosters for this
Noticed it was logged as MU in AX – are Dunamis doing the electric?
Regards,

https://www.google.co.uk/maps/place/Church+Rd,+Croydon+CR0+1SE/@51.3702628,-0.1030502,348m/data=!3m1!1e3!4m5!3m4!1s0x48760737a2f9796f:0xdfe7221eed09a728!8m2!3d51.3700765!4d-0.1034948

FULCRUM

JONATHAN WINDLE | Design Engineer
Direct: 01142 804131
Email: Jonathan.Windle@fulcrum.co.uk | Web: www.fulcrum.co.uk

Address: Fulcrum, 2 Europa View, Sheffield Business Park, Sheffield, S9 1XH. Tel: 03330 146 466

From: Rive, Jason <Jason.Rive@wsp.com>
Sent: 21 October 2019 09:27
To: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Connection application for Croydon DH Energy Centre

Morning Andy.

Good to speak with you on Wednesday. As requested, I've attached the C1/C2 forms and an indicative layout showing preference for gas meter/kiosk location.

Note that we require boosters only if the required 150mbar pressure can not be met from the local gas supply network.

As discussed, I will send through further information on the electrical connection once I have received a response from UKPN.

Please get back to me if you have any further queries.

Regards,
Jason

Jason Rive ***MEng AMIMechE***

Project Engineer
Energy Solutions

T+ 44 (0)1392 267 588
M+ 44 (0)789 669 1662

The Forum, Barnfield Rd, Exeter EX1 1QR

wsp.com

From: Rive, Jason
Sent: 15 October 2019 13:08
To: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Connection application for Croydon DH Energy Centre

Hi Andy,
Yes, around 0930 sounds good. Give me a call when you're ready.
Jason

Jason Rive ***MEng AMIMechE***
Project Engineer
Energy Solutions

T+ 44 (0)1392 267 588
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WSP UK Limited, a limited company registered in England & Wales with registered number 01383511. Registered office: WSP House, 70 Chancery Lane, London, WC2A 1AF.

From: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Sent: 15 October 2019 09:00
To: Rive, Jason <Jason.Rive@wsp.com>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Connection application for Croydon DH Energy Centre

Hey Jason no problem, would 9.30ish work tomorrow morning for a call to allow me to better understand the above scheme Gas & Electric requirements?

On 15 Oct 2019 08:12, "Rive, Jason" <Jason.Rive@wsp.com> wrote:

Morning Andy,

Sorry about the delayed response. I'm working from a client today and yesterday – shall we talk this through tomorrow instead?
Any time in the morning should be fine.
Thanks,
Jason

Jason Rive ***MEng AMIMechE***
Project Engineer
Energy Solutions

T+ 44 (0)1392 267 588
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The Forum, Barnfield Rd, Exeter EX1 1QR

wsp.com

From: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Sent: 11 October 2019 17:42
To: Rive, Jason <Jason.Rive@wsp.com>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Connection application for Croydon DH Energy Centre

Thanks Jason,

Your Ref number is 5097016 Croydon DH Energy Centre.

Look forward to quoting for both the gas and electric provision for this scheme.

Will it be possible to catch up on Monday and run through this project ? if so when would be best to call?

Kind Regards

ANDY WILLIAMS | Business Development Manager
Mobile: 07557 233 025 |
Email: andy.williams@fulcrum.co.uk | Web: www.fulcrum.co.uk

FULCRUM

Address: Fulcrum, 2 Europa View, Sheffield Business Park, Sheffield, S9 1XH. Tel: 03330 146 466

From: Rive, Jason <Jason.Rive@wsp.com>
Sent: 11 October 2019 17:15
To: WILLIAMS Andy <andy.williams@fulcrum.co.uk>

Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Connection application for Croydon DH Energy Centre

This email was sent by an external party
It may contain links, a virus or attempt to steal personal data. If in doubt use the 'Phish Alert' button or delete it.

Hi Andy,

Thanks for the response. Postcode was CR0 1SE.

Regards,

Jason Rive ***MEng AMIMechE***
Project Engineer
Energy Solutions

T+ 44 (0)1392 267 588
M+ 44 (0)789 669 1662
The Forum, Barnfield Rd, Exeter EX1 1QR

wsp.com

From: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Sent: 11 October 2019 17:13
To: Rive, Jason <Jason.Rive@wsp.com>
Cc: Eland, James <james.eland@wsp.com>
Subject: RE: Connection application for Croydon DH Energy Centre

Thanks Jason for the enquiry, sent across earlier today.

To allow me to find the enquiry what was the site postcode you registered the scheme under please?

Many Thanks

ANDY WILLIAMS | Business Development Manager
Mobile: 07557 233 025 |
Email: andy.williams@fulcrum.co.uk | Web: www.fulcrum.co.uk

FULCRUM

Address: Fulcrum, 2 Europa View, Sheffield Business Park, Sheffield, S9 1XH. Tel: 03330 146 466

From: Rive, Jason <Jason.Rive@wsp.com>
Sent: 11 October 2019 16:25

To: WILLIAMS Andy <andy.williams@fulcrum.co.uk>
Cc: Eland, James <james.eland@wsp.com>
Subject: Connection application for Croydon DH Energy Centre

Good afternoon Andy.

I submitted a budget quotation request for the Croydon Energy Centre earlier today (around 1500) using the online application process. The application appeared to go through okay but I was not given a reference number nor have I yet received an email confirming that the application was submitted.

As I understand you are the Business Development Manager who covers the Croydon region, could you please confirm for me that this application has gone through? Feel free to forward this on to the appropriate person if I've addressed this incorrectly.

Many thanks,
Jason

Jason Rive ***MEng AMIMechE***
Project Engineer
Energy Solutions

wsp

T+ 44 (0)1392 267 588
M+ 44 (0)789 669 1662

The Forum, Barnfield Rd, Exeter EX1 1QR

wsp.com

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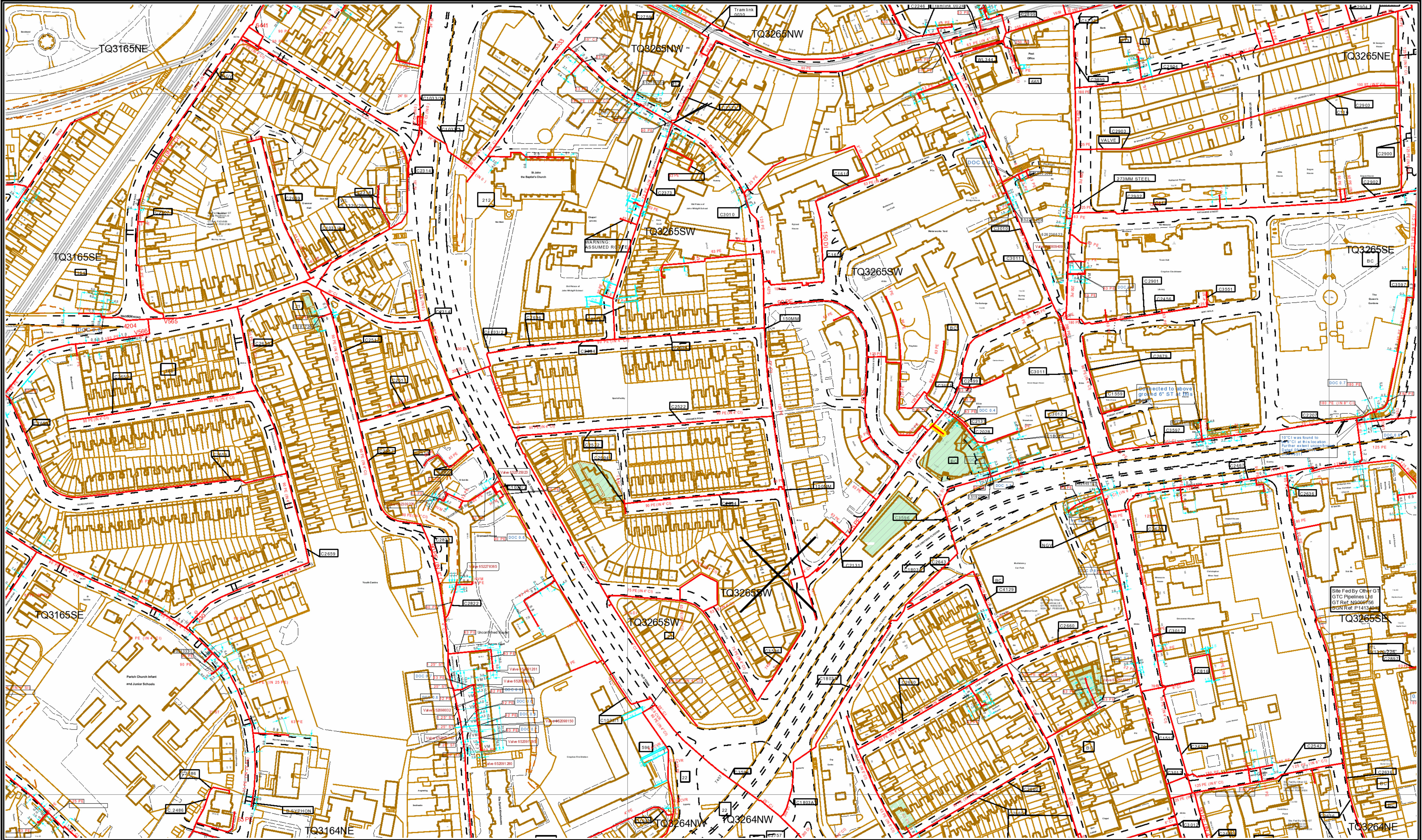


SCALE :	1 : 2500
USER ID :	Ful
DATE :	21/10/2019
GRID REFERENCE :	E532059,N165266,TQ 32 65

LP MAINS

MP MAINS

IP MAINS

LHP MAINS

Some examples of Plant Items

Valve Syphon Depth of Cover Diameter Change Material Change

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Plant Protection Team on 08450703497 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Internet WebGIS 2.1

Scotia Gas Networks plc

Our ref: P19148807/01
Your ref: 5097016

9th December 2019

SGN
3rd Party Connections Team
St Lawrence House
Station Approach
Horley
Surrey
RH6 9HJ

Contact: Lubna Khan
Tel: 01293 818 241
Lubna.khan@sgn.co.uk

Jonathan Windle
Fulcrum Pipelines Ltd c/o Fulcrum Infrastructure Services Ltd
2 Eupora View
Letsby Avenue,
Sheffield Business Park,
Sheffield
S9 1XH

Dear Jonathan Windle,

Re: Croydon District Heating Centre, Wandle Road Car Park site, Croydon, CR0 1SE

Thank you for your Request dated the 22th October 2019 relating to the Connection at the address detailed above.

I am writing to inform you that we will need to produce a detailed Sufficiently Complex Job (SCJ) design study before being able to progress your request any further.

Connection work is considered 'Sufficiently Complex' when specific reinforcement is considered to be of significant value or technically challenging. The following elements are contributory factors in our requirement to undertake a design study.

- ☐ A reinforcement is required, and is likely to include apparatus that is designed to operate at above 7 barg
- ☑ A reinforcement is required and there are known obstacles on the proposed route of the reinforcement apparatus and the anticipated total cost of the construction work, including applicable overheads, is expected to exceed £10,000, or where the total construction costs, including applicable overheads, is expected to exceed £250,000

Indicative specific reinforcement of approximately £361k is required which indicatively would be split between SGN and customer based on economic test. This reinforcement will take the form of approximately 462m of 355mm PE and 143m of 315mm PE on the low pressure system .Given the lengths and complexities involved, these works are defined as "Sufficiently Complex Job" (SCJ).

Larger and more complex projects that are designated as Sufficiently Complex may require several stages of design work. For example, a project may require a feasibility study and conceptual design study before it's possible to proceed to a detailed design study. Each stage of the process would be fully rechargeable.

This SCJ study is chargeable with payment required in full before we may quote for the connection therefore to avoid unnecessary work we will not progress this Request further until we have received written confirmation that you wish us to do so. The cost of the Design Study to you will be £6115.57 excluding VAT).

Any charge made in respect of sufficiently complex reinforcement may be refunded, subject to the application of the Economic Test, where applicable, when the project proceeds.

You do not have to do anything at this stage other than confirm in writing that you wish us to produce a Quote for the SCJ study. We will then send you our quotation along with our agreement for signing and return along with payment.

SGN
Your gas. Our network.

At this stage, the potential issues we will need to look at within the SCJ study along with the indicative costs are as follows:

- ☑ Work which involves the crossing of, or which is affected by, the presence of motorways, dual carriageways or highways, and which have been designated by the Highway Authority to have special engineering difficulties
- ☐ Work which involves the crossing of, or which is affected by, the presence of a railway line or tramway
- ☐ Work which involves the crossing of, or which is affected by, the presence of a river, stream, estuary or canal (navigable or otherwise), body of water, aqueduct, or a drainage channel
- ☐ Where work is in, or likely to affect, a site of special scientific interest (SSSI), nature reserve, scheduled monument or archaeological site
- ☐ Where work is situated within, or likely to affect, a woodland, marsh, peat bog or coastal wetland
- ☐ Connections to blocks of flats where any service pipe will terminate more than five stories above the adjacent Work which involves any requirement for a public enquiry or planning permission, including planning permission associated with any buildings including meter houses
- ☐ Where the route of any apparatus involves a significant (greater than 2m) change in elevation within a short horizontal distance (eg a cliff or retaining wall)
- ☐ Where any apparatus will be laid in contaminated ground, disused slag heaps or rubbish dumps
- ☐ Where any apparatus will be laid in land likely to suffer from severe subsidence or other significant ground movement including the laying of apparatus near to disused mine shafts/workings
- ☐ Where work is likely to be affected by special security provisions (eg military bases, prisons etc)
- ☐ Where work will take place within top tier COMAH sites
- ☐ Where work is situated within, or likely to affected by Easements/Servitudes
- ☑ Any other work where special difficulties or unusually high costs might occur

This SCJ will be completed as soon as is possible but please note that where dealing with third parties the discussions and negotiation required can be protracted potentially taking several months if not longer to complete. We will be happy to provide updates on request where lead times have been extensive.

If we do not hear from you within a period of 30 days from the date of this letter we will cancel your request in which case we will send you confirmation in writing.

If you would like to discuss any of the points raised in this letter further please contact the above named person quoting our reference number.

Yours sincerely

Leigh Keegan
Network Support Manager
leigh.keegan@sgn.co.uk

Appendix B

PIPE NETWORK COST INFORMATION

This section illustrates the information received for the DH pipework costs:

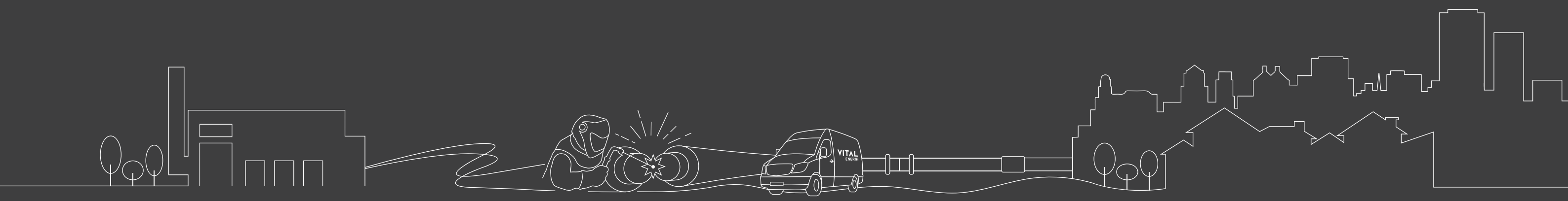
Vital Energi
Chiltern Thrust Bore
SDEN meeting notes (clarifying demarcation assumptions)

WSP Energy Solutions

Croydon DES

BUDGET SCHEDULE OF RATES

11 OCTOBER 2019



VITAL ENERGI UTILITIES LTD

Schedule of Rates for District Heating Network – Croydon DES

Introduction

As requested, we have provided you with a schedule of rates for district heating which should complement a take-off you may have made of the route, assuming your take-off considers valves, pipe, bends and tees.

The range of costs provided considers different excavation types for civil works (e.g. soft, mixed, hard and very hard excavations). The images provided within the document should assist with explaining the application of the civil rates.

The schedule of rates is not intended to be overly complex, but it should help you to build an accurate cost plan, using the different rates, rather than a “broad brush” set of rates which can produce an artificially low cost plan.

We recognise that there is a lot of information presented here and would be happy to meet with you to talk through the schedules and how they can best be applied to your client’s scheme.

Items to note

1. The prices are prepared on the basis of the works commencing within the next 12months (i.e. by October 2020).

2. They are based on pipes with Series 3 insulation thickness.

3. The prices are inclusive of design.

4. The district heating matrix is prepared so that the individual components can be populated and the total allowance generated. The grey cells will auto calculate. The green cells are for operator adjustment. Each individual component must be counted, or alternatively the flow pipe take-off should be duplicated for the return pipe, a trench length of 150metres is 300metres of pipe.

5. These rates do not include delivery/offloading, project management/prelims and risk which have been identified separately.

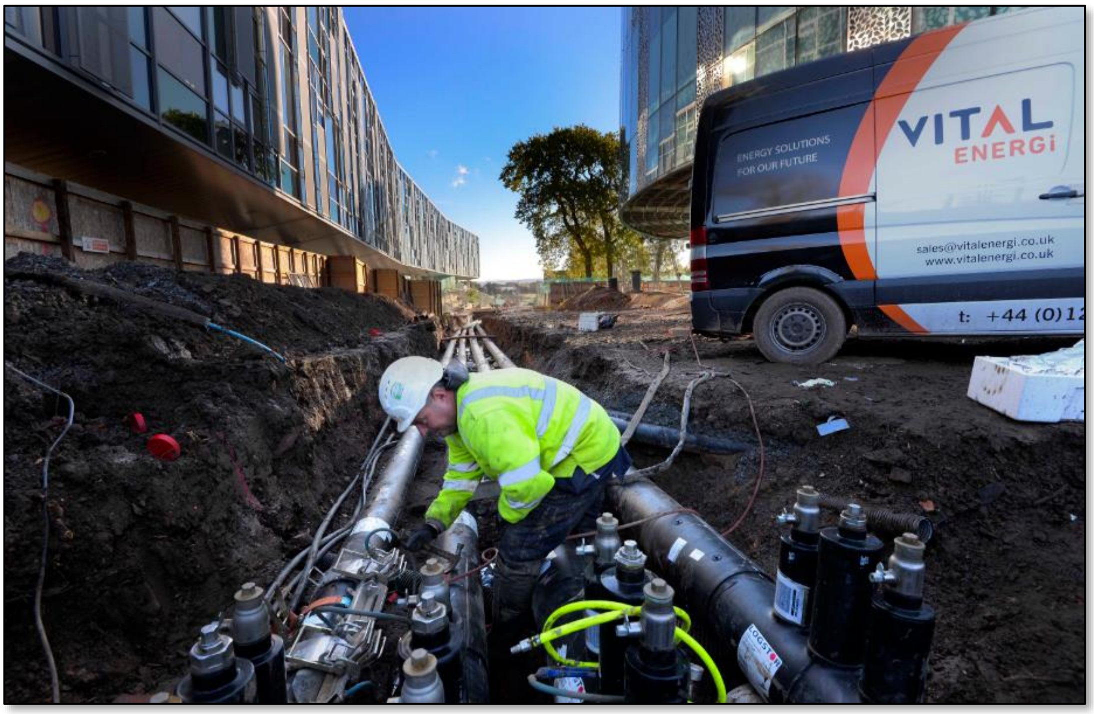
6. The trenching rates are fully inclusive of prelims, traffic and construction management.

7. This information is prepared without knowledge of the pipework route and on the basis of minimum depths of cover (i.e. 600mm), no existing services obstructions or contaminated ground. We would suggest consideration to the above aforementioned risks are made and a pricing contingency identified. At this stage we would indicate an overall pricing contingency of 15% to 25% for an ‘all risk’ price for the district heating mechanical installation and trenching.

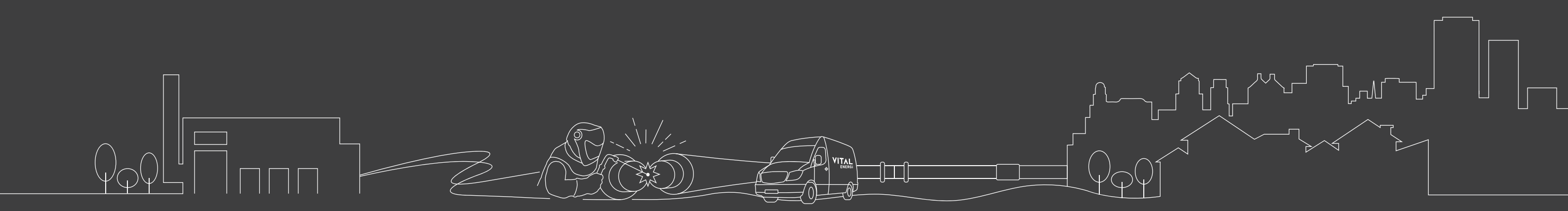
Appendices

We have included the following appendices:

- Appendix 1 – Supplier Response
- Appendix 2 – Typical Trench Section
- Appendix 3 – Example Photographs for Trenching Installations & Crossings
- Appendix 4 – District Heating Pipework Pricing Matrix
- Appendix 5 – Civils & Trenching Pricing Matrix



APPENDIX 1



WSP - Energy Solutions

Croydon DEN - Information Request

Queries regarding specific installation areas

Query 2: Re-use of existing utlities bridge

Query	Response
In your view would it be possible / feasible to re-use the existing pipe bridge?	Technically yes, subject to all the necessary structural investigations, it may be feasible to install the proposed DH pipes within the existing structure but practically not so straight forward. This may also not be acceptable to the actual owner of the existing pipe bridge. Understanding first who owns the existing bridge is critical i.e. is it Network Rail or could it be the local Highways Authority as this will have a bearing on how to approach this option. We have been in meetings recently where two authorities have claimed ownership of the same bridge!
Would you be willing to estimate the cost of this crossing (to nearest £100k) for the full installation, assuming that you think it might be possible? If yes, could you provide us with a budget cost for this? Costs should include structural assessment, Network Rail liaison, etc.	Based on schemes of a similar nature the budget costs could be in the region of £200k, but this does not allow for the costs of any necessary wayleaves and permissions. Our understanding is that Network Rail would require an additional bond to be put in place before they will engage with you in any design assessments. Once ownership has been established then an early engagement with Network Rail would be wise as the time required for detailed planning for such an option should not be under estimated.
Do you have any experience or are aware of such a re-purposing of assets for District Heating?	Where ever possible we would avoid overhead crossings. In our opinion it would be better to go under the obstacle. We are involved with a number of schemes where the proposed DH pipes have to cross Network Rail assets and it has been clear from our initial discussions with Network Rail that their preference was for us to go under rather than above. We are also in discussions with Canals & River Trust (CRT) regarding a similar scheme. The proposed district heating networks have to cross a navigational river so we have been discussing what CRT preferred options are. Fr your information please see their response to our recent request to install the proposed district heating pipes within their existing bridge structure: "*Accommodating the pipes inside or attached to the bridge causes significant problems when it comes to maintenance, inspection and also liability due to the bridges condition which may affect the utilities on it. For example if we need to do work to the structure and divert all utilities your services might be out of use for months at a time and we would need to compensate or divert at our own cost. Obviously we have several utilities over the bridge currently in the surfacing courses however these utilities companies have statutory powers and they are easily accessible from the surface of the structure.* *The engineers first preference is the same as my own, to go underneath the canal using auger bore technique. This will be better visually and also reduce maintenance to a pipe bridge. The other option is to put a pipe bridge in place a few metres away from the existing structure, to be fully maintained by yourselves (cladding and appearance to be agreed at a later date). Either of these options would work at the site so if you can look into them further that would be appreciated* ."

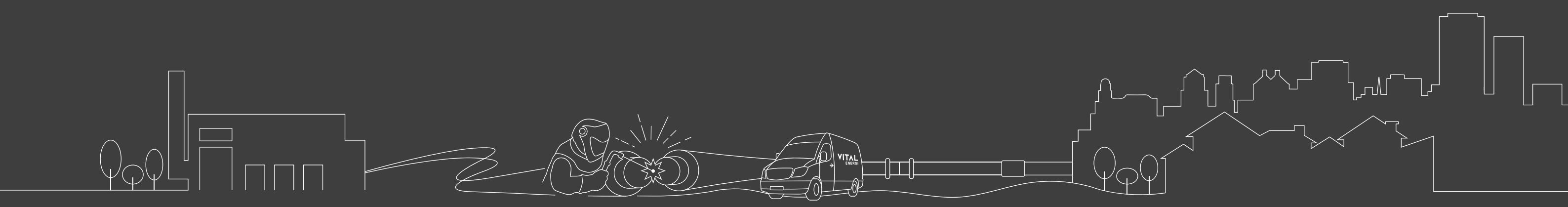
Query 3: Pipebridge to private land

Query	Response
In your experience, is it possible to come to an agreement with private landowners to install pipework? Is this a 'normal' commercial arrangement that can be made e.g. wayleaves / easement?	This can certainly be a barrier to a schemes viability. Unfortunately not being a statuary body, it can be extremely difficult to come to an agreement with a third party land owner, whether this is for the siting of a new energy or routing of the proposed heat network. There is no obligation on a third party land owner agreeing to DH apparatus being installed on their land. For your information please see attached a copy of a document that was prepared by Western Power as a guide to understanding legal permissions and consents to place equipment on third party land. Whilst we appreciate that the document relates to power generation equipment the information is still relevant to the issues you face on this scheme.
Do you have experience of costs for pipe bridges for DH pipework? Might you be willing to provide a cost estimate (to nearest £50k) for the design, supply and installation of a DH pipe bridge for 250mm ID pipes and a crossing width of approximately 30m?	Every crossing has its own challenges and from our experience the type of crossing i.e. rail track, rivers and canals has a bearing on the final design and subsequent costs. For your information we are aware of a recent bridge crossing in Beddington which had to cross the existing rail track and we understand that the final cost was in the region of £400,000.00. It should be noted that these costs did not allow for any costs associated with third party land owners. If we have understood your information correctly the location identified within your briefing notes indicate that to enable the proposed bridge to be sited it would require an agreement with a local landowner. This in our opinion could be a barrier so alternative route options should investigated.
If you are not willing / able to provide a cost estimate for this, do you have any suggestions of where we could turn to, to obtain a budget cost for this?	See above budget cost

Query 4: Directional drilling / auger boring

Query	Response
Do you have experience of installing DH via directional drilling or auger boring? If yes, which methodology would you recommend in light of the proposed crossing?	We have experience with installing DH pipes via Guided Auger Boring and based on the desk type information you have kindly provided to us we believe that this would be the best methodology. Guided Auger Boring is the ideal solution for trenchless installations where accuracy relating to line, level and gradient is critical. It was designed and predominately used for drainage but is evermore becoming the methodology of choice for district heating and duct installations particularly in sensitive areas or in adverse ground conditions. By utilising an Optical Guidance System, this quick and efficient trenchless technique can complete thrust boring activities with little or no risks of heave and settlement and minimal disruption to the surface, surrounding areas and services. This technique is the ideal No-Dig solution for district heating pipes, gravity pipelines, drainage pipes and various ducting requirements. Distances: Pipe lengths up to 80 metres. Installation Rates: Up to 10 metres per day dependent on the required diameter and the ground conditions. Accuracy: +/- 1% Ground dependent. Advantages of Guided Auger Boring: • Highly accurate process. • Dry method of installation – no slurry removal. • Quick, efficient and therefore economic/cost effective. • No disruption to the surface infrastructure or services. • Unaffected by surface obstacles. • Cost effective and time saving alternative to open cut methods when installing pipes amidst extensive underground infrastructure or at significant depths. • Relatively small overall footprint for the Works. • A reduced requirement for possessions, road closures or opening notices etc if required. • A reduced requirement for restricted working hours. • A reduced requirement for premium rate working.
For a network diameter of 200mm ID, would you expect to drill a single bore, or two (or more) individual bores for the network pipework (and fibre links?)	There are two possibilities for this diameter of pipe; First option would be to drill and install 2 separate sleeves to accommodate the DN200/400mm Series 3 pipes. This would require a pair of sleeves sized at circa 550mm ID to accommodate the separate flow and return pipes. Alternatively we could install a transition pipe piece that would convert the separate Flow & Return pipes into a Twin pipe system, where both F&R pipes are installed within one outer casing, and by doing this we would only need to drill and install one suitably sized sleeve to accommodate both F&R pipes.
Would you be willing to provide a cost estimate for directional drilling of a crossing of around 50m (total bore length), to a depth of around 5m in the centre of the arc? (200mm ID pipes).	Based on previous schemes a budget cost of circa £8,000pm should be allowed. Please note though that this cost includes for the additional costs associated with entire works, i.e extra over excavation costs for the Cranage, thrust blocks and the driving and receiving chambers also the slip trenches. Please be aware that the drilling company do not allow for any civil engineering works associated with the works.
If you are not willing / able to provide a cost estimate for this, do you have any suggestions of where we could turn to, to obtain a budget cost for this?	See above rates

APPENDIX 2



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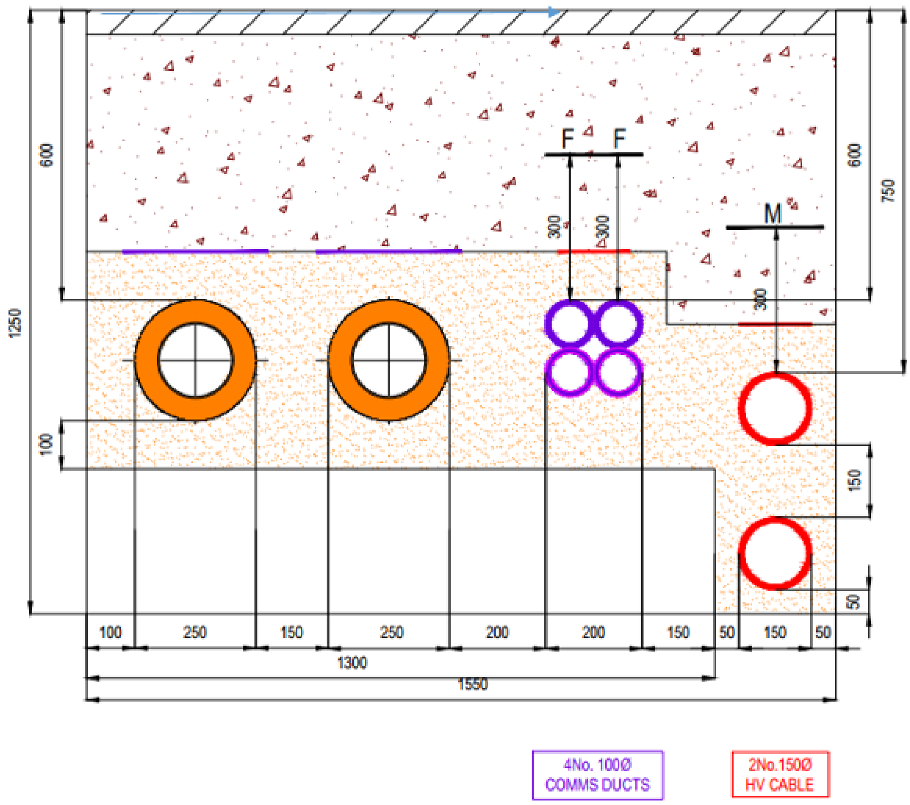
Appendix 2 – Typical Trench Section (based upon 600mm cover)



See Below = k

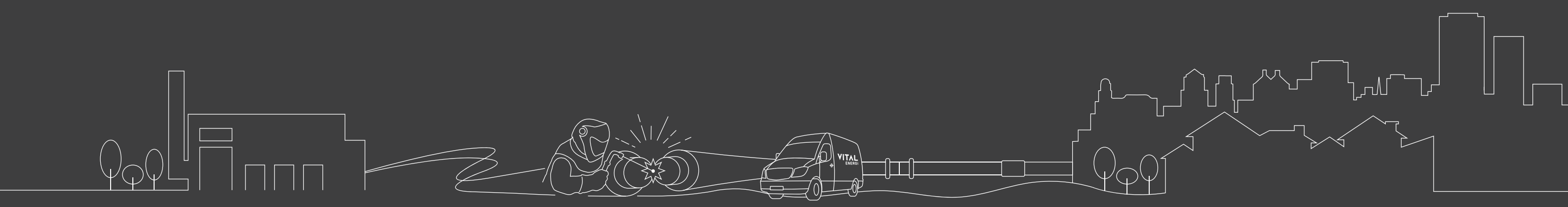
Add 400mm

Add further 300mm

TYPICAL STANDARD TRENCH SECTION SERIES 2

NOMINAL BORE mm	OUTER CASING DIAMETER mm	K MIN METERS	D MIN METERS
25	110	0.57	0.81
32	125	0.60	0.825
40	125	0.60	0.825
50	140	0.63	0.84
65	160	0.67	0.86
80	180	0.71	0.88
100	225	0.80	0.925
125	250	0.85	0.95
150	280	0.91	0.98
200	355	1.16	1.055
250	450	1.35	1.15

APPENDIX 3



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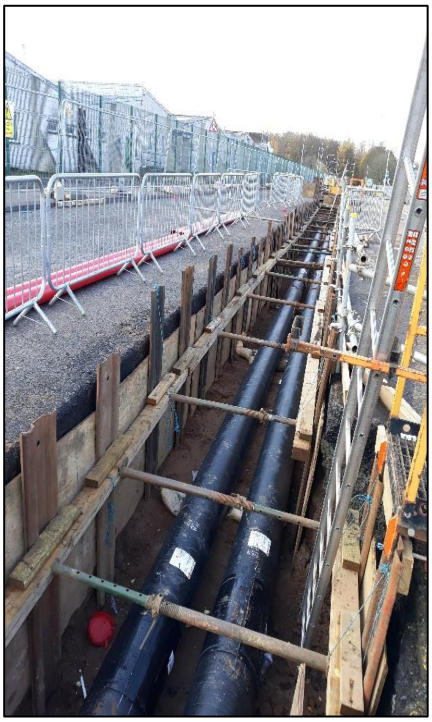
Appendix 3 - Excavation and Trench Example Photographs

Hard Dig/Reinstatement (Project photographs taken from the Glenrothes DHN Project)



Remediated excavation/reinstatement

(Project photographs taken from the Paddington Village DHN Project in Liverpool)

Soft Dig excavation/reinstatement (Project photographs taken from the Leeds PIPES DHN Project)

Crossings

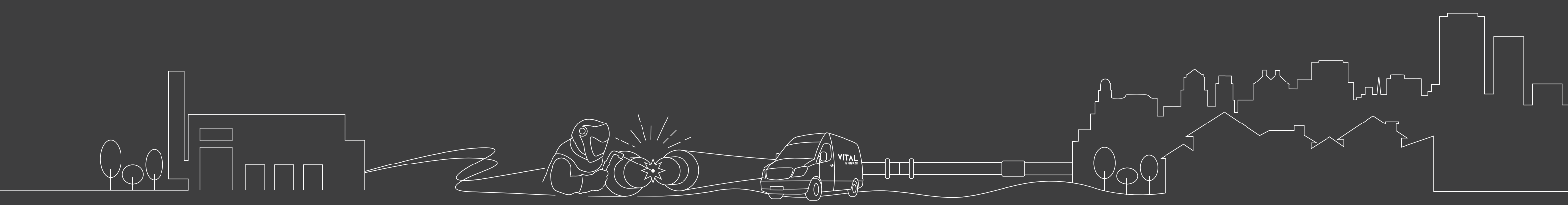
Minor Road Crossing – Single Lane

Major Road Crossing – Dual Carriageway

Pipe Bridges

Guided Auger Bore

APPENDIX 4



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Oct-19

VITAL ENERGI - MARKET TESTING INFORMATION FOR WSP

DHN MECHANICAL PRICING MATRIX

Exchange Rate Factor (assumes 1GBP = 8.2DKK)	1.05
2019 Prices add Increased Price Allowance for 2020	1.05
Add allowance for GPRS, Design and Coordination	1.04

Tee Factor (DN32, DN40)	2.00
Tee Factor (DN50 to DN250)	1.20
Tee Factor (DN300)	1.07

Pre-Insulated Pipework (Series 3)	Metres	Installed Cost Per Metre	Total Measured Cost
DN32 Pre-Insulated Pipe 12m length		£24.23	£0.00
DN40 Pre-Insulated Pipe 12m length		£25.65	£0.00
DN50 Pre-Insulated Pipe 12m length		£34.39	£0.00
DN65 Pre-Insulated Pipe 12m length		£35.96	£0.00
DN80 Pre-Insulated Pipe 12m length		£43.78	£0.00
DN100 Pre-Insulated Pipe 12m length		£59.42	£0.00
DN125 Pre-Insulated Pipe 12m length		£75.06	£0.00
DN150 Pre-Insulated Pipe 12m length		£89.13	£0.00
DN200 Pre-Insulated Pipe 12m length		£128.21	£0.00
DN250 Pre-Insulated Pipe 12m length		£189.20	£0.00
DN300 Pre-Insulated Pipe 12m length		£237.67	£0.00
Total Pipe	0		**£0.00**

Bends & Reducers	Quantity	Installed Cost Per Bend	Total Measured Bends
DN32		£295.18	£0.00
DN40		£311.81	£0.00
DN50		£520.36	£0.00
DN65		£545.40	£0.00
DN80		£640.14	£0.00
DN100		£756.79	£0.00
DN125		£771.87	£0.00
DN150		£942.00	£0.00
DN200		£1,782.17	£0.00
DN250		£2,228.85	£0.00
DN300		£2,672.69	£0.00
Total Bends	0		£0.00

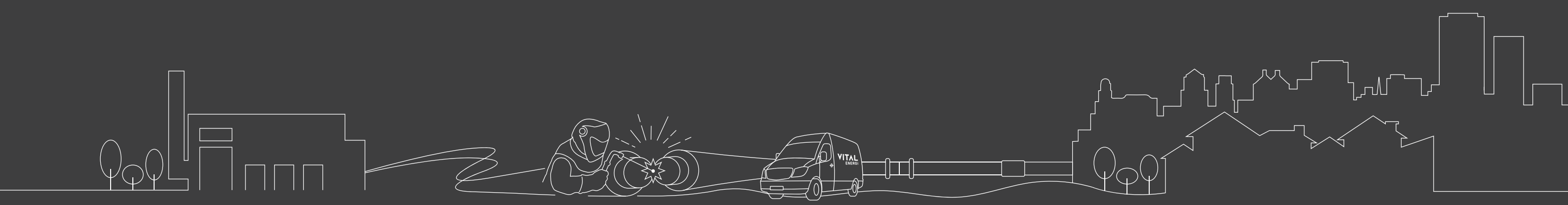
Insulation Joints - 1 per pipe length, 2 per bend, 3 per tee	Joints	Installed Cost Per Joint	Total Measured Cost
DN32 (this table self calculates)	0	£350.64	£0.00
DN40 (this table self calculates)	0	£356.83	£0.00
DN50 (this table self calculates)	0	£389.45	£0.00
DN65 (this table self calculates)	0	£449.52	£0.00
DN80 (this table self calculates)	0	£548.41	£0.00
DN100 (this table self calculates)	0	£559.20	£0.00
DN125 (this table self calculates)	0	£720.41	£0.00
DN150 (this table self calculates)	0	£822.55	£0.00
DN200 (this table self calculates)	0	£936.35	£0.00
DN250 (this table self calculates)	0	£1,024.11	£0.00
DN300 (this table self calculates)	0	£1,319.62	£0.00
Total Insulation Joints	0		£0.00

Tees	Quantity	Installed Cost Per Tee	Total Measured Tees
DN32		£560.55	£0.00
DN40		£623.61	£0.00
DN50		£624.43	£0.00
DN65		£654.48	£0.00
DN80		£768.16	£0.00
DN100		£908.15	£0.00
DN125		£1,018.43	£0.00
DN150		£1,130.40	£0.00
DN200		£2,138.61	£0.00
DN250		£2,674.62	£0.00
DN300		£2,859.78	£0.00
Total Bends	0		£0.00

Buiding Entry Points - Per Building Entry Point including Bypass	Quantity	Cost Per Building	Total Measured Cost
DN32 Building Entry with IV's and H bypass		£1,307.18	£0.00
DN40 Building Entry with IV's and H bypass		£1,432.95	£0.00
DN50 Building Entry with IV's and H bypass		£2,087.03	£0.00
DN65 Building Entry with IV's and H bypass		£3,053.80	£0.00
DN80 Building Entry with IV's and H bypass		£5,288.03	£0.00
DN100 Building Entry with IV's and H bypass		£6,682.14	£0.00
DN125 Building Entry with IV's and H bypass		£8,354.76	£0.00
DN150 Building Entry with IV's and H bypass		£10,299.28	£0.00
DN200 Building Entry with IV's and H bypass		£13,204.80	£0.00
DN250 Building Entry with IV's and H bypass		£16,748.03	£0.00
DN300 Building Entry with IV's and H bypass		£19,915.63	£0.00
	0		£0.00

Pricing Summary	Unit of Measure	Total Quantity	Total Price
Pipe	Metres	0	**£0.00**
Bends & Reducers	Each	0	**£0.00**
Tees	Each	0	**£0.00**
Insulation Joints	Each	0	**£0.00**
Building Entry Points	Each	0	**£0.00**
Sub Total			**£0.00**
Delivery & Offloading	2.5%		£0.00
Project Management, Preliminaries, NDT & Flush	16%		£0.00
Risk & Contingency (Depth & Obstructions)	10%		£0.00
Total Price			**£0.00**

APPENDIX 5



VITAL ENERGI UTILITIES LTD

Oct-19
VITAL ENERGI - MARKET TESTING INFORMATION FOR WSP

VITAL ENERGi

DHN CIVILS & TRENCHING PRICING MATRIX

District Heating Network Only

Cost/M of civils trench based on a 600mm cover to the top of the pipe insulation.

	Soft Dig	Trench Length	Remediated Land	Trench Length	Hard Dig	Trench Length	Total Measured Cost
DN350	£771	0	£1,233	0	£1,664	0	£0
DN300	£701	0	£1,121	0	£1,513	0	£0
DN250	£659	0	£1,055	0	£1,405	0	£0
DN200	£591	0	£945	0	£1,234	0	£0
DN150	£512	0	£819	0	£1,103	0	£0
DN125	£512	0	£819	0	£1,075	0	£0
DN100	£493	0	£788	0	£1,054	0	£0
DN80	£461	0	£738	0	£924	0	£0
DN65	£416	0	£666	0	£911	0	£0
DN50	£412	0	£659	0	£897	0	£0
DN40	£408	0	£653	0	£883	0	£0
DN32	£402	0	£644	0	£854	0	£0
		0		0		0	**£0**

Pricing Summary	Unit of Measure	Total Quantity	Total Price
Excavation & Re-instatement (DHN Only)	Metres	0	**£0**
Excavation & Re-instatement (DHN + Comms + PW)	Metres	0	**£0**
Excavation & Re-instatement (DHN + Comms + PW)	Metres	0	**£0**
Valve Chambers	Each	0	**£0**
Road Crossings Single Lane (2-way)	Each	0	**£0**
Road Crossings Dual Carriageway	Each	0	**£0**
Thrust Bore	Metres	0	**£0**
Sub Total			**£0**
2019 Prices add Increased Price Allowance for 2020	5%		£0
Risk & Contingency	10%		£0
Total Price			**£0**

District Heating Network with 4No Cable Ducts

Cost/M of civils trench based on a 600mm cover to the top of the pipe insulation.

	Soft Dig	Trench Length	Remediated Land	Trench Length	Hard Dig	Trench Length	Total Measured Cost
DN350	£1,057	0	£1,611	0	£2,129	0	£0
DN300	£961	0	£1,465	0	£1,936	0	£0
DN250	£924	0	£1,407	0	£1,834	0	£0
DN200	£864	0	£1,311	0	£1,675	0	£0
DN150	£801	0	£1,234	0	£1,587	0	£0
DN125	£814	0	£1,230	0	£1,577	0	£0
DN100	£797	0	£1,204	0	£1,569	0	£0
DN80	£777	0	£1,171	0	£1,506	0	£0
DN65	£744	0	£1,118	0	£1,486	0	£0
DN50	£738	0	£1,109	0	£1,465	0	£0
DN40	£732	0	£1,100	0	£1,445	0	£0
DN32	£723	0	£1,085	0	£1,400	0	£0
		0		0		0	**£0**

District Heating Network with 4No Cable Ducts & Private Wire

Cost/M of civils trench based on a 600mm cover to the top of the pipe insulation.

	Soft Dig	Trench Length	Remediated Land	Trench Length	Hard Dig	Trench Length	Total Measured Cost
DN350	£1,343	0	£1,989	0	£2,593	0	£0
DN300	£1,221	0	£1,809	0	£2,358	0	£0
DN250	£1,189	0	£1,759	0	£2,263	0	£0
DN200	£1,138	0	£1,677	0	£2,116	0	£0
DN150	£1,131	0	£1,650	0	£2,137	0	£0
DN125	£1,116	0	£1,641	0	£2,100	0	£0
DN100	£1,102	0	£1,619	0	£2,084	0	£0
DN80	£1,093	0	£1,605	0	£2,070	0	£0
DN65	£1,072	0	£1,571	0	£2,061	0	£0
DN50	£1,064	0	£1,559	0	£2,034	0	£0
DN40	£1,056	0	£1,546	0	£2,006	0	£0
DN32	£1,045	0	£1,527	0	£1,947	0	£0
		0		0		0	**£0**

Additional Considerations:			Quantity	Total Measured Cost
Valve Chamber to house 1 pair of valves	£5,000	each	0	£0
Road Crossings Single Lane (2-way)	£12,600	/crossing	0	£0
Road Crossings Dual Carriageway	£45,500	/crossing	0	£0
Thrust Bore Drilling including sending and arriving pits	£8,125	/M	0	£0
				£0

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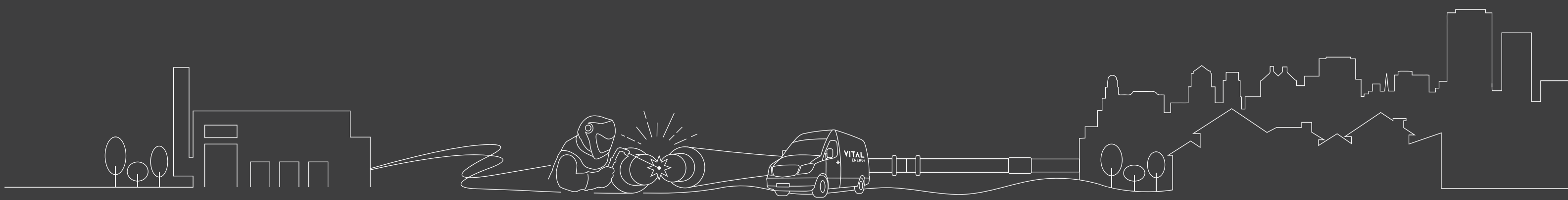

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Prepared by Brendan Clancy

Date: 31.01.19

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Notes
Rates shown are "All Inclusive Rates, Per Trench Metre." i.e Flow and Return inclusive
Rates allow for supply, delivery, offloading, installation, hydraulic testing, 10% N.D.T
Rates shown are for large/medium-sized projects. For projects under 100 trench metres add 50% to rates and 25% to all rates for projects between 100m and 500M

All inclusive means there is an allowance in the rates for fittings, site joints and termination seals.

PRE-INSULATED STEEL - DISRICT HEATING PIPE INSTALLATION COST

Urban

	Heating network trench (m)	Total (m)	Trench Mechanical £/m pipe (S1)	Trench Mechanical £/m pipe (S2)	Trench Mechanical £/m pipe (S3)	Trench £/m civils for Hard Dig (S1)	Trench £/m civils for Hard Dig (S2)	Trench £/m civils for Hard Dig (S3)	Trench £/m civils for Soft Dig (S1)	Trench £/m civils for Soft Dig (S2)	Trench £/m civils for Soft Dig (S3)
DN25 (33mm)	0	0	£260.00	£286.52	£315.75	£355.00	£391.21	£431.11	£190.00	£209.38	£230.74
DN32 (42mm)	0	0	£280.00	£308.56	£340.03	£460.00	£506.92	£558.63	£248.00	£273.30	£301.17
DN40 (48mm)	0	0	£315.00	£347.13	£382.54	£500.00	£551.00	£607.20	£254.00	£279.91	£308.46
DN50 (60mm)	0	0	£322.00	£354.84	£391.04	£547.00	£602.79	£664.28	£278.00	£306.36	£337.60
DN65 (76mm)	0	0	£357.00	£393.41	£433.54	£640.00	£705.28	£777.22	£300.00	£330.60	£364.32
DN80 (89mm)	0	0	£377.00	£415.45	£457.83	£720.00	£793.44	£874.37	£324.00	£357.05	£393.47
DN100 (114mm)	0	0	£430.00	£473.86	£522.19	£740.00	£815.48	£898.66	£356.00	£392.31	£432.33
DN125 (139mm)	0	0	£489.00	£538.88	£593.84	£790.00	£870.58	£959.38	£388.00	£427.58	£471.19
DN150 (168mm)	0	0	£547.00	£602.79	£664.28	£800.00	£881.60	£971.52	£400.00	£440.80	£485.76
DN 200 (219mm)	0	0	£589.00	£649.08	£715.28	£825.00	£909.15	£1,001.88	£423.00	£466.15	£513.69
DN 250	0	0	£670.00	£738.34	£813.65	£887.00	£977.47	£1,077.18	£450.00	£495.90	£546.48
DN 300	0	0	£698.00	£769.20	£847.65	£935.00	£1,030.37	£1,135.47	£490.00	£539.98	£595.06
DN 350	0	0	£870.00	£958.74	£1,056.53	£990.00	£1,090.98	£1,202.26	£520.00	£573.04	£631.49
DN400	0	0	£990.00	£1,090.98	£1,202.26	£1,200.00	£1,322.40	£1,457.28	£550.00	£606.10	£667.92
DN450	0	0	£1,015.00	£1,118.53	£1,232.62	£1,500.00	£1,653.00	£1,821.61	£600.00	£661.20	£728.64
DN500	0	0	£1,489.00	£1,640.88	£1,808.25	£1,600.00	£1,763.20	£1,943.05	£700.00	£771.40	£850.08
DN600	0	0	£2,200.00	£2,424.40	£2,671.69	£2,000.00	£2,204.00	£2,428.81	£890.00	£980.78	£1,080.82
DN700	0	0	£3,000.00	£3,306.00	£3,643.21	£2,250.00	£2,479.50	£2,732.41	£980.00	£1,079.96	£1,190.12
DN800	0	0	£3,500.00	£3,857.00	£4,250.41	£2,500.00	£2,755.00	£3,036.01	£1,020.00	£1,124.04	£1,238.69
	0										

Underground
Cable ducting &
Pipe installation
Specialists

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WSP
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70 Chancery Lane
London
WC2A 1AF

Tel: 0203 116 9316

For the attention of James Eland

28 October 2019 **By email & post**

Our Ref: DRC/Q1/11063

Dear James

Re: Installation by Guided Auger Boring – Croydon.

Thank you for your recent enquiry, I now have pleasure in enclosing our quotation for the works detailed above, the hard copy together with our terms and conditions will follow in the post.

Should you have any queries, or I can be of any further assistance please do not hesitate to contact me.

Yours sincerely

David Croot
Project Manager

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QUOTATION NO: DRC/Q1/11063

Project: Trenchless Installations using BPU800 Guided Auger Boring Unit of 762mm steel sleeves up to 39 metres.
Site: Croydon.

We have priced below for installation by guided auger boring of steel pipes. The price quoted is for the installation of steel pipe at depths and falls based on your invert requirements.

We shall require an 8.0 metre long x 3.5 metre wide shaft for the launch position which must incorporate a minimum 600mm thick concrete thrust block and a level concrete base 150mm thick at a depth **1300mm below pipe centre line.**

No reception shaft required; for the Guided Auger Boring only.

Price only based on displaceable ground

Item No	Description	Unit	Quantity	Rate	Total
1	**Mobilisation:** **Demobilisation** **Set-up**	Sum Sum Sum	1 1 1	£5000.00 £4800.00 £1750.00	£5000.00 £4800.00 £1750.00
2	**Installation Rate:** 762mm x 12.5mm W/T steel sleeves.	Sum	1 (39M)	£34,000.00	£34,000.00
3	**Supply of pipe:** 762mm x 12.5mm W/T steel sleeves.	Metre	40	£281.75	£11,270.00

Materials Pricing: Materials offered are subject to remaining unsold at time of order confirmation. Due to the unprecedented increase in material prices we have seen over the last 18 months this quotation may be subject to a materials surcharge, any amendment will be notified at time of order.

Pricing Note: The distances specified in the 'Installation Rate' section are as obtained from/agreed with the Client during the tendering process.
This sum covers drilling up to (including shorter measures) the specified distance and deductions shall not be applied to this figure if there is a reduction in distance on site without agreement with CTB Ltd i.e. pro-rata reductions will not be accepted as CTB Ltd reserves the right to re-evaluate its quotation should the actual distances on site contradict those specified within the tender submission.

The above price includes supply and installation of the steel pipe from a shaft prepared by others. Client to supply suitable lifting equipment for the installation/removal of casings, augers and spoil.

Should our lorry be unable to access close to the work area then the Client will be responsible for transporting our equipment to the work area.

Client to supply suitable lifting (3.5 tonnes) for the BPU 800 auger boring machine.

It should be noted that offsite disposal of drill spoil is not included.

Pipe supplied is done so on the specific instructions of **The Customer** and is for the work specifically detailed in quotation no. DRC/Q1/11063. **All pipe supplied will be paid for in full by the Customer** irrespective of it being fully utilised.

Butt fusion is only inclusive if the method of installation is as detailed in the quotation.

Issue of an order in favour of **The Company** confirms **The Customer's** acceptance of the enclosed Terms and Conditions. Should the order contain any alternative printed contract conditions, subject to negotiation and written acknowledgment, such conditions are only binding in so far as they are not in variance with the terms, conditions and requirements specified by **The Company** and contained herein.

Client to be responsible for:
Excavations: start/exit pits with dewatering/maintenance as required.
Site access/egress.
Site Security.
Setting out of line and levels.
Breaking out manhole rings/cutting out sheet piles for pipe entry in to formation.
The over-pumping, cleaning and sanitisation of any existing manholes.
Traffic management, site safety to include all signs and barriers.

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Site attendance for the duration of contract including lifting.
Site survey providing details and depths of all existing services in bore path.
Trial holes to establish a clear safe working route & ground conditions.
A suitable cranage is to be provided to assist with setting up and drilling including qualified slingers/banksmen as required.
Dewatering.
Plant fuel.
Site welfare, in accordance with current CDM Regulations.
Copy of F10, Supplied to this office, before commencement of works.
Pipe testing and commissioning.

This quotation is subject to the following notes and our standard trading terms and conditions enclosed:

1. Payment Terms: 30 days from date of Invoice/Application for Payment.
2. All charges are subject to VAT.
3. The price does not include for the supply of any construction, materials, pipe or jointing unless stated.
4. The rates and prices include for working up to 10 hours per day, but do not include for weekend or night working. There will be an uplift of 50% on agreed rates for night time and weekend working (Based on 10 hour shifts).
The rates for reduced hours working, whether during the day, the night or the weekend, are to be discussed and agreed.
Every endeavour will be made to work to an agreed programme, but start dates and periods for completion are estimates given in good faith based on previous experience.
5. Daywork or standing time charges for delays incurred beyond our control where we are unable to utilise our crew or equipment provided for the works with the exception of the mechanical breakdown of our equipment will be £360.00 per hour for the duration of the delay up to 10 hours in a given working day (Not including welder).
Note: The above rate includes for CTB Ltd's Thrust Boring plant, equipment and labour only. Any hired in plant, labour and/or additional items shall be charged in addition to this; rates to be agreed.
6. Once mobilised, obstructions/restrictions to drilling which prevent completion for reasons beyond our control will attract standing time charges as detailed in Section 5 above.
We cannot accept responsibility for non-completion due to underground obstructions and reserve the right to charge mobilisation, set-up, demobilisation and/or costs as stated in the aforementioned Section 5.
7. The client to be responsible for checking of line and levels set by Chiltern Thrust Bore.

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8. No allowance is made in this quotation for retention once final checks on line & level are made.
9. No allowance has been made in this quotation for design.
10. This quotation is based only on a standard penetration test (SPT) provided.
11. Any programmes submitted are given in good faith based on previous experience. Standing time charges for delays beyond our control will still be incurred irrespective of works programme. Chiltern Thrust Bore Ltd will not be held liable should over-run occur.
Chiltern Thrust Bore Ltd shall not be penalised and still reserve the right to charge standing time should the completion of our works occur prior to any duration/completion date stated within works programme.
12. Chiltern Thrust Bore has allowed to carry out the works during one site visit only. Any change to this will necessitate re-approval of our quotation to incorporate additional mobilisation, demobilisation etc. Please note, should such a revised sequencing or works invoke an extension to the anticipated programme duration, Chiltern Thrust Bore reserve the right to recover any consequential standing-time, prolongation cost and further cannot guarantee continued availability of a particular drilling rig.
Prices quoted assume unrestricted, uninterrupted, continual and sequential working unless previously discussed and agreed.
13. Chiltern Thrust Bore has made no allowance for design of any part of the works including temporary or enabling works.
14. Prices quoted are inclusive of 2.5% Main Contractor discount; no deductions shall be applied to the figures stated above unless otherwise agreed.
15. Underground loss or damage. Any loss through ground conditions or obstruction to Chiltern Thrust Bore's plant and tooling or of hired in plant or tooling will be charged to Customer at cost plus 12.5%.
16. The rates quoted do not include for boring in rock, man-made materials/structures, boulders or wet/unstable conditions.
17. The submission of this tender does not deem CTB Ltd to be in agreement or acceptance of any terms and conditions and/or stipulations supplied in the ITT and is subject to contractual negotiations/agreements.
18. The above quotation is subject to our Standard Terms and Conditions.

We trust the above is of interest to you. Should you have any queries or we can be of any further assistance to you please do not hesitate to contact us.

Yours sincerely

David Croot
Project Manager

MEETING NOTES

PROJECT NUMBER	70057109	**MEETING DATE**	16 October 2019
PROJECT NAME	Croydon DEN	**VENUE**	BWH, Croydon
CLIENT	Croydon Council	**RECORDED BY**	JDTE
MEETING SUBJECT	Sutton DEN and Croydon interactions		

PRESENT	Simon Woodward, David Culver, Maris Puks, Bob Fiddik, James Eland
APOLOGIES	N/a
DISTRIBUTION	As above
CONFIDENTIALITY	**Confidential**

ITEM	SUBJECT	ACTION	DUE
1	Introductions		
2	Scheme background Sutton – SW explained that SDEN has a 25yr heat purchase agreement with Viridor for up to 15MWth of waste heat. The contract covers initial heat supply from the Landfill gas plant (approx. 1.2MWth) up to around 2023, whereupon the heat supply will need to switch to the ERF plant. Heat from the ERF will be available in 2021 at the earliest (connection is contingent upon ERF plant shut-downs). There is currently a 250mm ID pipeline that SDEN has installed to the 'Weavers Quarter' (formerly Felnex) site that will serve the main energy centre on the site. Currently the site is served from a boilers-only temporary energy centre (currently approx. 250 homes). An extension through to site to serve other loads (200mm ID) towards Sutton is also allowed for in designs / installed (?). The SDEN model for this site is to adopt the entire system up to and including HIUs, with individual heat supply agreements with residents. Heat prices are broadly based upon the Heat Trust methodology. Veolia has a maintenance contract for the energy supply plant and network. SDEN has aspirations to expand to both the north and west of the ERF plant – i.e. towards Merton and Sutton town centres. Croydon – BF noted the evolution to date of the project through several studies, and the current political background, where despite		

	the fact that the current Labour administration was opposed to the development of the ERF plant, they are now open to the prospect of utilising the use of waste heat for environmental and business benefit. JE / BF outlined the plant to kick-start / de-risk the Croydon network with an initial CHP phase, and thereafter expand to serve other loads at the same time as the ERF supply link is introduced.		
3	Demarcations SW / DC clarified that there was no objection from a technical perspective to the currently envisaged single hydraulic system from the ERF heat offtake to the Croydon Town Centre EC. It was agreed that the project could sensibly proceed on the basis of the hydraulic demarcation at the town centre, and with the understanding that commercial discussions around the funding of the link will be undertaken at a future point in time. General discussion around who might pay for the pipe link. Agreed that multiple configurations are possible, to be discussed further when project basis is more firmly established. BF noted that given the future loads fall predominantly within Croydon, that the heat offtake volume risk falls more within Croydon's gift than Sutton's and therefore that the investment risk in the pipework link is arguably best managed by Croydon. [Post meeting note – it is proposed that WSP model the purchase of heat from SDEN assuming that the cost of pumping is implicit/included within the heat unit cost that SDEN would provide– i.e. that SDEN would take responsibility for appropriate pumping to supply heat along the ERF link to the Croydon Town Centre EC. It is further proposed for the purposes of modelling and project cashflow development, that a heat metering station is installed at the ERF interface with the Croydon link and that the cost of heat therefore excludes heat losses (i.e. should only account for pumping energy costs).] In order to allow SDEN to indicate potential costs of heat under different scenarios, it was agreed that two approaches would be possible – • Where WSP provides SDEN with a profile through time of anticipated heat purchase volumes at the site boundary, such that SDEN can evaluate how the Viridor contract translates into a potential price for Croydon [Post meeting note – would this also need to reflect day/night volumes on an annual basis] • Where WSP works out the overall project cashflow performance assuming a maximum grant value, and 'back-calculates' the SDEN heat price that would be required to make the project viable for Croydon. SDEN could then comment on		

	this price and whether it would be realistic to anticipate sales at this price point. [Post meeting note – would it be possible for SDEN to indicate the potential differential that might be seen between day and night heat prices (presumably linked to the terms of the Viridor contract?). This is relevant to our design of thermal storage at the Town Centre, and the value of additional volume to exploit this potential differential in cost.] In order to evaluate potential pumping requirements, WSP to provide initial pipework details to SDEN – e.g. anticipated pressure drops and elevation differences, peak / annual demands through time.		
4	Network Rail crossing SW outlined the process that SDEN had been through for the installation of a new pipebridge at the Hackbridge crossing. This started with BAPA, then proceeded through design approval-in-principle stage, followed by negotiation and further design with another elements of NR for the wayleaves / right to cross the railway. The need to agree to the NR terms and conditions with regard to liabilities was highlighted. SW also outlined various rules regarding track possession and the difficulty in organising track closures as a non-statutory utility. SW suggested that it might be possible to share the budgeted cost of the Hackbridge pipebridge crossing if requested through appropriate channels.		
5	Organisation structures There was a brief discussion of the organisational structure within Croydon		

NEXT MEETING

Provisionally noted that another session around end November might be useful.

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wsp.com