PARSONS BRINCKERHOFF

June 2015

NEW CROSS HEAT NETWORK - NETWORK EXPANSION ASSESSMENT

London Borough of Lewisham

3514033A-BEL

Draft

New Cross Heat Network - Network expansion assessment

3514033A-BEL

Prepared for
London Borough of Lewisham

Prepared by
Parsons Brinckerhoff

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CONTENTS

LIST OF ABBREVIATIONS

°C	degrees celsius
CHP	Combined Heat and Power (engine)
DECC	Department of Energy Climate Change
DECC	Decentralised Energy
DHW	Domestic Hot Water
DH	District Heating
EfW	Energy from Waste
GW	Gigawatts
GWh	Gigawatt-hour
HIU	Heat Interface Unit
kW	Kilowatts
kWh	Kilowatt-hour
LBL	London Borough of Lewisham
m	metres
m/s	metres per second
mm	millimetres
MW	Megawatts
MWh	Megawatt-hour
SCR	Surrey Canal Road
SELCHP	South East London Combined Heat and Power
SH	Space Heating
SSA	Strategic Site Allocation
TfL	Transport for London
WSP | PB	WSP | Parsons Brinckerhoff

EXECUTIVE SUMMARY

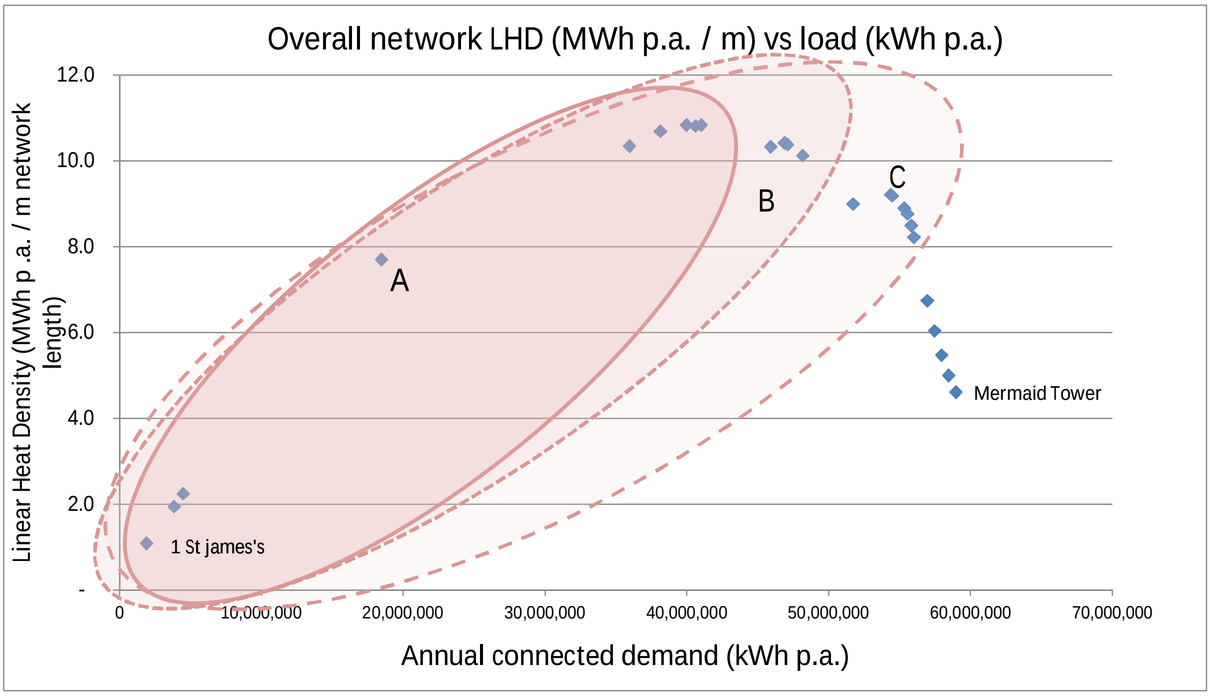
3514033A	**Element B report – Linear Heat Density testing**

WSP | Parsons Brinckerhoff (WSP | PB) has analysed potential network configurations that represent options for the expansion of a core heat link between Goldsmiths University of London and the South East London Combined Heat and Power (SELCHP) site.

This report summarises the load assessment undertaken and the network route options analysed. Heat demand data has been derived from a variety of sources including planning application energy statements for the majority of development sites, metered gas consumption data for existing buildings, and the application of benchmark figures where necessary.

WSP | PB has used a process of linear heat density testing in order to identify those configurations of network that appear to offer the best potential to result in an economically attractive scheme.

The results of the linear heat density testing process are displayed below. Based on the clustering of heat loads in this chart, three combinations of loads (A, B & C on the diagram below) have been selected for further assessment.



Each point on this graph represents the addition of a site to the network based around an analysis of which load adds the best balance of increased annual heat demand versus increased distance from the core network (a heat link between SELCHP and Goldsmiths).

The loads included in each of the schemes to be tested are displayed below:

A	B	C
Goldsmiths - 1 St James's	Goldsmiths - 1 St James's	Goldsmiths - 1 St James's
Goldsmiths - Education Bldg	Goldsmiths - Education Bldg	Goldsmiths - Education Bldg
Batavia Rd	Batavia Rd	Batavia Rd
Surrey Canal Triangle	Surrey Canal Triangle	Surrey Canal Triangle
Convoys Wharf	Convoys Wharf	Convoys Wharf
Arklow Estate	Arklow Estate	Arklow Estate
Achilles St	Achilles St	Achilles St
Goodwood Rd	Goodwood Rd	Goodwood Rd
Bond House	Bond House	Bond House
	The Wharves Deptford	The Wharves Deptford
	Grinstead Rd/Neptune's Wharf	Grinstead Rd/Neptune's Wharf
	Childeric Primary	Childeric Primary
	Deptford Green school	Deptford Green school
		Grindling Gibbons
		Marine Wharf West
		Cannon Wharf
		SFD Primary
		Marine Wharf East
		14 Ludwick Mews
		Deptford Park

The three combinations of loads (A, B, C) identified by the linear heat density testing process are shown below in their network configurations:

A	B	C
		

The analysis of the network configurations has resulted in the following indicative costs for the options. Network costs were taken from indicative installed network costs provided by a DH contractor:

A	B	C
£4.7m	£5.7m	£7.7m

Having established indicative network costs, we assessed the payback period for each of the tested network configurations using an indicative cost of heat from SELCHP and indicative heat sales price to connected loads. The results of this analysis are presented below.

	Scheme A	Scheme B	Scheme C
CAPEX			
Network Capital Cost	£4,675,000	£5,705,000	£7,705,000
Network information			
Annual heat supplied	41,039,000	48,182,000	56,030,000
Heat prices			
Cost of heat from SELCHP (p/kWh)	1.83	1.83	1.83
Heat sold to customers (p/kWh)	3	3	3
Profit margin (p/kWh)	1.17	1.17	1.17
Annual cost balance			
Payment to SELCHP	£751,014	£881,731	£1,025,349
Annual income	£1,231,170	£1,445,460	£1,680,900
Annual profit margin	£480,156	£563,729	£655,551
Years to payback	**9.7**	**10.1**	**11.8**

WSP | PB concludes from the analysis undertaken that network option A appears to offer the best combination of loads in terms of potential to deliver an economic scheme. This recommendation is qualified by noting that there is a need for additional analysis in terms of:

- The ability of SELCHP to meet the peak loads of the different schemes, and the means of centralised top-up and standby heat provision (if any)
- The costs of conversion to centralised heat provision for electrically heated dwellings (if applicable) in the existing council housing estates.
- The overall viability of the preferred scheme based on more detailed techno-economic analysis (this will be assessed in Elements C and D of this feasibility assessment.

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 Background

1.1.1 WSP | Parsons Brinckerhoff was appointed by the London Borough of Lewisham (LBL hereafter) to undertake a feasibility study for a heat network supplying Goldsmiths, University of London (Goldsmiths hereafter) with heat from the SELCHP energy-from-waste plant. The wider assessment consists of four elements:

Element A: A *route optimisation* study to determine the most effective route between SELCHP and Goldsmith's College;

Element B: A *network expansion* assessment to identify opportunities to establish additional connections to the network;

Element C: A *design* study to identify the technical requirements of the heat network, allowing likely costs to be calculated;

Element D: A *governance and delivery options* study for the heat network.

1.1.2 This report represents the output for Element B. Element A has already been issued and Elements C and D will be delivered in separate reports.

1.2 Report structure

1.2.1 This report is based on the preferred route option identified in Element A of this study for a link between SELCHP and Goldsmiths. We describe the methodologies used for identifying additional loads to be considered for extending the network and present the heat demands for those loads. We present the outputs of modelling in which we compare the economic performance of different network configurations to identify a preferred network, discuss the financial risks associated with the proposed network and discuss the significance of the findings in the context of the preferred route identified in Element A. We also make recommendations for next steps and the discuss pipe sizing.

SECTION 2

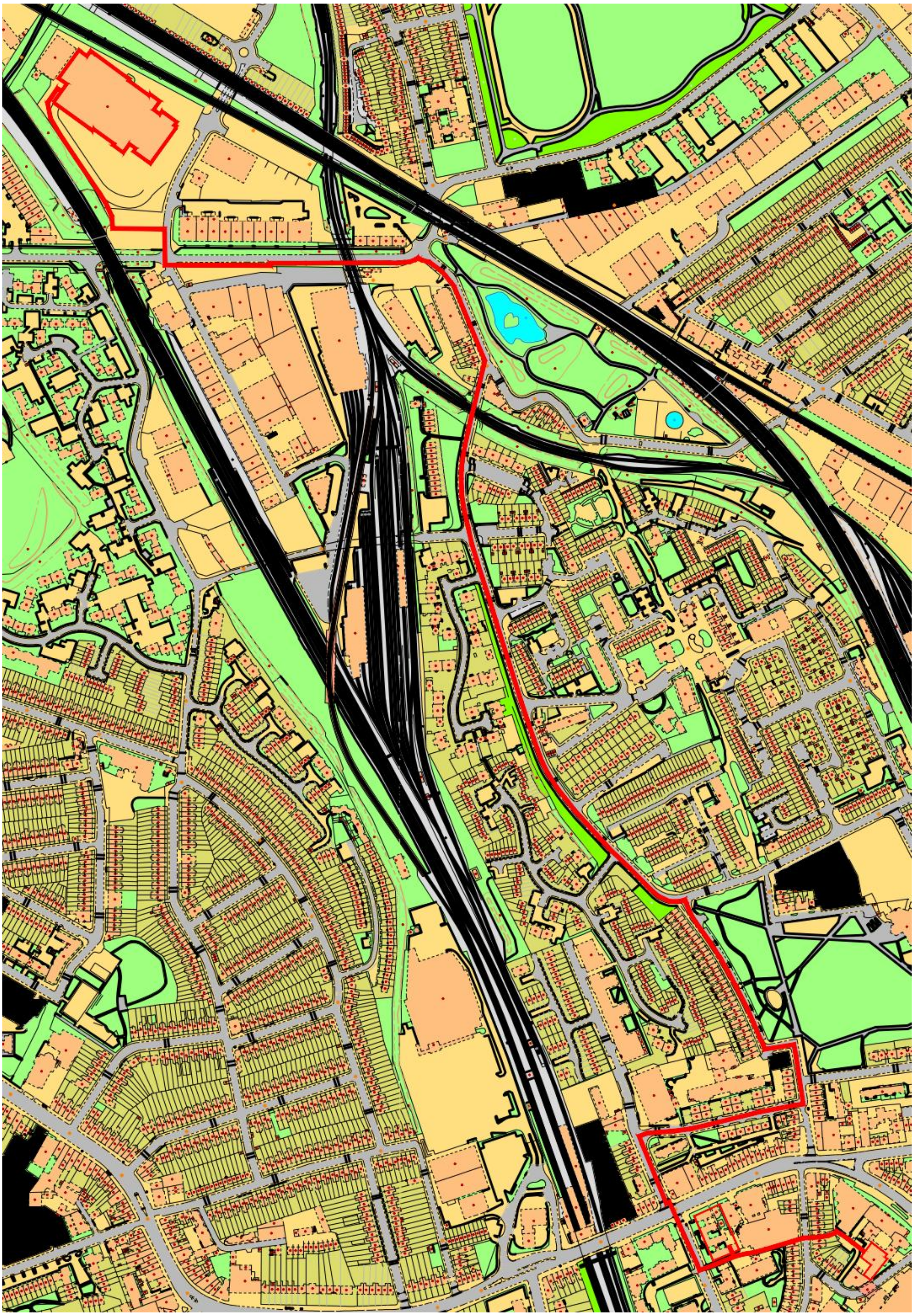
SELCHP TO GOLDSMITHS PREFERRED ROUTE

2 SELCHP TO GOLDSMITHS PREFERRED ROUTE

2.1.1 *Element A* of this feasibility study identified a preferred route between SELCHP and Goldsmiths based on a multi-stage process of surveys, meetings with LBL officers, utility mapping consultation and site investigations. That process took account of the location of several Strategic Site Allocations (SSAs) i.e. new and future developments with a planning requirement to connect to an area heat network if one becomes available. As such, the preferred route runs east along Surrey Canal Road, in the direction of most of the SSAs, despite some challenging site characteristics (in terms of pipework installation) in this area.

2.1.2 The preferred route identified in Element A is presented in Figure 2-1. Element A highlighted some areas of the route where further investigation is required in order to 'prove' the route. This is particularly the case around Surrey Canal Road and Trundley's Road, where there is a high number and density of existing services, and limitations on route selection.

Figure 2-1: Preferred route – SELCHP to Goldsmiths



SECTION 3

HEAT LOAD ASSESSMENT

3 HEAT LOAD ASSESSMENT

3.1 Goldsmiths load

WSP | Parsons Brinckerhoff liaised with Goldsmiths to determine the extent of the campus heat load that would be connected to the network. As discussed in the *Element A* report, this will be done via two connections – one at the Education Building plant room and one at the new energy centre to be included in the 1 St James building, which is planned for completion in 2018. The positions of the Education Building and future 1 St James buildings are show in Figure 3-1.

Figure 3-1: Goldsmiths Education and 1 St James buildings location

3.1.1 Goldsmiths provided WSP | PB with trended half-hourly heat load data for all of the gas meters on their campus. They advised as to which plant rooms / boilers are supplied from which gas meter and any other gas consumption (other than boiler gas) supplied from those meters.

3.1.2 Goldsmiths advised that the gas meters which supply boiler plant that is currently, or will in the future, be connected to the campus heat network are as follows:

- Main Boiler House
- Education Building
- Barriedale Gate
- Loring Halls
- 21 Laurie Grove

3.1.3 These heat loads will, in the future, all be connected to heat networks that are served from either the Education Building or 1 St James, hence there are only two connections at Goldsmiths to the New Cross Heat Network.

3.1.4 It was confirmed with Goldsmiths that none of the relevant gas meters supply anything other than boiler gas, with the exception of Barriedale Gate, which also supplies a wax melting hob. Goldsmiths advised that the annual gas consumption of the hob is very low as a proportion of the total gas consumption from that meter. As such, we have modelled heat load on the basis of total gas consumption from each of the above meters.

3.1.5 In modelling heat load, we have taken an average of the hourly heat demand for 2013 to 2015 for each of the relevant gas meters.

3.1.6 We have used an assumed boiler efficiency of 80 percent to convert gas consumption to heat demand for Goldsmiths.

3.1.7 The annual heat demand calculated using the above methodology is **3,869MWh**. The coincident peak across each of the gas meters is **2MWth** (expressed as peak heat demand, with assumed boiler efficiency of 80%). A peak of 1MWth on each of the two connection points is therefore assumed in this project (and the annual demand is spread equally across each).

3.1.8 It is noted that Goldsmiths' masterplan includes for the replacement of existing buildings at 1 St James' with a new, larger building (within which a new energy centre will be located). In discussion with Goldsmiths, we raised the possibility of future loads being different to the current heating demand; however it was agreed that, although the new building will be significantly larger, it will be far more thermally efficient. Goldsmiths' ambition is for the new building at 1 St James' to be as thermally efficient as possible, therefore it is reasonable to assume there will be minimal or no net change in annual heat load on the campus. As such, and as agreed with Goldsmiths, we have assumed that the campus heat load calculated from recent AMR data is suitable for modelling anticipated future demands.

3.2 Identification of network expansion options

3.2.1 WSP | Parsons Brinckerhoff used a number of resources and methodologies in order to identify potential loads in the vicinity of the preferred network:

- Consultation with LBL's Planning department highlighted major developments in the vicinity of the proposed scheme;
- Consultation with LBL's Housing department highlighted council stock that may be redeveloped in the future;
- A list of existing council-owned property in the area was provided by LBL;
- Site surveys and assessment took note of key existing loads in the area, e.g. schools;
- Loads identified in the Lewisham heat mapping exercise undertaken by Ramboll were plotted on a map to highlight demands that had not been identified using the above methodologies;
- Liaison with Goldsmiths as outlined above.

3.2.2 Based on the above, we have selected loads for testing within this *Element B* analysis. Loads were selected on the basis of their magnitude and proximity to the preferred network route identified in *Element A*.

3.2.3 Some loads were excluded based on the practicalities of connecting them. For example, the Sainsbury's New Cross store which could only be served by crossing multiple rail tracks at New Cross Gate station, either by going under the tracks or using the existing road bridge. Neither of those options would be commercially viable for connecting a single supermarket, so it has been excluded on that basis.

3.2.4 We have included electrically heated tower blocks: Hawke Tower and the Evelyn Estate. However our analysis will take account of the additional cost of converting them to wet systems for connection to a DH network.

Table 3-1: Loads selected to be assessed for inclusion in expanded heat network

New developments	Existing	Council housing
Bond House	Childeric Primary School	Achilles Street
Goodwood Road	Sir Francis Drake Primary School	Hawke Tower
The Wharves Deptford	Grinling Gibbons Primary School	14 Ludwick Mews
Batavia Road	Woodpecker Community Centre	Lapwing Tower - Evelyn Estate
Convoys Wharf	Deptford Green School	Marine Tower - Evelyn Estate
Surrey Canal Trinagle	Deptford Park Primary School	Dolphin Tower - Evelyn Estate
Marine Wharf East		Mermaid Tower - Evelyn Estate
Marine Wharf West		
Grinstead Road		
Arklow Estate		

3.2.5 For each of the proposed new developments we have taken estimated heat loads from the energy strategies included in their planning applications and posted on the LBL planning portal. A summary of each of those development heat loads is presented below.

<u>Bond House</u>

3.2.6 The proposed scheme at Bond House consists of a C-shaped building incorporating commercial and retail units, together with 89 residential units, varying between five and nine stories in height.

3.2.7 The energy statement[1] sets out the following demands (once lean energy measures have been taken into account):

Table 3-2: Bond House heat demand from energy strategy

Heat use	Energy (kWh/year)
Hot water	210,050
Space heating	206,190
Total	416,240

<u>Goodwood Road</u>

3.2.8 The Goodwood Road energy statement[2] states that the development at Goodwood Road is planned to consist of 148 residential units with 200m^2 of commercial space.

3.2.9 Residential heat loads, taken from the energy statement, are as shown in Table 3-3.

[1] *Energy Statement,* XCO2 Energy, September 2014
[2] *New Cross Gate Energy Statement Planning Submission Document*, 24th May 2011, JS Lewis Ltd

Table 3-3: Goodwood Road residential heat demands from energy strategy

Heat use	Energy (kWh/dwelling/year)	Annual development residential load
Hot water	2,086	308,728
Space heating	2,076	307,248
Total	**4,162**	**615,976**

3.2.10 No heat demands were provided in the energy strategy for the commercial element of the Goodwood Road development, so a benchmark was used. A benchmark of 94kWh/m^2/year was extrapolated from the retail benchmark in CIBSE's TM46 document, which provides benchmarks for a 2006 Building Regulations compliant building. We used percentage reductions in CO_2 emissions in subsequent Building Regulations to determine a suitable benchmark.

3.2.11 The calculated annual heat demand for commercial use in the Goodwood Road development is as set out in Table 3-4.

Table 3-4: Commercial heat load calculated for Goodwood Road

Commercial floor area (m^2)	200
Benchmark (kWh/m^2/yr)	94
Annual commercial heat load (kWh)	**18,800**

The Wharves Deptford

3.2.12 The Wharves Deptford consists of 8 plots, each with a mixture of residential and commercial development. The Sustainability Statement[3] sets out heat demands for the plots as follows.

Table 3-5: The Wharves Deptford heat load

Plot ID	Residential		Commercial	
	Floor area (m^2)	Heat demand (kWh/yr)	Floor area (m^2)	Heat demand (kWh/yr)
Plot 1	10,248	541,000	5,472	59,000
Plot 2	13,456	710,000	2,069	24,000
Plot 3	8,606	459,000	1,070	5,000
Plot 4	12,792	750,000	0	0
Plot 5*	10,396	541,629	1,190	6,000
Plot 6	10,543	627,000	1,401	15,000
Plot 7	6,978	421,000	4,158	338,000
Plot 8	6,248	378,000	1,441	20,000
TOTAL	**79,267**	**4,427,629**	**16,801**	**467,000**

Batavia Road

3.2.13 The development at Batavia Road, which will be completed in September of this year, consists of 114 residential flats comprising 25 one bedroom, 60 two bedroom, 9 three bedroom, 6 two bedroom duplexes, 14 three bedroom duplexes), and 1,724m² of B1 office accommodation and 116m² of A3 cafe space.

[3] *The Wharves Deptford, Sustainability Statement*, December 2009, Max Fordham

3.2.14 The Energy and Sustainability Statement[4] provides the following information on gas demands within the development; heat demands were calculated using an assumed boiler efficiency of 90%, as set out in Table 3-6.

Table 3-6: Batavia Road annual heat loads from energy strategy

Usage type	Energy	Gas (kWh/yr)	Heat (kWh/yr)
Residential	Heating	412,709	371,438
	Hot Water	221,521	199,369
Commercial	Heating	35,668	32,101
	Hot Water	2983	2,685
Cafe	Heating	10,047	9,042
	Hot Water	13,668	12,301
Total		**696,596**	**626,936**

Convoy's Wharf

3.2.15 The energy demands for the development at Convoy's Wharf, as extracted from the energy statement[5] are as shown in Table 3-7. These figures are 'back-calculated' by PB, as the energy statement itself contains erroneous figures for kWh p.a. demands (in the Energy Statement the kWh figures are duplicates of the emissions figures).

Table 3-7: Convoys Wharf annual heat loads from energy statement (PB calc from raw figures)

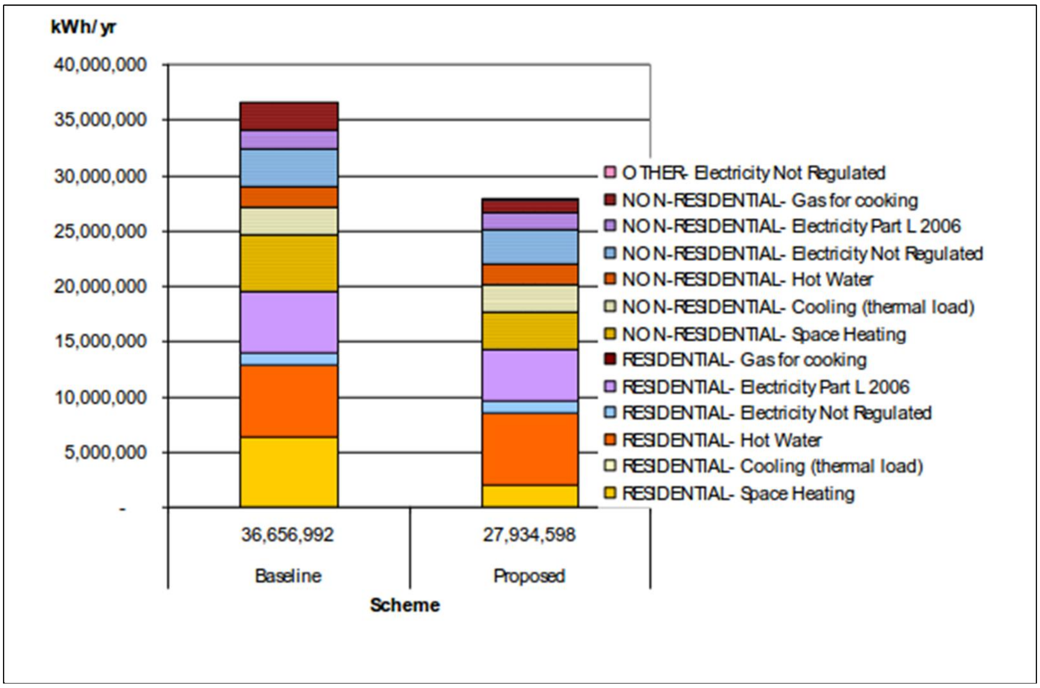
	Heat demand (kWh p.a.)
Residential (with comfort cooling)	1,366,497
Residential (without comfort cooling)	7,743,483
Employment	935,929
Wharf	1,844,094
Retail	354,439
Restaurant / bar	1,012,932
Hotel leisure	2,106,384
Culture	2,120,235
Total	**17,483,993**

Surrey Canal Triangle

3.2.16 The energy statement for Surrey Canal Triangle[6] does not explicitly set out energy demands; however it does contain the following graph.

[4] *Batavia Road Energy & Sustainability Statement*, April 2011, EngDesign Ltd
[5] *Convoys Wharf Energy Statement,* April 2013, Hoare Lea Sustainability, http://planning.lewisham.gov.uk/online-applications/files/A62DBF85D074508D67A52992BDF4DD21/pdf/DC_13_83358-ENERGY_STATEMENT-212275.pdf
[6] *Energy Strategy, Surrey Canal: London's Sporting Village,* January 2011, Mott MacDonald

Figure 3-2: Energy demands as presented in the Surrey Canal Triangle energy statement



3.2.17 Demands were estimated from the graph above, leading to the following values.

Table 3-8: Surrey Canal Triangle annual heat loads estimated from energy statement

Type	Estimated annual heat load (kWh)
Residential Space Heating	2,000,000
Residential Domestic Hot Water	7,000,000
Non-residential Space Heating	3,000,000
Non-residential Domestic Hot Water	2,000,000
Total	**14,000,000**

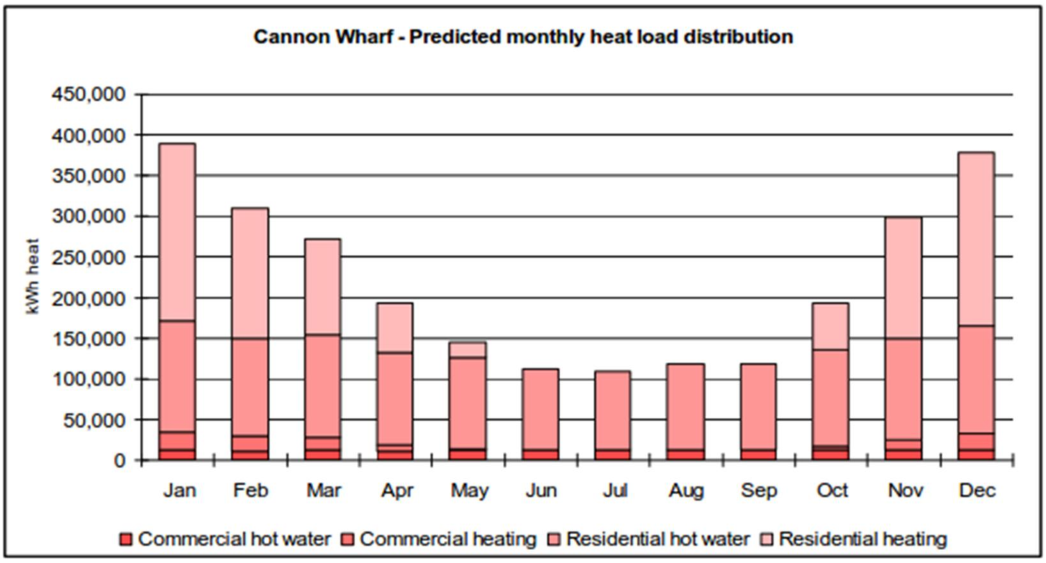
Cannon's Wharf

3.2.18 The planned development at Cannon's Wharf consists of 679 dwellings and 6500m^2 of commercial space.

3.2.19 Heat demands for Cannon's Wharf were provided in the energy statement[7] solely in graphical form, as presented in the figure below.

[7] *Energy Statement, CHP details and emissions savings,* June 2013, Bespoke Builder Services Ltd

Figure 3-3: Cannon's Wharf annual heat demands taken from energy statement



3.2.20 Heat demands as estimated from this graph are set out in the table below:

Figure 3-4: Cannon's Wharf monthly heat demand estimated from energy statement

Month	Estimated annual heat demand (MWh)
January	375,000
February	310,000
March	275,000
April	195,000
May	149,000
June	110,000
July	110,000
August	120,000
September	120,000
October	198,000
November	300,000
December	380,000
Total	**2,642,000**

Marine Wharf East

3.2.21 The development at Marine Wharf East comprises 225 residential units and 1044.5m^2 of commercial space.

3.2.22 Heat demands, taken from the energy strategy[8] are set out in Table 3-9.

[8] *Energy Strategy*, February 2015, metropolis green

Table 3-9: Marine Wharf East annual heat load from energy statement

Item	Annual heat load (kWh/yr)
Residential space heating	313,357
Residential domestic hot water	525,056
Commercial heat	4,316
Total	**842,729**

Marine Wharf West

3.2.23 The Energy Report for Marine Wharf West[9] sets out energy demands for the "energy efficient building scenario". These are summarised in Table 3-10.

Table 3-10: Marine Wharf West annual heat load from energy report

Energy	Annual heat load (kWh/yr)
Residential space heating	1,083,699
Domestic hot water	1,893,741
Commercial	592,572
Total	**3,570,012**

Grinstead Road

3.2.24 The Energy Efficiency Report for Grinstead Road[10] sets out the following heat demands:

Table 3-11: Grinstead Road annual heat load from energy efficiency report

Energy	Annual heat load (kWh/yr)
Residential space heating	269,422
Domestic hot water	512,641
Commercial	185,400
Total	**967,463**

Arklow Estate

3.2.25 The redevelopment of the Arklow trading estate is currently going through the planning process, with development proposed to start in November 2015. It comprises up to 320 residential units with up to 2,110m^2 of commercial space.

3.2.26 There is currently no publically available energy statement for the proposed development, so we have used the average heating requirement for a 2-bedroom flat built between 2010 and 2016, taken from a 2015 *Which?* report[11], which sources heat load data from the updated

[9] *Revised Energy Report*, Marine Wharf (West), 2010, Meinhardt
[10] *Energy Efficiency Report for Project Neptune,* 2010, Macdonald Egan
[11] *Turning up the Heat: Getting a fair deal for district heating users*, March 2015, Which?

Cambridge Housing Model, produced by Cambridge Architectural Research for DECC. This data has been used in the absence of any development specific heat load assessment.

3.2.27 For commercial space, we have used a retail benchmark extrapolated from CIBSE's TM46 energy benchmarking document – 94kWh/m^2/year. The calculated heat loads for the Arklow Estate redevelopment are presented in the table below:

Table 3-12: Arklow Estate redevelopment calculated heat loads

Energy	Annual heat load (kWh/yr)
Residential	1,966,080
Commercial	198,340
Total	**2,164,420**

Council housing

3.2.28 Fuel consumption for some council-owned housing stock were provided by LBL. Hawke Tower and 14 Ludwick Mews were stated as being as follows:

- Hawke Tower – 91 dwellings, electrically heated, 90MWh/year;
- 14 Ludwick Mews – 28 dwellings, 2,592MWh/year.

3.2.29 The energy consumptions above are not compatible with the number of dwellings served (90MWh for 91 flats is too low and 2,592MWh for 28 dwellings is too high). We confirmed with LBL that the data they provided was correct, so it can only be concluded that there is an issue with the metering or that the loads provided do not correspond to the number of dwellings in each building (i.e. the meter for 14 Ludwick Mews records gas consumption for more than the 28 dwellings in the property). In light of the above, we have used figures from the *Which?* report to calculate heat demands, as shown in Table 3-13.

Table 3-13: Hawke Tower and Ludwick Mews calculated heat demands

Building	No of dwellings	When built	Assumed property type	Benchmark (kWh/dwelling /yr)	Annual heat load (kWh)
Hawke Tower	91	Early 70s	2 bed	10,376	944,216
14 Ludwick Mews	28	Assumed 1976-1995	2 bed	7,868	220,304

3.2.30 Because Hawke Tower is electrically heated, we will include an indicative cost for conversion to a communal, wet heating system in our analysis. The proposed heat network will not be able to provide resilience of supply as SELCHP does not have any back-up plant. As such, any buildings requiring conversion from an electric heating system will also require the addition of back-up boiler plant. This will also be factored into the analysis that follows.

3.2.31 LBL also advised that the Achilles Street housing estate is likely to undergo redevelopment in the future, although the timeframe is not known. There are 300 dwellings on the estate and we have assumed that each of them will undergo fabric energy efficiency improvements, such that heating demand is equivalent to a 2010 to 2016 constructed building in line with the average heat loads presented in the *Which?* report. We have assumed that dwellings in Achilles Street are, on average, two bed flats.

3.2.32 The annual heat load for the redeveloped Achilles Street estate, calculated using the methodology described above, is **1,843,200kWh**.

3.2.33 The Evelyn Estate is located between the spine of the proposed heat network to the west and Convoys Wharf to the east. The estate comprises several multi-storey maisonette buildings and four tower blocks of 17 storeys and 64 flats – Lapwing, Dolphin, Mermaid and Marine Tower. As such, the four tower blocks would be potentially attractive as connections to a heat network if they had communal, boiler-supplied heating systems. However, following consultation with LBL, it is believed that they are electrically heated, so any connection to a DH network would require conversion to wet heating systems. We have not excluded these tower blocks from the assessment at this stage due to the size of the loads, and the cost of converting them to wet systems is included in the analysis.

3.3 Existing loads

3.3.1 In addition to council-owned housing, we identified several other existing loads, either on site visits or from the Lewisham Heat Map, to be considered for connection to a New Cross heat network. All of the additional loads identified are presented in column 2 of Table 3-1, and the demands used in modelling are presented below in Table 3-14.

3.3.2 We contacted LBL to enquire as to whether any of the identified loads are council-owned and they confirmed that they all are. Annual gas consumption for each of the existing loads was provided by LBL and we have used an assumed boiler efficiency of 80 percent in calculating the annual heat demands presented in Table 3-14.

Table 3-14: Existing heat loads

Building	Annual heat load (kWh)
Childeric Primary School	218,400
Sir Francis Drake Primary School	120,000
Grinling Gibbons Primary School	184,000
Woodpecker Community Centre	80,000
Deptford Green school	1,063,200
Deptford Park Primary School	268,800

3.4 Summary

3.4.1 Based on the information presented in Section 3.3 the following annual heat demands were be used in our network expansion modelling.

Table 3-15: Summary of loads assessed in network expansion

Potential connection	Type	Annual heat load used in modelling (kWh)
Bond House	Future development	416,240
Goodwood Road	Future development	634,776
The Wharves Deptford	Future development	4,894,629
Batavia Road	New development	626,936
Convoys Wharf	Future development	17,483,993
Surrey Canal Triangle	Future development	14,000,000
Cannon's Wharf	Future development	2,642,000
Marine Wharf East	Future development	842,729
Marine Wharf West	Future development	3,570,012
Grinstead Road	Future development	967,463
Arklow Estate	Future development	2,164,420
Hawke Tower	Existing resi - electric	944,216
14 Ludwick Mews	Existing resi - gas	220,304
Lapwing Tower	Existing resi - electric	503,552
Marine Tower	Existing resi - electric	503,552
Mermaid Tower	Existing resi - electric	503,552
Dolphin Tower	Existing resi - electric	503,552
Achilles Street	Future redevelopment	1,843,200
Childeric Primary School	Existing - other	218,400
Sir Francis Drake Primary School	Existing - other	120,000
Grinling Gibbons Primary School	Existing - other	184,000
Woodpecker Community Centre	Existing - other	80,000
Deptford Green school	Existing - other	1,063,200
Deptford Park Primary School	Existing - other	268,800

SECTION 3

LINEAR HEAT DENSITY TESTING

4 LINEAR HEAT DENSITY TESTING – PEAK SUPPLY

4.1 Process description

4.1.1 WSP | Parsons Brinckerhoff have assessed the heat loads presented in Section 3 using our bespoke linear heat density model.

4.1.2 This model in based around the understanding that commercial viability is a product of the relationship between the additional length of pipework and the resulting additional heat load for a potential heat network customer. Essentially it is quantifying the balance between income that could be generated through connection to a load, against an indicator of the cost to make that connection (network length).

4.1.3 The model developed by PB is innovative in that it is generates a *progression* of loads that could be connected. This means that starting from an anchor customer (in this case Goldsmiths), the model looks at the *additional* length of network required to connect to each of the other loads on the scheme, and the resulting linear heat density (i.e. demand divided by length of connection) of the marginal addition of each. The highest linear heat density connection is selected, and then the process begins again. This iterative approach delivers a ranked order of likely connection viability for the identified potential loads on the scheme.

4.2 Assumption of availability of heat from SELCHP

4.2.1 In conversation with SELCHP we have been advised that a maximum of 17MWth of heat would be available from the plant for a New Cross heat network. This *Element B* report is concerned with identifying additional sites of potentially suitable heating demand. As described in Section 4.1, the assessment process uses outline network design and annual demands to identify what are likely to be the most commercially attractive network expansion configurations; however, it does not include detailed energy balance modelling to determine the coincident peak heat demand of each assessed network configuration. *Element D* of this feasibility study will look in more detail at the energy balance of the proposed network as part of a detailed economic analysis and will therefore provide an assessment of the coincident peak heat demand in relation to the 17MWth available from SLECHP.

4.2.2 The supply of heat to Goldsmiths is always taken to be the first priority connection within this analysis. This work considers which additional loads over and above the Goldsmith connection appear to offer the best potential to help create a viable network.

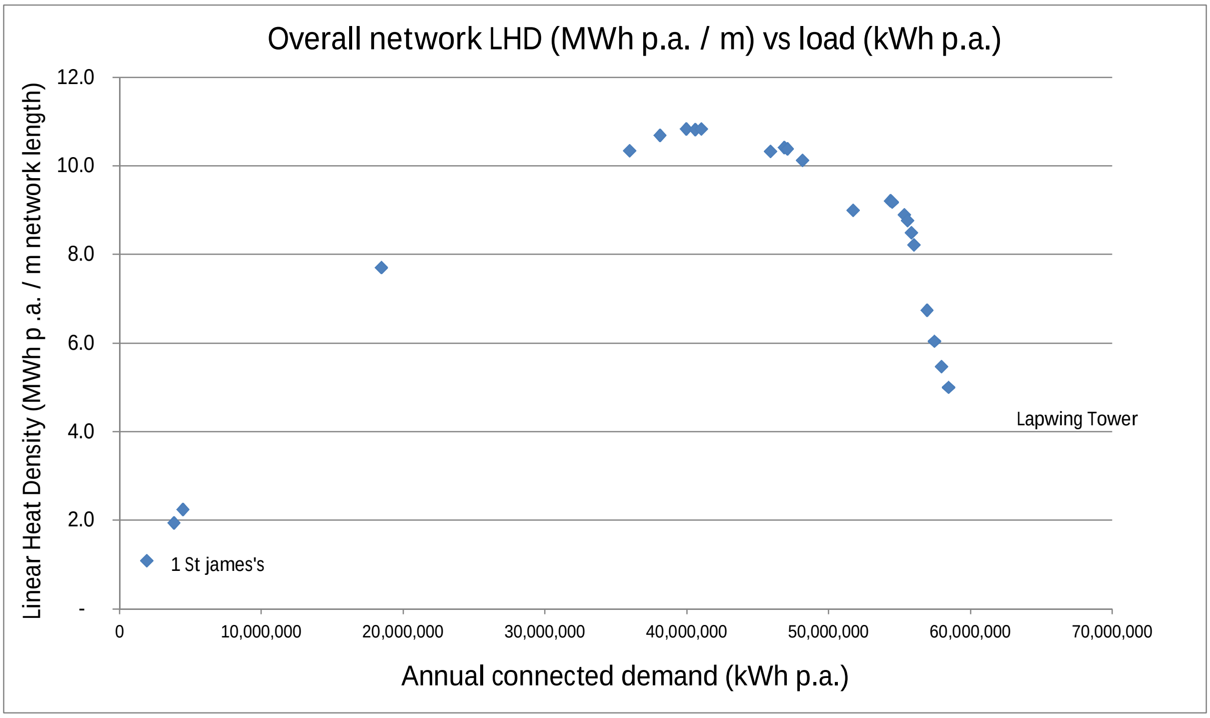
4.3 Other assumptions

4.3.1 It is assumed for the purposes of this analysis that all development sites are fully built-out i.e. that analysis of potential linear heat densities of connections are carried out on the basis of completed sites. Commentary on phasing risks is included within the financial risk section of this report (see Section 6).

4.4 Linear heat density results

4.4.1 The following graph shows the progressive linear heat density of the overall network with increasing numbers of load points connected:

Figure 4-1 Linear heat density results



4.4.2 This graph should be interpreted in conjunction with the following list of demand points that correspond to the addition of load to the network from left to right on the graph above:

Load Name
1 St James's
Education Bldg
Batavia Rd
Surrey Canal Triangle
Convoys Wharf
Arklow Estate
Achilles St
Goodwood Rd
Bond House
The Wharves Deptford
Grinstead Rd/Neptune's Wharf
Childeric Primary
Deptford Green school
Marine Wharf West
Cannon Wharf
SFD Primary
Marine Wharf East
14 Ludwick Mews
Deptford Park
Grindling Gibbons
Hawke Tower
Marine Tower
Dolphin Tower
Lapwing Tower
Mermaid Tower

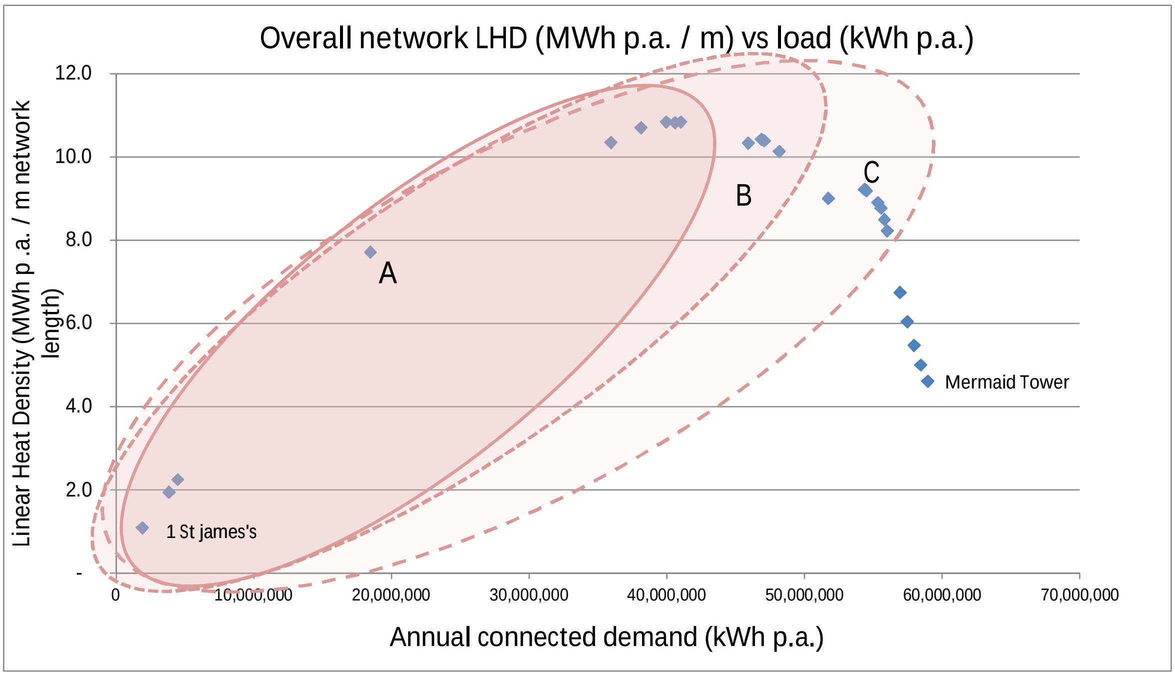
4.4.3 This graph shows a number of aspects of the network as configured:

- There are some significant step-changes in linear heat density and demand growth at certain connections (i.e. Surrey Canal Triangle and Convoy's Wharf in particular)
- The maximum linear heat density for the network configurations tested is > 11MWh p.a. / m of network (at the point of Achilles Street connection)
- The graphical representation of the results shows a bell-shape for the connected loads – indicating a 'sweet spot' or optimal set of loads for network design.

4.5 Network selections identified for testing

4.5.1 Three selections of loads are identified for further testing, as illustrated on the graph below, and shown in tabular format:

Figure 4-2 Selection for further testing



4.5.2 These three selections A, B and C effectively represent different levels of total demand, network length and by extension, risk. As customer numbers grow, network length and capital expense rises and system complexity increases. These factors all increase overall project risk.

4.5.3 The rationale behind the selection is therefore, in the case of selection A – to maximise linear heat density whilst minimising total project risk. Selection B extends the network, but maintains a high overall linear heat density, and therefore arguably improves project viability. Selection C increases the scale of the network, but this is also accompanied by a reduction in linear heat density, and therefore potentially economic viability.

4.5.4 The potential disadvantage of a small network is the ability of the project income streams to meet the fixed cost elements of the works.

4.5.5 All of these selections of network linear heat densities are above a 'threshold' level that PB has seen on a recent project that is proceeding to implementation, where the linear heat density was 5.58MWh / m. This scheme was based on a somewhat different configuration (i.e. gas-fired CHP and private wire) than the 'waste' heat distribution concept under consideration here, but as an overall indicator of potential density levels that could be successful; the level is still considered appropriate.

4.5.6 The following table shows the selection of loads corresponding to the groupings A, B and C illustrated graphically above:

Table 4-1 Scheme variant load selections

A	B	C
1 St James's	1 St James's	1 St James's
Education Bldg	Education Bldg	Education Bldg
Batavia Rd	Batavia Rd	Batavia Rd
Surrey Canal Triangle	Surrey Canal Triangle	Surrey Canal Triangle
Convoys Wharf	Convoys Wharf	Convoys Wharf
Arklow Estate	Arklow Estate	Arklow Estate
Achilles St	Achilles St	Achilles St
Goodwood Rd	Goodwood Rd	Goodwood Rd
Bond House	Bond House	Bond House
	The Wharves Deptford	The Wharves Deptford
	Grinstead Rd/Neptune's Wharf	Grinstead Rd/Neptune's Wharf
	Childeric Primary	Childeric Primary
	Deptford Green school	Deptford Green school
		Grindling Gibbons
		Marine Wharf West
		Cannon Wharf
		SFD Primary
		Marine Wharf East
		14 Ludwick Mews
		Deptford Park

4.5.7 It should be noted that within this analysis, it can be seen that the electrically heated tower blocks do not positively contribute to linear heat density levels. This is because the cost of conversion from an electric system to a wet system has been converted to an equivalent length of pipework leading to each of these blocks, i.e. the analysis for these loads is based around a total *equivalent* length, based on the physical distance plus a factor that accounts for the cost of wet system conversion.

4.5.8 The cost of wet system conversion has been based upon previous work that PB has undertaken in an owner's engineer role, based upon removal of electrical systems, installation of radiators, HIUs (including heat metering), and risers and laterals to each property.

SECTION 4

NETWORK VARIATIONS TESTED

5 NETWORK VARIATIONS TESTED

5.1 Network capacity modelling

5.1.1 In order to 'size' a network – i.e. to select appropriate pipe diameters to serve the anticipated loads across the network – the peak supply requirement of each element of the system must be estimated. Flow rates are determined by the energy transfer requirement and the temperature differential that is anticipated to be achieved for the supply of heat across each substation.

5.1.2 The following table illustrates the overall peak demand assumptions that have been used (diversified for hot water supply to the base of each block / estate):

Load name	Peak demand (kWth)	Notes
Arklow Estate	1,515	Based on estimated per-dwelling HIU rating and diversity within block (new build), plus load factor on commercial load
Marine Wharf East	1,085	Based on estimated per dwelling HIU rating and diversity within block (new build), plus BSRIA Blue Book 2015 figure for retail (100W/m2) and office heating peak (70W/m2) elements (assumed 50% / 50% mix). (assumed 793 dwellings)
Marine Wharf West	2,538	Based on estimated per dwelling HIU rating and diversity within block (new build), plus load factor on commercial load
Cannon Wharf	3,167	Based on estimated per dwelling HIU rating and diversity within block (new build), plus BSRIA Blue Book 2015 figure for retail (100W/m2) and office heating peak (70W/m2) elements (assumed 50% / 50% mix). (assumed 793 dwellings)
Childeric Primary	250	Based on annual demand and 10% load factor
Deptford Green school	1,220	Based on annual demand and 10% load factor
Woodpecker Youth Ctr	120	Based on annual demand and 10% load factor
Hawke Tower	604	Based on estimated HIU rating and diversity within block
Education Bldg	1,001	As per monitored metered peak
1 St James's	1,001	As per monitored metered peak
Batavia Road	701	Based on estimated per dwelling HIU rating and diversity within block (new build), plus BSRIA Blue Book 2015 figure for office heating peak (70W/m2) element and assumed 200W/m2 for café element
Convoys Wharf	20,877	Based on estimated per dwelling HIU rating and diversity within block (new build), plus BSRIA Blue Book 2015 figures
SELCHP	n/a	
Bond House	463	Based on estimated per dwelling HIU rating and diversity within block (new build)
Grinstead Road	1,066	Based on estimated per dwelling HIU rating and diversity within block (new build), plus load factor on commercial load
The Wharves	4,481	Based on estimated per dwelling HIU rating and diversity within block (new build), plus BSRIA Blue Book 2015 figure for retail (100W/m2) and office heating peak (70W/m2) elements (assumed 50% / 50% mix). (assumed 793 dwellings)
Surrey Canal Triangle	13,430	Based on estimated per dwelling HIU rating and diversity within block (new build), plus assumed load factor on non-residential element (15%)
Goodwood Road	744	Based on estimated per dwelling HIU rating and diversity within block (new build), plus BSRIA Blue Book 2015 figure for Retail heating peak (100W/m2) for commercial element.
Achilles St	1,252	Based on estimated per dwelling HIU rating and diversity within block (assumed refurbished)
14 Ludwick Mews	245	Based on estimated per dwelling HIU rating and diversity within block
SFD Primary	140	Based on annual demand and 10% load factor
Deptford Park	310	Based on annual demand and 10% load factor

Load name	Peak demand (kWth)	Notes
Lapwing Tower	457	Based on estimated per dwelling HIU rating and diversity within block
Marine Tower	457	Based on estimated per dwelling HIU rating and diversity within block
Mermaid Tower	457	Based on estimated per dwelling HIU rating and diversity within block
Dolphin Tower	457	Based on estimated per dwelling HIU rating and diversity within block
Grindling Gibbons	220	Based on annual demand and 10% load factor

5.1.3 The following temperatures for the primary network are assumed:

Load name	Domestic SH return temp (°C)	Domestic DHW return temp (°C)	Non-domestic elements return temp (°C)
Arklow Estate	60	35	55
Marine Wharf East	60	35	55
Marine Wharf West	60	35	55
Cannon Wharf	60	35	55
Childeric Primary			75
Deptford Green school			75
Hawke Tower	75	35	75
Education Bldg			75
1 St James's			75
Batavia Rd	60	35	55
Convoys Wharf	60	35	55
SELCHP	60	35	75
Bond House	60	35	
Grinstead Rd/Neptune's Wharf	60	35	55
The Wharves Deptford	60	35	55
Surrey Canal Triangle	60	35	55
Goodwood Rd	60	35	55
Achilles St	60	35	
14 Ludwick Mews	75	35	
SFD Primary			75
Deptford Park			75
Lapwing Tower	75	35	
Marine Tower	75	35	
Mermaid Tower	75	35	

Load name	Domestic SH return temp (°C)	Domestic DHW return temp (°C)	Non-domestic elements return temp (°C)
Dolphin Tower	75	35	
Grindling Gibbons			75

5.1.4 These temperatures are estimated, based on whether the development is a new-build or existing site.

5.1.5 Three network variants were tested, comprising the loads set out in Table 4-1. The results are summarised in the following sections.

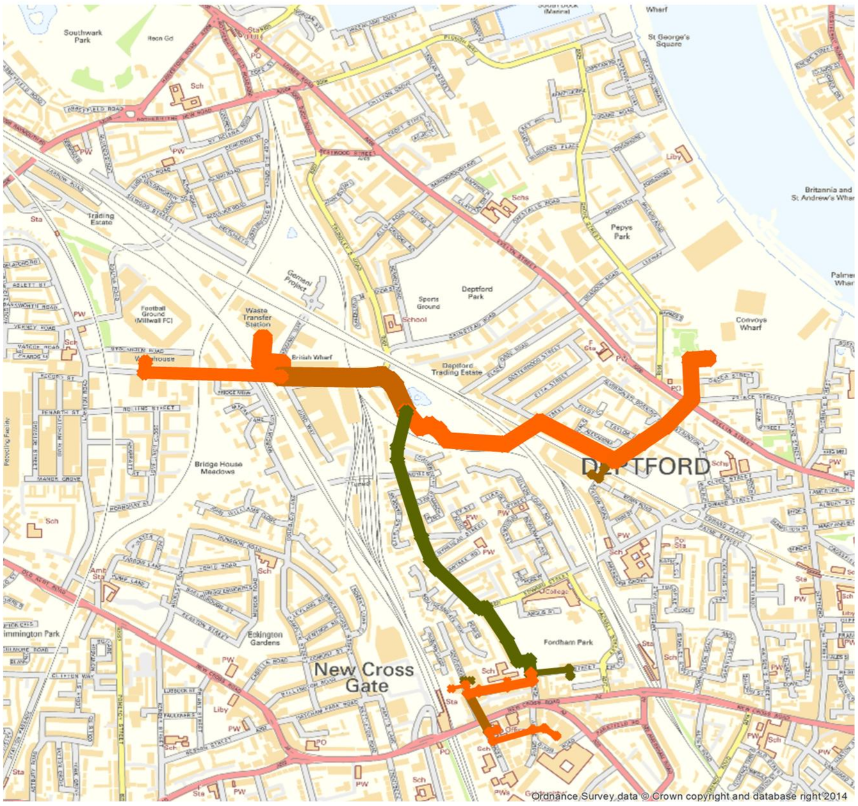
5.2 General note on costing network

5.2.1 The costs shown in this section are based upon typical per metre trench prices for hard-dig pre-insulated DH pipework (including materials, installation, project management and reinstatement) supplied by a DH contractor. They are therefore generalised costs, and do not take into account potential reductions from soft-dig sections, or increases in costs where hand-dig sections are required. The costs here also do not include for utility diversions nor other site-specific factors. Development-based heat substation costs are also excluded.

5.2.2 It is noted that these project specific elements will be assessed in Elements C and D of this feasibility assessment.

5.3 Network A

5.3.1 The proposed network linking the loads which make up Network A is illustrated in the figure below. The thickness of the lines represents the diameter of the pipes, whilst the colour represents pressure drop across the pipe length (where the more intense orange colours represent higher pressures drops). This network has an estimated capital cost of £4.7 million for the pipework alone. This figure comprises the cost of the pipework and its installation for the main network, but does not include the cost of heat interface units (HIUs) or the final connection works.



5.4 Network B

5.4.1 The proposed network for option B is illustrated in the figure below. The estimated network cost is £5.7 million.

5.5 Network C

5.5.1 The proposed network for option C is illustrated in the figure below. The estimated network cost is £7.7 million.

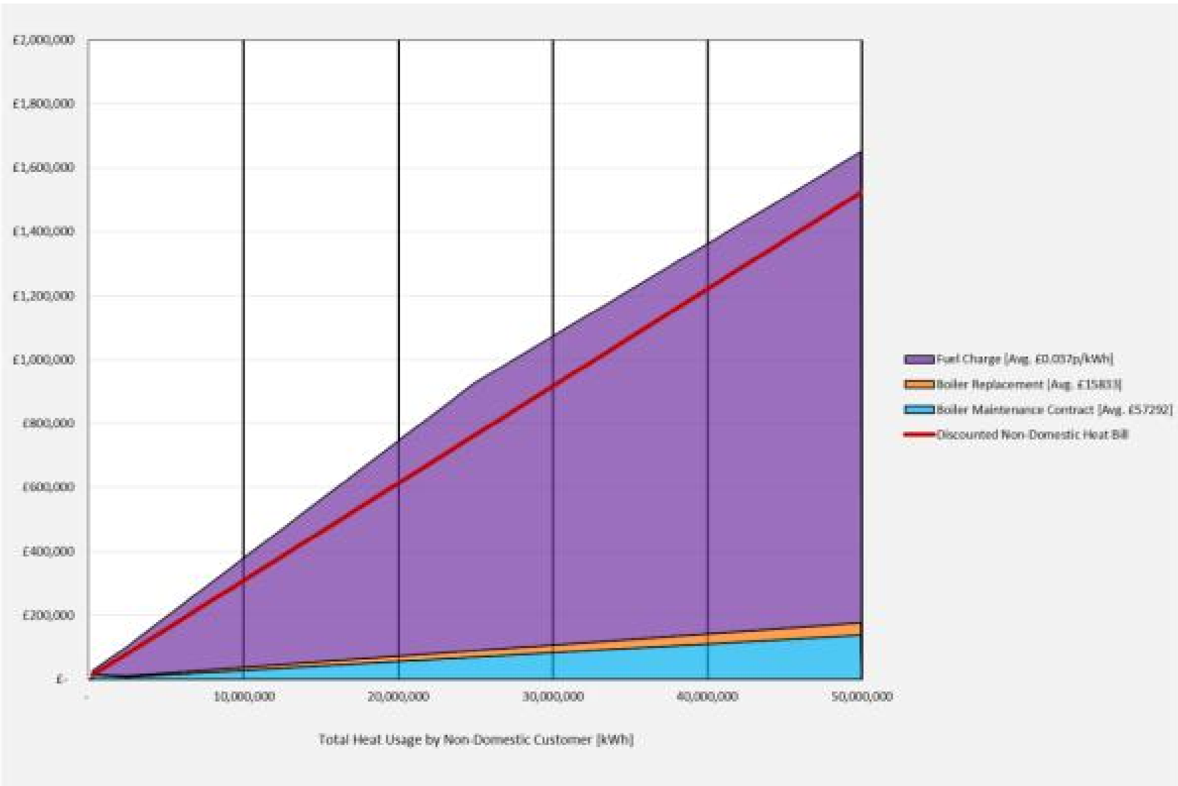
5.6 Payback period analysis of selected networks

5.7 Cost of heat

5.7.1 The price at which heat may be purchased from SELCHP will be the subject of negotiations between the facility and Lewisham Council. For the purposes of this report, a cost of heat of 1.83p/kWh is used. This assumes an electricity value of 5p/kWh (using a notional wholesale value informed by historic prices), a SELCHP z-factor of 6 (based on our experience of similar installations) and a SELCHP margin of 1p/kWh.

5.7.2 CIBSE / Arup has published a presentation: *The Price of Heat*[12] which details domestic and non-domestic energy costs. The following graph – for non-domestic heat prices - is extracted from this report:

Figure 5-1 Extract from *The Price of Heat (CIBSE)*



5.7.3 There are three elements to this graph:

- Fuel charge
- Boiler replacement cost
- Boiler maintenance contract

5.7.4 District heating should offer a discount over the status quo (in particular for existing developments); this is represented by the red line, which represents a price of heat of approximately **3p/kWh.** This is the value used for the analysis within this report for both

[12] http://www.cibse.org/getmedia/e59fa045-9e59-4c18-8629-c4cbb58850ac/040-Briault-Slides.pdf.aspx, accessed June 2015

residential and non-residential customers. Please note that this is not a recommended selling price to customers – it is a notional value that PB has adopted for the purposes of this analysis as derived from the figure above.

5.8 Financial comparison

5.8.1 A high-level financial comparison of the payback of the three schemes is presented in the table below. This takes into account the cost of heat and the capital cost of the network, and serves to show the comparative financial performance of the three options.

5.8.2 It should be noted that there are additional costs which will need to be taken into account within a full financial assessment. These include:

- Cost of heat substations
- Annual network and substation maintenance costs
- Billing costs
- Staff/other management costs

5.8.3 NB – it is assumed that for the new-build schemes the cost of on-site distribution and HIUs is considered to fall within the responsibility of the developer (in order to comply with the London Plan). Existing council housing schemes are assumed to operate central boilers, and hence connection to a central plant room is assumed for these loads at this stage. This assumption will be reviewed at the next stage of analysis.

	Scheme A	**Scheme B**	**Scheme C**
CAPEX			
Network Capital Cost	£4,675,000	£5,705,000	£7,705,000
Network information			
Annual heat supplied (kWh)	41,039,000	48,182,000	56,030,000
Heat prices			
Cost of heat from SELCHP (p/kWh)	1.83	1.83	1.83
Heat sold to customers (p/kWh)	3	3	3
Profit margin (p/kWh)	1.17	1.17	1.17
Annual cost balance			
Payment to SELCHP	£751,014	£881,731	£1,025,349
Annual income	£1,231,170	£1,445,460	£1,680,900
Annual surplus	£480,156	£563,729	£655,551
Years to payback	**9.7**	**10.1**	**11.8**

5.8.4 It can be seen from the table above that the smaller schemes, with the higher heat densities, have the shorter payback periods.

5.8.5 However, there is very little difference across all of the networks and in particular between Schemes A and B. There is thus significant scope for factors other than financial performance to influence the extent of the preferred network. Key factors that will need to be taken into account in subsequent analysis include:

- The ability of SELCHP to meet the peak loads of the different schemes, and the means of providing top-up and standby heat provision (if any)

- The cost of conversion to centralised heat provision (if applicable) in the existing council housing estates that are electrically heated.

SECTION 6

RISK ASSESSMENT

6 RISK ASSESSMENT

6.1 Network risks

6.1.1 There are three network variants described here and the following attempts to capture some of the additional risks associated with the expanded schemes:

	Risks description
Lowest risk (A)	• Key risks addressed and minimised through initial route feasibility exercise, as described in Element A report
Additional risks associated with network variant (B)	• Incorporates additional crossing of network rail assets (where Grinstead Rd meets Surrey Canal Rd) • Includes additional length of pipework and crossing of A200 (Evelyn Street)
Additional risks associated with network variant (C)	• Significant additional length of excavation of A200 required to reach Deptford Park Primary • Additional crossing of A200 required to reach Marine Wharf area

6.2 Development risks

6.2.1 With a scheme of this nature there is always a degree of risk associated with the phasing and emergence of new development, which may be delayed or emerge in a different form from that anticipated. However, the planning system does apply some leverage on new-build or refurbishment schemes to connect, and hence from the perspective of regulatory pressure, it is an advantage for a district heating scheme to include new-build elements. WSP | PB would argue that new-build elements are the more critical to DH scheme success, and would note in this context that as the schemes tested (i.e. moving from A to C) increase in size, the number and proportion of demand from existing buildings increase. From this perspective, risk is also increased.

SECTION 6

CONCLUSIONS AND RECOMMENDATIONS

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 This analysis shows that network option A appears to deliver the shortest payback based on initial modelling of the scheme connections. However, the overall difference in payback periods between the options analysed is relatively small.

7.1.2 The preferred network option A also contains predominantly new-build sites, where it may be possible to exert planning pressure on some sites to ensure that connection to an off-site DH network is pursued. In some cases, for example Convoys Wharf, this has already been done and the

7.1.3 The additional connections associated with network options B and C only have a short 'shared' section with the network option A (i.e. along Surrey Canal Road). This implies that if a connection between SELCHP and Goldsmiths is a key aim of this project, then the additional connections associated with network Options B and C only have a limited potential to 'share' the cost of this core network link, i.e. the reduction in cost burden achievable on the 'core' SELCHP to Goldsmith's connection is only likely to be marginal.

7.2 Recommendations

7.2.1 On the basis of our analysis, PB would suggest that initial focus should be on the potential connection of the following loads – corresponding to network variant A outlined in this report:

A
Goldsmiths - 1 St James's
Goldsmiths - Education Building
Batavia Rd
Surrey Canal Triangle
Convoys Wharf
Arklow Estate
Achilles St
Goodwood Rd
Bond House

7.2.2 This combination of loads gives the highest linear heat density of the variants tested, which suggests that it should be the most economic network to implement.

7.2.3 The majority of loads in this selection are new-build sites, many of which have an obligation under their planning application process to connect to a heat network should one be available. Enforcement of this obligation will therefore be a key element of the realisation of this project.

7.2.4 The next stages of this feasibility report – Elements C and D – will investigate in more detail the route for the proposed heat network, (option A identified above). A technical assessment of the design requirements will be provided in *Element C*, including a specification for the implementation of the option A network identified in this *Element B* report. In *Element D*, the commercial viability and delivery options for the heat network will be discussed, including an assessment of the cost of delivery.

7.2.5 It is noted that it will be necessary to confirm with LBL Housing whether, and over what timeframe, the Achilles Street redevelopment will be taking place. This should include confirmation of the requirement for works to ensure full compatibility with a heat network solution. This will be discussed at a risk workshop to be held with LBL officers as part of the *Element D* study. It is worth noting, however, that none of the other connections' viability is contingent upon the integration of Achilles Street with the network (i.e. there are no connections that require Achilles Street to connect in order for them to be viable).