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Feasibility Report

Bevin Court and Holford House Communal Heating Renewal (2019)

Bevin Court South West and Eastern Wings (2013)

Feasibility Report Completed by:

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Position: Mechanical Inspector
Signed:
Date: 13/2/19

Feasibility Report Authorised by (immediate line manager)

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Signed: TParkin
Date: 06 Feb 2019

Contract title:	Bevin Court and Holford House Communal Heating Renewal (2019)	
Estimated contract start date:	30/10/2019	
Estimated end date of initial contract period:	16 months	
Extension period (if applicable):	N/A	
Contract manager (if applicable):	Thomas Forsythe	
Contact details (telephone, email):	0207 527 3914 thomas.forsythe@islington.gov.uk	
Procurement number:	1819-0168	
Total estimated spend on goods, works or services for total contract period including any extensions	**£1,500,000.00**	**Capital**

Executive Summary

This report investigates the current condition of the heating system which serves 114 of the 118 properties in Bevin Court and all 12 properties which make up Holford House.

A programme of renewal works has been recommended encompassing the phased renewal of the Bevin Court and Holford House Heating System. The first phase will include the replacement of the distribution system and the heating equipment within the dwellings, with works aiming to be onsite in the 2019/20 financial year. A second phase should also be included in the long term plan, with a scope to replace the current boilers and primary circuit once they have reached the end of their economic service life in 2024/25.

The first phase of works is estimated to cost a total of £1,500,000 to complete and should be included within the 2019/20 Capital Budget. Additional funds of £1,068,000 needs to be requested from the Housing Investment Team before these works proceed.

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1.0 Introduction

Bevin Court is a Grade II* listed building that was built 1954 and is located in Cruikshank Street, London WC1. The scheme is a tri-wing design and consists of 118no. dwellings which are made up of the following units:

- 27no. purpose built maisonettes;
- 4no. two bedroom dwellings,
- 9no. three bedroom dwellings,
- 14no. four bedroom dwellings.
- 91no. purpose built flats; 63no. one bedroom dwellings,
- 27no. two bedroom dwellings,
- 1no. four bed dwelling.

Holford House was also built in 1954 and is covered under the same Grade II* listing, and is located just south-west of Bevin Court on Great Percy Street. There are 12no. purpose built maisonettes in Holford House, which are designated in the following way:

- 10no. three bedroom dwellings.
- 2no. four bedroom dwellings.

There are a combined 130 dwellings between Bevin Court and Holford House, of these there are a combined 44 leaseholders. Of these leasehold properties, four of them, all located in Bevin Court, have disconnected from the communal heating system.

2.0 Scope

The Bevin Court and Holford House communal heating system was originally installed circa 1979, some components have been replaced during this time but other components such as the heating distribution network pipe-work, heat emitters and associated valves are estimated to be at least 39 years old. This feasibility study has been commissioned to investigate the current condition of the plant and to consider the viability of replacing major components in an effort to reduce the plant's life cycle cost and ensure continued service to residents throughout the year.

Additionally, in line with the Council's policy, any changes will be designed to minimize their impact on the environment. However, this study will not be considering any improvements to the buildings thermal performance.

3.0 Methodology

A visual inspection has been undertaken to establish the current operating condition of the plant. Recent maintenance records as well as the energy usage data for the plant has been analysed, then the associated costs have been calculated. This information will be used to establish how far major components are through their life cycle using accepted industry practices with empirical life expectancy data taken from The Chartered Institute of Building Services (CIBSE) Guide M "Maintenance Engineering and Management".

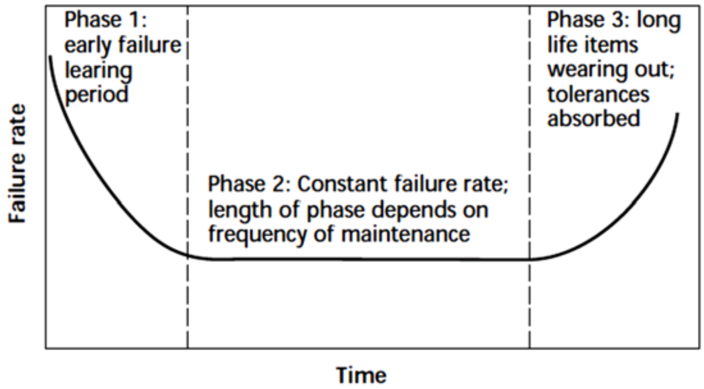


Figure showing a general lifecycle for plant as failure rate vs time

A review of system improvements has also been undertaken to address the operational risks identified within the CIBSE Guide B1- Heating, Strategic Design Decisions framework to establish an outline for a replacement system. Each option will be assessed and compared on capital investment, operating cost, environmental impact, and social value over their service life. Based on this assessment an outline system design will be recommended.

The proposed design will then be presented in several implementation plans for comparison to help select a preferred option for capital investment for the Estate's heating system going forward.

Based on these assessments the council will recommend a course of works to renew a selection of components in the system that have reached the end of their anticipated economic service life, for Bevin Court and Holford House.

4.0 Current System Configuration

The existing communal heating system serves both Bevin Court and Holford House and is a traditional 'two pipe (flow & return) open vented system', which provides heating and hot water provisions within the dwellings via radiators and hot water cylinders.

The system has three Ideal Viceroy GT 400 boilers with forced draught burners rated between 450kw and 540kw that supply a constant temperature heating circuit to the dwellings, via motorized three-port blending valves downstream of each boiler outlet. There are currently no block level heat meters installed on the system.

There are two control panels connected together which control the three-port blending valves, boilers, pumps and various other components of heating system. The original panel and wiring were installed around the original installation, making them in excess of 25 years old. The second panel is a TREND that was retrofitted in 2010, allowing for better control of the plant as well as remote monitoring via 3G mobile network. There is also a relay switch which controls a valve in each dwelling to turn the radiators on/off between winter/summer.

The heated water is distributed through four mild steel distribution circuits; one for each of the three wings of Bevin Court, with an additional circuit serving Holford House. Each circuit has two 'Holden & Brooke' belt driven pumps, operating on a duty/stand-by arrangement. A 25 litre BOSS dosing pot is connected to the heating pipework within the pump plant area for sampling and manually dosing chemicals into the heating system water.

The distribution pipe-work rises through the building and laterally across to each dwelling via purpose built pipe ducts. As the pipe-work enters the dwelling it is distributed through surface mounted piping at low level, the pipe-work serves the steel panel radiators which are configured as 'opposite ends, top and bottom entry'. The individual radiators are controlled by thermostatic and lock-shield radiator valves.

The hot water is provided by an Elson Unit, which is a bespoke hot water cylinder with integrated cold water storage. Where the Elson units have failed a variety of solutions have been implemented in their place, the most common is separate cold water storage tanks and hot water cylinders. However, there are also two gas water heater units and one gas boiler which has been configured for hot water service only, that have been installed in place of faulty Elson units. The original Elson units are connected to the heating system by the primary flow and return pipe-work and which is located in a purpose built cupboard. A combination of manually operated tap-thermostats and motorized valves control the hot water temperature to the Elson Units and cylinders.

5.0 Current System Condition

5.1 Visual Inspection

The three boilers were installed in a phased programme of work between 2004-09 and are in reasonable condition; the No.2 Boiler had a split in the casing at the time of inspection, but a repair order was subsequently issued. There have been verbal reports from maintenance operatives of the boilers working above anticipated operating loads, even in the summer months. This is most likely due to losses and inefficiencies of the components downstream of the boilers causing higher than desired loading on the boilers.

The control system for the heating plant is run by two different, interconnected panels, which have been installed at different times. The original panel is looking dated, however the wiring insulation inside the cabinet did not look overly brittle or dulled and there were no black burn marks on any of the terminals. The cables outside the cabinet were not accessible for inspection as they have been run through cable ducts or overhead cable-trays. The second, TREND panel is much more modern; installed in 2010 it still seems to be functioning well, however there is no interface on-site and only one user can access the panel via the 3G network at a time, due to a lack of ports. The relay controlling the dwelling radiator valves was operated and could be heard to work, however we were not able to test the valves in each of the dwellings for the purpose of this report.

The pumps are original and have been regularly maintained over their life, however their age would indicate that they are now overdue for replacement.

The external distribution pipe-work is original and can be described as aged, excluding the twelve risers which feed the North-Western and Eastern Blocks which were replaced in 2009 and are in good condition. However due to access issues and underground piping runs much of the external heating distribution pipework could not be inspected. It was also noted during the survey that numerous fittings and valves are not fitted with insulation blankets.

The general condition of the pipe-work and radiators inside the dwellings can be described as aged with some signs of external corrosion in places, but in many instances the pipe-work has been heavily painted making judgment of condition difficult. Although the majority of pipework is still original, it is evident that in the properties surveyed some have had various components replaced as a part of the maintenance regime.

The Elson units and associated copper pipework is all original and can again be described as aged. Similar to the heating system, it was evident that some of the hot water system components have also been replaced under the maintenance regime.

5.1.1 Inspection Findings

i. The external heating distribution pumps and pipework are aged where visible, but was not able to be inspected in its entirety.

ii. The heating equipment within the dwellings is also aged and in many dwelling has already failed, requiring replacement.
iii. All three boilers and ancillary equipment are in reasonable condition.
iv. The original control panel and wiring is aged, but are not showing signs of imminent failure.
v. The TREND control panel is now out dated but still has multiple years left before replacement is necessary.

5.1.2 Limitations of the Inspection

Whilst undertaking the visual inspection no attempt was made to dismantle plant, pipework or valves etc. or expose services which were not easily accessible from a visual inspection. Neither was there any specialist testing undertaken on gas, electric water or drainage equipment. It is anticipated that further investigations will be undertaken when a contractor is appointed.

5.2 Heating Equipment Register

A list of the heating equipment and background information on their condition has been compiled in the table below, the majority of this information was referenced from a 2009 survey completed by D. Watts, as a part of Servicing and Maintenance Contract. The equipment age and the remaining life expectancy has been updated to show the correct numbers, as of August 2018.

	Manufacturer and description	Quantity	Approx. age (yrs)	Approx. remaining life (yrs) [a]	Condition [b]
Boilers	Ideal Viceroy GT 10	3	10-14	10-6	B
Gas Burners	Nu-Way XGN1000 - 25T3D240	3	10-14	10-6	B
Boiler Shunt Pumps	Grundfos UPS 50-60/2F	3	10-14	10-6	B
Flue [c]	External powder coated flue stack	1	25+	5	-
Heating Pumps	Holden & Brooke (100-200 Starflex)	2	25+	0	D
	Holden & Brooke (65-200 Starflex)	2	25+	0	D
	Holden & Brooke (50-200 Starflex)	4	25+	0	D
	Holden & Brooke (40-200 Starflex)	2	25+	0	D
Heating Distribution Pipework	Renewed risers (North-West and Eastern Blocks) [c]	12	10	15	-
	Remaining Distribution Pipework	Multiple	25+	0	C
Control Equipment [c]	Original control panel incl. Plant Room wiring	1	25+	0	-
	Retrofitted TREND panel	1	8	2	-
Gas Valve	Johnsons AH-5209-0610	1	14	6	D
Serviceable Valves	Various	Multiple	25+	0	C
Motorized Valves	Belimo three-port heating valves	3	10-14	10-6	B
Heating System within the Dwellings	Pipework, radiators, HW cylinders and associated valves within the dwellings	Multiple	25+	0	C

[a] The life expectancy data provided in the table above was based on methods and information given in the CIBSE Guide M: Maintenance Engineering and Management.

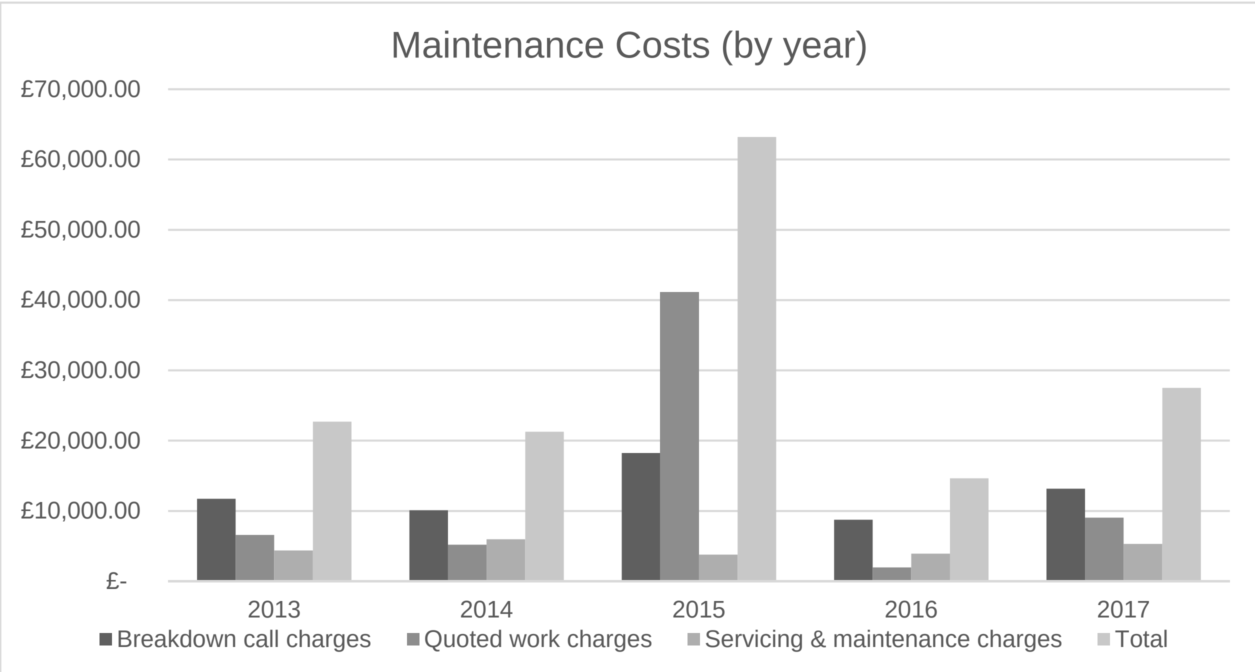
[b] It should be noted that the condition of the plant is marked on a scale of A-D; A = excellent condition and D = poor condition and that this is based on the educated opinion of the attending engineer at the time.

[c] Data not taken from the 2009 Servicing and Maintenance Survey

5.3 Maintenance History

The maintenance records for the past five years have been compiled and summarized in the table and figures below:

Date	Number of Breakdown calls	Breakdown call charges	Quoted work charges	Servicing & maintenance charges	Total per annum
2013	85	£11,734.47	£6,580.43	£4,383.81	£22,698.71
2014	80	£10,086.47	£5,202.83	£5,973.44	£21,262.74
2015	96	£18,253.78	£41,169.62	£3,787.73	£63,211.13
2016	57	£8,753.25	£1,973.99	£3,918.07	£14,645.31
2017	69	£13,160.53	£9,039.15	£5,311.63	£27,511.31
Totals	**387**	**£61,988.50**	**£63,966.02**	**£23,374.68**	**£149,329.20**



Overall LBI's breakdown and repair records indicate that failures occur regularly within the heating system, both in the plant room and within the dwellings. Although there is no clear trend of increasing maintenance requirements, it is the position of the Mechanical Team that based upon the data available a renewal works program is required to prevent major failure as many components have exceeded their quoted service life.

5.4 Energy Efficiency

The current energy consumption data for Bevin Court and Holford House is listed in the table below.

Description	Values
Current Annual Gas Usage	3,074,506 kWh
Current Annual CO_2 Emissions	568,784 kg
Current Annual Gas Costs	£ 80,358

Given the age of the system, there are now several components within the Bevin Court and Holford House Heating System which have been identified as inefficient by today's standards and are responsible for higher than desired energy losses within the system.

5.5 Condition Summary

The distribution pumps, pipework and heating equipment within the dwellings are all past their expected life expectancy (CIBSE Guide M) and there were many components which we were not able to adequately inspect, hence their condition is unknown. Given their age and the lack of hydraulic separation within the system, these components pose a significant risk to the continued effective operation of the heating system, and to the other major components, such as the boilers.

The boilers have an estimated six years left on their life expectancy and do not show any signs to cause concern, hence they do not present a risk to the continued operation of the heating system.

The original control panel is beyond its expected service life, however there are no signs of imminent failure on the board. The condition of Plant Room wiring was not able to be assessed but is expected to be in a similar condition to that of the wiring within the cabinet, as the environment within the Plant Room is not harsh. The condition of these components pose a moderate risk to the continued operation of the heating system. The new TREND board including the communications module is now outdated, but it still has an additional two years to go on its expected service life. Hence, it does not pose a tangible risk to continued operation of the plant.

6.0 Strategic Design Decisions

The breadth of options for a replacement heating system at Bevin Court and Holford House is limited by the existing heat demands and space/layout restrictions within the plant room, service tunnels and dwellings themselves. Subsequently, only solutions which can satisfy all of these conditions have been considered, - i.e. a hydronic, two-pipe, Low-Temperature Hot Water (LTHW) systems, with radiator emitters within the dwellings.

All designs options will be implemented to ensure the project will have a positive impact on residents. They shall bring a greater level of reliability and resiliency to the heating system, and will provide a greater level of control, to residents, of the heating within their dwellings. The provision of a reliable heating system will also greatly reduce the chance of condensation and subsequent mould growth, helping to ensure heathy and comfortable living environment for all

The remaining major design decisions for the proposed heating system are outlined in the following sections, then quantified and concluded in Section 6.3:

6.1 Centralised or Decentralised System

Decentralised heating systems place the heat generating equipment within the dwellings, so only local piping within the dwelling is required to distribute the heat. Conversely, centralised heating systems generate heat for a number of dwellings in a plant room located remotely. Mechanical plant and piping is then used to distribute the heat to the dwellings.

Centralised systems have a much larger duty, allowing energy efficiency measures and/or renewable heat sources to be integrated into the system. In addition to these measures, by serving many dwellings a centralised system combines a variety of heat usage profiles, with each dwelling's demands being slightly different. This, helps to distribute peak loads across a wider time period, allowing plant to operate at their most efficient for longer periods.

One consequence of a centralised system is that a higher percentage of energy lost in distribution compared with a decentralised system. However, these losses can be minimised to ensure they do not outweigh the potential savings of a more efficient primary plant by implementing the system in suitable properties which; a) have a large number of dwellings (>25); b) do not have a large footprint (i.e. multi-level buildings).

In operation, a centralised system will implement a variety of resiliency by design. These features will enable continuity of operation even when individual component malfunction. Additionally, centralised equipment also ensures it is easier to access and maintain, which in-turn reduces ongoing maintenance costs.

By contrast, a decentralised system is not likely to have the same resiliency features. However, because each system is completely independent Estate-wide breakdowns are extremely unlikely. Conversely, on larger Estates having many independent systems located within each dwelling can cause complication for maintenance activities, increasing the maintenance costs for the Estate.

In the longer term, the commercial equipment involved in a centralised system has a much longer life expectancy than the domestic equipment used in a decentralised system. This ensures less frequent system renewals and a much longer window to utilise the equipment, decreasing the equivalent annual life cycle cost.

6.2 Heat Generation Plant

The heat generation plant can come a variety of forms, but we will only be considering gas boilers and gas boiler supplemented by integrated renewable heating as we do not have the additional space to retrofit biomass boilers or Combined Heat and Power (CHP) plant in Bevin Court Plant Room. Additionally, Bevin Court and Holford House are not within the catchment area of any existing or planned district heat networks.

Modern commercial gas boilers can have efficiencies over 95%, this is the major benefit of implementing larger scale communal boiler schemes. Furthermore, it is possible to use supplementary heat generated by renewable sources to further decrease the carbon emissions of large scale communal schemes. In the case of Bevin Court and Holford House heating system, we have considered roof mounted solar options as a potential sources of carbon neutral power.

Cost-Benefit analysis have been undertaken for both solar thermal and photovoltaic panels (Appendix 11.2 & 11.3, respectively) mounted on the rooftop of Bevin Court. We used monthly weather data to predict the performance of both sets of panels and to estimate the power generated and the income from rebates/tariffs associated with that power. The income generated is then offset that against the initial capital investment and ongoing maintenance costs associated with the panels.

It was clear from our analysis that both solar thermal and photovoltaic panels were only marginally profitable over their lifecycle. Additionally, the tariffs associated with generating power from these types of systems will shortly conclude and there has not yet been a new tariff scheme announced. Hence, it is unlikely that we would be able to implement new solar panels in-time to utilise the current tariffs scheme.

In operation, the addition of solar panels will add points of failure and a requirement for maintenance staff whom are competent in undertaking solar panel maintenance activities. These on-going intangible costs must be weighed against any potential profits.

Conversely, gas boilers are the incumbent technology for heat generation, so they are already covered under the Council’s current maintenance regime. Similarly, current maintenance staff are already proficient in their up keep.

6.3 Options Appraisal Table [1]

		Cost				Environmental Perspective		Social Perspective			Social Value	
		Capital Investment	Operating Cost Saving	Maintenance	Life Expectancy Based on CIBSE Guide M	Energy Efficiency	CO_2 Emissions Saving	Resident Comfort	Reliability / Resiliency	Resident Control	Resident Operating Cost	Option Selection
Centralised or Decentralised System	Centralised [2]	£5,500	£122.29	£37.10	20 years	91%	865.55	ALL SYSTEMS WILL MEET PERFORMANCE CRITERIA	High	Medium	SAME AS OPERATING COST	✓
	Decentralised	£4,400	£98.59	£64.78	10 years	86%	697.83		Medium	High		
Heat Generation Plant	Gas Boiler	£2,200	£122.29	£37.10	20 years	91%	865.55		High	N/A		✓
	Gas Boiler with Integrated Renewables	£3,600	£140.38	£53.77	20 years 25 years	91% boiler 68% solar	993.64		Medium	N/A		

[1] All figures listed in the table are per dwelling and only include the relevant component(s) contribution, not the total system figure
[2] Figures include the contribution of the distribution network

7.0 Implementation Strategy

Given the design decisions in the previous section, several implementation strategies have been outlined below. Each strategy has been assessed for strengths and weaknesses across a variety of fields and the capital investment and recharges have been estimated.

7.1 Phased Renewal Works

A phased implementation would involve splitting the work to enable the most urgent portion of the works to be completed first, in this case the distribution network, including hydraulic separation and pumps, as well as the heating systems within the dwellings. Then, at a later stage completing the remaining works within the plant room, namely the boilers.

	Strengths	**Weaknesses**
Cost	Splitting the works into two parts will limit the Council’s financial exposure at any one time.	Higher overall cost due to double payment of mobilisation and preliminary costs.
Social Value	Splitting the works would ensure that the Council receive the full service-life out of the boilers and other newer equipment within the Plant Room that is not yet exceeded it’s expected service life.	Splitting the works would cause higher leaseholder re-charges compared with one single project due additional preliminary costs.
Social Perspective	Smaller project scope should enable a higher quality implementation and therefore higher resident satisfaction.	Longer window of works would cause more inconvenience to the residents.
Environmental		The full efficiency improvements would not be fully realised until the completion of the second phase.
Technical		Compromises may have to be made during the design, to ensure that the heating system within the dwellings is compatible with both the current and future plant room configurations. Operating new equipment in conjunction with existing equipment often limits functionality can expose the newer equipment to undesirable operating conditions (e.g. low heating set points, dirty working fluid) .
Administrative	Smaller projects should be easier to successfully execute.	The Council would have twice the administrative load to implement two different projects and less than a ten percent increase in fees to account the additional work load.

7.1.1 Capital Investment and Recharge

The first phase is estimated to cost £1,500,000, not including the cost of future works, which equates to a per dwelling cost of £11,904.76 accounting for the 126 dwellings connected to the communal heating system.

The Council would be eligible to claim a total recharge of £528,571.43, including an 11% professional fee charge, from the 40 leaseholders connected to the communal heating system.

There is also estimated to be an annual gas usage saving, based on system efficiency improvements, equating to a total of £18,624, or £140.81 per dwelling.

The future works for the scheme are assumed to take place in five years, and have been estimated to cost an additional £330,000 which has been adjusted for annual inflation of 2.9% over those years, this brings the total cost to £1,830,000.

7.2 Complete System Renewal

A complete system renewal would involve the replacement of the entire system during one large project.

	Strengths	Weaknesses
Cost	Lower overall costs compared with phased implementation.	Higher financial exposure during project execution than two smaller phased projects.
Social Value	Lower overall cost will also result in lower leaseholder re-charge compared with phased implementation.	Replacing the boilers concurrently with the rest of the secondary circuit will cut the service life of the boiler short, limiting the return on those investments. The loss on return, i.e. the cost of the new boilers, would need to waived from the leaseholder re-charge,
Social Perspective	Shorter total implementation time would mean less disruption to the residents.	A larger project can result in a decrease in Implementation quality if not properly managed.
Environmental	A positive step-change in efficiency would be realised immediately.	
Technical	A complete system renewal would enable a new turnkey system to be designed, avoiding the compatibility issues of a phased renewal. This would likely result in increased efficiencies and lower costs.	
Administrative	The council would only have to complete the procurement and legal processes once for all the works, minimising administrative requirements.	Large projects often result in complexities that can complicate project implementation and cause delays.

7.2.1 Capital Expenditure Forecast

A complete system renewal is estimated to cost a total of £1,700,000, which equates to a per dwelling cost of £13,492.06 accounting for the 126 dwellings connected to the communal heating system.

The Council would be eligible to claim a recharge including the 11% professional charge, however circa £250,000 would need to be waived from the total cost to account for loss in return from the boilers. This would result in only £1,450,000 being eligible for recharge, equating to a total recharge of £510,952.38 from the 40 leaseholders connected to the communal heating system. This is a loss of £88,095.24 recharge income for the Council.

There is also estimated to be an annual gas usage saving, based on system efficiency improvements, equating to a total of £27,642, or £219.38 per dwelling.

7.3 Reactive Capital Programme

A reactive capital programme was considered, whereby components are regularly maintained, but run to failure. Hence, capital works are prompted by major equipment failure.

	Strengths	Weaknesses
Cost	Capital investment is not committed earlier than absolutely necessary.	Failure of individual pieces of equipment can often result in a domino effect, causing damage to surrounding equipment and/or building fabric, which

		then require additional repair and result in an increase in the total cost of replacement. Procurement and legal aspects of the project require long lead times in order, especially to obtain the best value for money outcome for the project. Hence, the Bevin Court heating system could be out of operation for an extended period of time, leading to the long term use of high cost temporary heating solutions.
Social Value	Leaseholders and the Council get the longest possible operating life from their original investments.	
Social Perspective		Breakdowns of any kind, especially those which result in extended down time on heating systems would result in resident inconvenience, hence a negative impact on the Council's reputation.
Environmental		Delay in all renewal works will mean no environmental improvements will occur
Technical		Often, expedited works involve a compromised solution which is not necessarily representative of the solution which is the best value for money over the life of the heating system.
Administrative		It is especially difficult to expedite a major repairs project whilst upholding the Council's commitment to value for money as full scale procurement and legal aspects require input from multiple departments.

8.0 Funding

The renewal works for the Bevin Court heating system have been allocated £432,000, this was approved in July 2015 for the 2016/17 Capital Programme. However, resourcing issues have delayed the procurement of the renewal works at Bevin Court and Holford House, as such over the last four years, additional plant has now exceeded their life expectancy and is now due for replacement. The requirement to replace these additional items is the reason for the higher spend forecast in all of the implementation strategies listed in the previous sections.

Any spending over the original allocation would need to be accounted for in savings on other approved works or unused resources. Alternatively, funding for the shortfall can be applied for by submitting a Key Decision report to the Housing Investment Team (HIT).

9.0 Conclusions

i. The majority of the Bevin Court and Holford House is currently now beyond its service life and is posing a risk to the systems continued operation, with the notable exception of the boilers.
ii. The replacement heating system at Bevin Court and Holford House must be a two-pipe, hydronic heating system, with radiators providing heat within the dwellings due to the constraints of the existing building.

iii. A centralized system was selected over decentralized system in the design process due to a longer service life, lower maintenance costs and higher efficiency ratings.
iv. The use of supplementary heat using renewable solar energy was ruled out due to the high initial capital cost and increased maintenance requirements.
v. Phased system renewal has a total implementation cost of approximately £1,700,000; first phase will cost circa £1,500,000; second phase will cost an additional £330,000.
vi. Complete system renewal has a total implementation cost of approximately £1,700,000. However, there is also a lost recharge income of £85,892.86 due to the waiver for the early replacement of the boilers.
vii. The lost recharge income erodes the financial benefit of a complete system replacement.
viii. A reactive capital programme carries a very large risk profile, and therefore a high potential for overspend. Therefore, it is extremely difficult to give a cost estimate for comparison, however historical evidence suggests emergency works increase spending compared with similar planned works.
ix. Additional funds need to be secured before any renewal strategy can be implemented.

10.0 Recommendations

We have outlined a set of recommendations that the LBI Mechanical & Electrical Team feel represent the best value for money to ensure comfortable and reliable heating to the residents of Bevin Court and Holford House going forward.

i. Proceed with planning the first stage of a phased implementation strategy, aiming to be onsite in the 2019/20 financial year.
ii. Request additional funds to the value of £1,068,000 from HIT to proceed with the first phase of a phased system renewal.
iii. Complete tender documentation for a design and build contract, specifying a partial system renewal with following system outline: centralized, two-pipe, hydronic heating system, powered by a high efficiency gas boiler, distributed to each dwelling.
iv. In partnership with our designer, select a method of domestic hot water generation within the dwellings from; heat interface units, hot water cylinders, or thermal stores.
v. Add the second stage of the phased implementation plan, to the replace boilers and primary circuit, to the long term investment plan.

11.0 Appendices

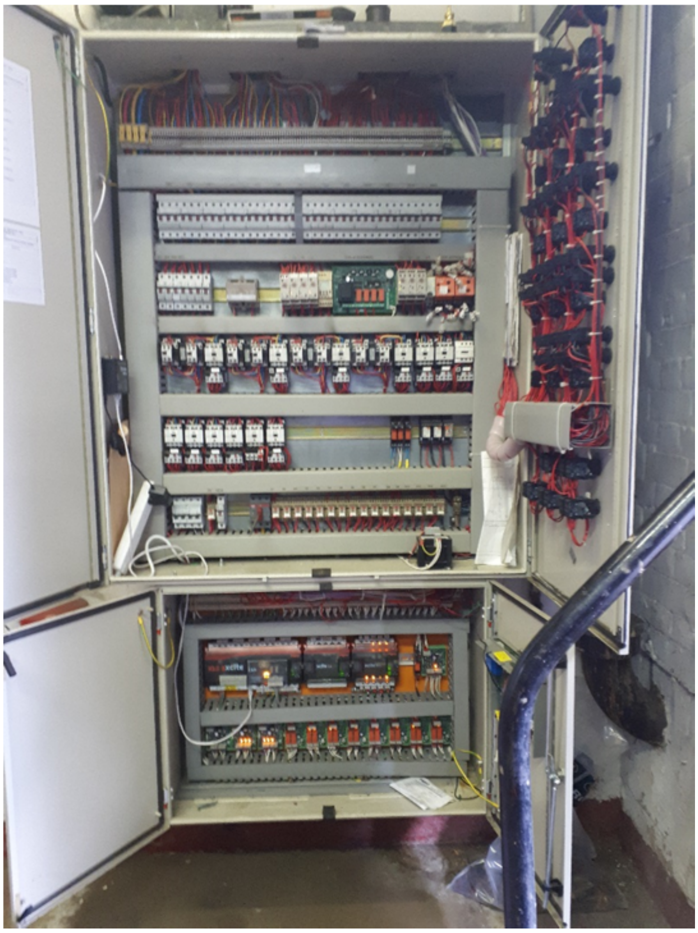
11.1 Photographs

11.1.1 Plant Room

Boilers and headers

Pump room

Flue



Control Panel

11.1.2 Distribution

Typical riser arrangement with insulation removed

Typical riser arrangement with insulation in situ

11.1.3 Dwellings

Elson unit controls

Elson unit

Typical control arrangement within the dwellings

Typical hallway radiators


Typical lounge radiator

11.2 Solar Thermal Calculations

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual			References
Days in each month	31	28	31	30	31	30	31	31	30	31	30	31	Total	365		
Solar Irradiance per day by month	635	1277	2175	3482	4604	4878	4668	4137	2966	1652	831	514	Average	2651.58	Wh/m2/day	CIBSE Guide A Table 2.12 (g) - 0deg (Laying flat)
Outside Temp by month (Average)	5.2	5.25	7.6	9.85	13.3	16.35	18.7	18.45	15.65	11.95	8	5.5	Average	11.32	degC	
High	8.1	8.4	11.3	14.2	17.9	21	23.5	23.2	19.9	15.5	11.1	8.3	Average	15.2		Metoffice Average Tables for Heathrow
Low	2.3	2.1	3.9	5.5	8.7	11.7	13.9	13.7	11.4	8.4	4.9	2.7	Average	7.43		Metoffice Average Tables for Heathrow
Mean Tube/Amb. Temp Difference by month	39.8	39.75	37.4	35.15	31.7	28.65	26.3	26.55	29.35	33.05	37	39.5	Average	33.68		
Panel Efficiency by month	51%	63%	68%	71%	72%	73%	73%	73%	71%	67%	58%	45%	Average	65%		High Performance Flat Plate Solar Thermal Collector Eva
Heat generated per day	320.85	802.55	1485.71	2475.15	3330.64	3548.39	3400.26	3001.02	2111.59	1111.18	479.35	231.33	Average	1,858.17	Wh/m2/day	
Heat generated per area	9946.25	22471.49	46057.06	74254.57	103249.73	106451.71	105408.12	93031.55	63347.61	34446.58	14380.49	7171.34	Total	680,216.48	Wh/m2	
Heat generated	1044.36	2359.51	4835.99	7796.73	10841.22	11177.43	11067.85	9768.31	6651.50	3616.89	1509.95	752.99	Total	71,422.73	kWh	
Reduction in CO2 Emmision	223.44	504.82	1034.68	1668.14	2319.52	2391.45	2368.01	2089.96	1423.11	773.85	323.06	161.10	Total	15,281.14	kg	
RHI Tarriff received annually	£ 112.27	£ 253.65	£ 519.87	£ 838.15	£ 1,165.43	£ 1,201.57	£ 1,189.79	£ 1,050.09	£ 715.04	£ 388.82	£ 162.32	£ 80.95	Total	£ 7,677.94		
Gas savings	£ 31.74	£ 71.71	£ 146.97	£ 236.96	£ 329.48	£ 339.70	£ 336.37	£ 296.88	£ 202.15	£ 109.92	£ 45.89	£ 22.88	Total	£ 2,170.67		

Annual Income	£ 9,848.61	
Annual Maintenance Cost	-£ 1,050.00	
Total income over lifetime	£ 218,879.86	Adjusted with predicted CPI annually
Cost of supply and install	£ 131,954.55	
Payback Period	11.85	years
IRR	4.97%	
NPV	-£32,142.56	

Figures

FPC Outlet Temperature Setpoint	55	degC	
Assumed FPC Inlet Temperature	35	degC	
Area limit due to 200kW cap	300	m2	
Potential available area	105	m2	
Orientation of Panels	S		
Incline of Panels	0	deg	
Condensing Boiler Efficiency	86%		
Optical Efficiency	75%		High Performance Flat Plate Solar Thermal Collector Eva
Standard FPC Loss Coeffiecient 1	3.6857	W/m2 -K2	High Performance Flat Plate Solar Thermal Collector Eva
Standard FPC Loss Coeffiecient 2	0.0055	W/m2 -K2	https://www.nrel.gov/docs/fy16osti/66215.p
CO2 Emissions per kW	0.184	kg/kWh	Greenhouse gas reporting - Conversion factors 2016
Cost for Gas	£ 0.0261		https://www.gov.uk/government/publicatio
Tariff Charges	£ 0.1075		
Estimated CPI increase	2.236%		Averaged for the UK over the last 10 years (ONS)
Estimated Lifetime	20	years	
Cost to supply and install solar	£ 1,256.71	/m2	European Market for Commerial Solar Thermal 2011 - B!
Investment Discount Rate	3.5%		

11.3 Photo-Voltaic Panels Calculations

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual			References
Days in each month	31	28	31	30	31	30	31	31	30	31	30	31	Total	365		
Solar Irradiance per day by month	635	1277	2175	3482	4604	4878	4668	4137	2966	1652	831	514	Average	2651.58	Wh/m2/day	CIBSE Guide A Table 2.12 (g) - 0deg (Laying flat)
Electricity generated per day	95.25	191.55	326.25	522.30	690.60	731.70	700.20	620.55	444.90	247.80	124.65	77.10	Average	397.74	Wh/m2/day	
Electricity generated per area	2952.75	5363.40	10113.75	15669.00	21408.60	21951.00	21706.20	19237.05	13347.00	7681.80	3739.50	2390.10	Total	145,560.15	Wh/m2	
Electricity generated	885.83	1609.02	3034.13	4700.70	6422.58	6585.30	6511.86	5771.12	4004.10	2304.54	1121.85	717.03	Total	43,668.05	kWh	
Reduction in CO2 Emmision	189.53	344.26	649.16	1005.73	1374.13	1408.95	1393.24	1234.75	856.69	493.06	240.02	153.41	Total	9,342.93	kg	
FIT Tarriff received annually	£ 46.42	£ 84.31	£ 158.99	£ 246.32	£ 336.54	£ 345.07	£ 341.22	£ 302.41	£ 209.81	£ 120.76	£ 58.78	£ 37.57	Total	£ 2,288.21		
Gas savings	£ 26.92	£ 48.90	£ 92.21	£ 142.86	£ 195.19	£ 200.14	£ 197.91	£ 175.39	£ 121.69	£ 70.04	£ 34.10	£ 21.79	Total	£ 1,327.15		

Annual Income	£ 3,615.36	
Annual Maintenance Costs	-£ 3,000.00	
Total income over lifetime	£ 15,308.05	Adjusted with predicted CPI annually
Cost of supply and install	£ 43,875.00	
Payback Period	10.86	years
IRR	-8.05%	
NPV	-£32,142.56	

Figures

Area limit due to 200kW cap	300	m2	
Potential available area	300	m2	
Orientation of Panels	S		
Incline of Panels	0		
Condensing Boiler Efficiency	86%		
Panel Efficiency	15%		High Performance Flat Plate Solar Thermal Collector Eva
CO2 Emissions per kW	0.184	kg/kWh	Greenhouse gas reporting - Conversion factors 2016
Cost for Gas	£ 0.0261		https://www.gov.uk/government/publicatio
Tariff Charges	£ 0.0524		
Estimated CPI increase	2.236%		Averaged for the UK over the last 10 years (ONS)
Estimated Lifetime	20	years	
Cost to supply and install solar	£ 146.25	/m2	
Investment Discount Rate	3.5%		