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Project name:

Maidstone DEN Feasibility Study Uplift

Project ref:

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To:

Kent County Council

From:

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CC:

Date:

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Subject: Alternative Energy Centre Location Appraisal

Introduction

During the previous stage of the project (HNDU Feasibility), 9 different sites were appraised for the location of the primary Energy Centre (EC) to serve a new District Energy Network (DEN) within Maidstone. This appraisal identified a plot of land at the north-west corner of the Maidstone East masterplan as the preferred option, as shown in the following image:

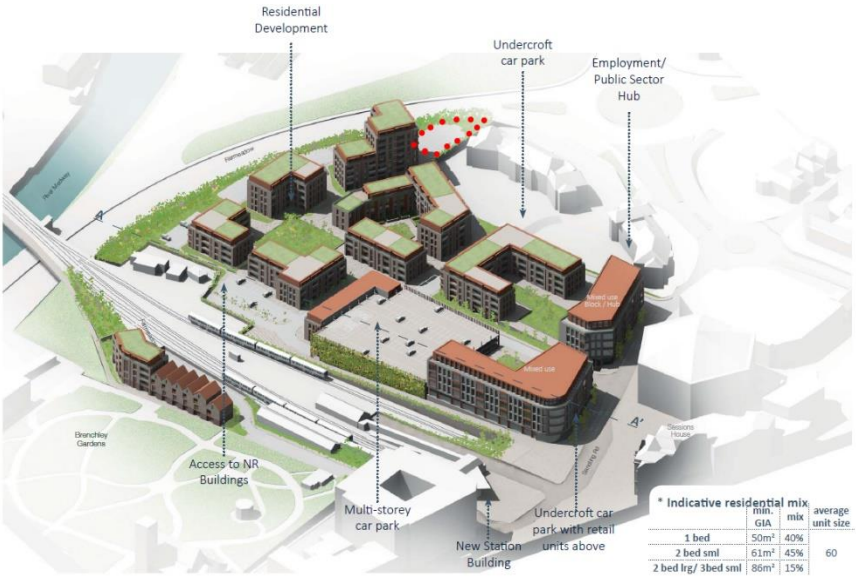

Figure 1: Image of current preferred masterplan of Maidstone East (EC location shown in red)

A secondary EC site was also proposed to be situated alongside the river for the purpose of positioning a river water abstraction sluice.

Due to the location within a 3rd party development site and the uncertainties around the eventual use of the land and programme the development, the EC location was identified as a key risk for the project. To mitigate this risk KCC are keen to identify alternative options for the primary EC.

Three sites, collectively identified by KCC and AECOM, have been proposed as possible alternative locations. A summary of each site is provided in Appendix A. As none of these sites was assessed in the original feasibility study a new comparative appraisal has been undertaken.

Following on from the creation of a RIBA stage 2 EC General Arrangement (GA) design, it is estimated that the required internal space to house the plant equipment is approximately 840m^2 (please refer to Appendix D).

Assessment Criteria

At the previous stage, the location appraisal was based upon the following criteria:

Appraisal Criteria	Summary
Plan area suitability	How suitable is the total available site area to the requirements of the EC? Ideal solution would be that there is enough space for a single-story building with ample room for access, deliveries, car parking and refuse areas.
Height restrictions	Are there any restrictions that would limit how tall the building could be? Ideal solution would be that there are no restrictions, allowing the EC design to be as tall as required (i.e. by the room required to house all mechanical equipment).
Access	Are there any restrictions that would limit how the site can be accessed from the main road transport systems? Ideal solution would be that the site is located on a quiet road (where implications on traffic flow would not be an issue) that large vehicles can easily gain access.
Utility connections	How close is the site to already developed utility networks (i.e. comms, drainage etc.)? Ideal solution would be that the site is located adjacent to all networks, and that suitable capacity is available.
Suitability for all technology options	How suitable is the site to the proposed technologies? Take into account consideration of for fuel utility networks, air quality limitations and waste heat source location. Ideal solution would be close to close to a gas main pipeline, with no stringent air quality limitations (for gas systems) and close to the canal and an electrical substation with available capacity (for the WSHP system).
Implications for current and planned use	How suitable is the site for locating an energy centre?
Suitability for flueing	How suitable is the site for the erection of flue systems? Ideal solution would be that the site is not located to any tall buildings and is situated away from residential areas resulting in a small and simplified system.
Visual impact	How stringent are the building visual considerations that would need to be considered? Ideal solution would be that minimal consideration of the EC visual impact is required, e.g. by integrating as part of another building, or by locating in an area where visual impact is not of such critical importance (such as an industrial estate or other sites not in an urban centre).
Heat network implications	What are the implications to the heat network design? Ideal solution would be that the site is located in the middle of all the proposed customer sites where distribution pipework is located, thus reducing both pipe bore diameters and total lengths.
Private wire implications	What are the implications to the private wire network design? Ideal solution would be that the site is located in the middle of all the proposed customer sites where distribution pipework is located, thus reducing total lengths.

Appraisal Criteria	Summary
Third party issues	Are there any third-party issues that need to be considered in the design and operation? Ideal solution is that the site is already owned by a company related to the proposed Special Project Vehicle (SPV) that will develop the EC (i.e. KCC), and is not accountable to any other local
Deliverability	Are there any other issues that could influence deliverability? Ideal solution is that there are none. Examples include the requirement to clear the site.

During feasibility stage, the optimal system solution was identified as a duel network district heating system, with heat generated by CHP, WSHP and gas boilers, and a private wire electricity network. As such, the following system-specific assessment criteria shall also be considered in the appraisal:

Appraisal Criteria	Summary
Suitability for gas boilers	How suitable is the site for the installation and operation of gas boiler plant? Ideal solution is that the site is adjacent to a gas main pipeline.
Suitability for gas CHP	How suitable is the site for the installation and operation of gas CHP plant? Ideal solution is that the site is adjacent to a gas main pipeline, and no stringent local area air quality limitations (i.e. being within an Air Quality Management Area (AQMA).
Suitability for WSHP	How suitable is the site for the installation and operation of WSHP plant? Ideal solution is that the site is both adjacent to the water source (canal) and is located near an existing electrical substation with suitable available capacity.

Other environmental criteria shall also be considered:

Appraisal Criteria	Summary
Other site restrictions	Are there any other criteria that need to be considered? Ideal solution is none. Examples include being located within a floor risk area, a Site of Specific Scientific Interest (SSSI) or other such classification.
Environmental impact	What is the overall environmental impact of using the site? Ideal solution is none. Examples include the development of green land or of the removal of protected trees.

Assessment

Qualitative Analysis

Table 1 below outlines the advantages and disadvantages for each site.

Site	Advantages	Disadvantages
Hare & Hounds Pub Site	Located close to all the proposed customers on the network, which will reduce pipe Ø and lengths (refer to Appendix B) of the DHN. Adjacent to two low pressure gas main pipelines (refer to Appendix C). Plot (1,200m^2) larger than the estimated EC Gross Internal Area (GIA, 840m^2), which will also allow for outside parking and refuse areas, as well as vehicle tracking. Easy site access available from Lower Boxley Road, a quiet street side road, or Stacey's Street (B2012). The land is currently available for sale and is going to be purchased by KCC, regardless of the intention to develop the DEN. EC will need to be incorporated into the design of a new or extended car parking area, which will reduce the visual impact of the EC (versus a standalone facility).	Adjacent to existing high-rise buildings, such as Invicta House, therefore tall flueing solutions will be required for all gas combustion plant. Highly visible plot in a town centre, therefore design of EC / new or extended car parking area will need to meet more stringent planning criteria. Site is circa 300m from the proposed river water abstraction point, meaning the water will need to be pumped over a large distance. The existing pub and advertising hoardings will need to be cleared from the site. The site currently has numerous mature trees situated on it, the majority of which will require clearing in order to develop the land. It is not known if any of these trees are subject to any protection orders. EC will need to be incorporated into the design of a new or extended car parking area, which may restrict the overall height / dimensions of the EC.
Maidstone East Undercroft Carpark	Site is located within the Maidstone East development area, which will reduce overhead costs, such as contractor preliminaries, as the site will already be an active construction site. Although the size of available plot is unknown, it is anticipated to be sufficient for the estimated EC GIA. The site does not have any proposed alternative use, resulting in no opportunity needing to be considered. Site will be adjacent to all other utilities, which will be being extended throughout the Maidstone East site as part of the redevelopment. Site relatively close to the river (circa 100m), resulting in relatively smaller system CAPEX and pumping energy in comparison to pub site.	Site is located at one end of the proposed catchment area of the DHN, which will result in larger pipe Ø. Site is located in an undercroft, the condition of which will - need to be assessed and potentially refurbished - restrict the maximum height that the EC can be - result in complex flueing arrangements No gas network currently exists within the Maidstone East site. The creation of a DEN would prevent the need for the creation of any network, therefore a gas network extension would be required across the A229 (where there is a medium pressure mains). As the site is located in Maidstone East, the flueing arrangement will likely need to consider the height of the tallest building in the development. The development of the site is subject to the construction program of the Maidstone East development, which could have adverse impact on the construction program of the DEN.
Maidstone Rowing Club Carpark	Site is adjacent to a medium pressure gas mains pipeline. Site is adjacent to the river, resulting in smaller system CAPEX and pumping energy in comparison to the other sites. Site is in a somewhat hidden location, which will reduce the visual impact on the landscape	Plot (870m^2) is only slightly larger than the estimated EC Gross Internal Area (GIA, 840m^2). This will likely result in the entire plot being taken by a single-story EC (resulting in little or no external areas for parking, vehicle tracking etc.), or a reduced plot area taken by a multi-story EC. Site would need to be leased or purchased from the Maidstone Rowing club, at an

Site	Advantages	Disadvantages
	and potentially reduce planning requirements. Site would require minimal clearance as it is currently a ground level car park. The current owners (Maidstone Rowing Club) have previously expressed an interest in the land being developed for the purpose of the DHN. The site is not currently near any tall buildings, reducing the likelihood of requiring tall flueing solutions (although this may change based on the finalised design of the Maidstone East development). The site would allow for a standalone EC building, which would not require integration into the designs of any other project.	expense to the project. Site is situated beyond the western end of the DEN catchment area. This would result in larger Ø and extended lengths of the DHN, and extended length of the private wire network Site would likely require the extension of other utilities (power, comms, waste water) to serve the site.

Table 1: Qualitative analysis of all the proposed EC sites

River Water Pumping Energy

In order to operate the WSHP, river water is required to be pumped from the secondary EC location, adjacent to the canal, to the primary EC location. In order to investigate the impact on the amount of distance between the two locations, the pumping energy for each solution has been estimated and a WLC analysis undertaken.

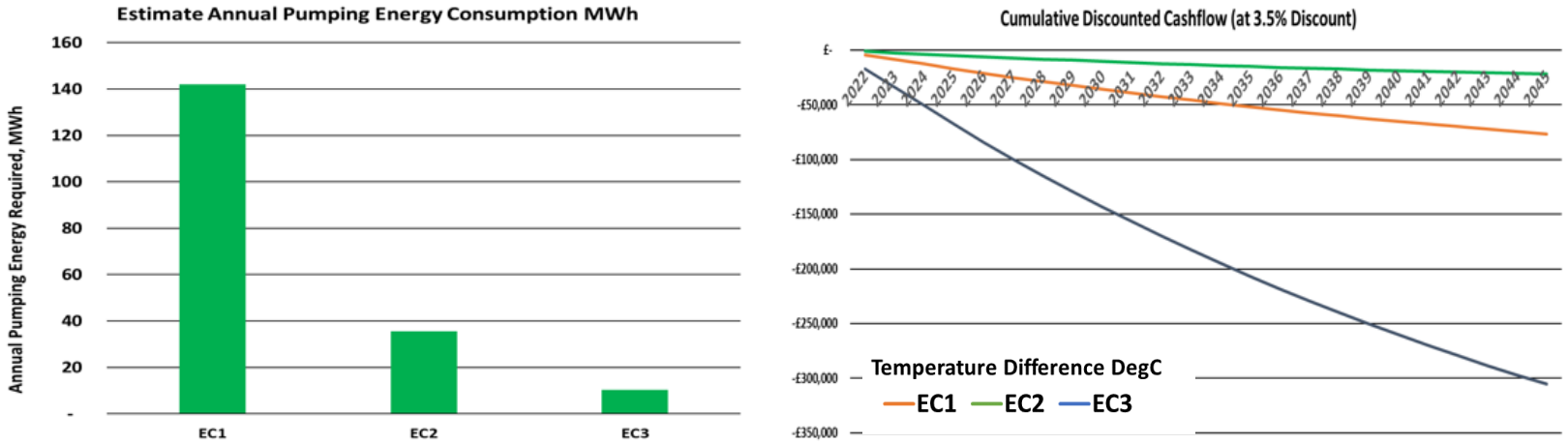

Figure 2: Results from river water pumping energy calculations to each EC site.

As can be seen from the graphs above, the pumping energy required to transport the river water to EC site #1 would be approximately 4x higher than EC site #2 and 14x higher than EC site #3 sites, resulting in a net increase in operational costs of £14,300 per annum compared to EC2 and £17,700 per annum compared to EC3.

Appraisal Results

	Option 1 - Pub Site		Option 2 - ME Undercroft Car Park		Option 3 - Maidstone Rowing Club Car Park	
Name Ref	**Pub Site**	*Notes*	**Car Park Site**	*Notes*	**Rowing Club Site**	*Notes*
Plan Area Suitability	5	*1,175 m2. No limits on EC GA design.*	3	*Size OK but cost implications*	3	*863 m2. Access area limits*
Height Restrictions	4	*Integrate with new car parking*	3	*Likely in basement*	5	*No issues identified*
Other Site Restrictions	5	*None identified*	2	*Within 'Low Risk' Flood Area*	2	*Within 'Low Risk' Flood Area*
Access	5	*Adjacent to road*	5	*Can be purposely designed*	3	*Access road required*
Utility Connections	5	*Adj. to all*	5	*Can be purposely designed*	3	*Extensions required*
Suitability for Gas Boiler	5	*Adj. to 2 gas mains*	5	*Can be purposely designed*	3	*Min. 80m gas extension required*
Suitability for CHP	5	*Adj. to 2 gas mains*	5	*Can be purposely designed*	3	*Min. 80m gas extension required*
Suitability for WSHP	2	*c. 350m from river*	3	*c. 65m from river*	5	*Adj. to river*
Implications for Current & Planned Use	4	*Land currently for sale*	3	*Currently not in design*	4	*Rowing club open to proposal*
Suitability for Flueing	3	*Flue higher than Inv. House*	2	*Part of Maid. East development*	5	*Low rise area*
Visual Impact	2	*Highly visible plot*	5	*Essentially hidden in ME design*	4	*Hidden plot*
Environmental Impact	2	*Removal of potentially protected trees required*	5	*No issues identified*	5	*No issues identified*
Heat Network Implications	5	*No extra pipe run required*	5	*No extra pipe run required*	4	*Small extension required*
Private Wire Implications	5	*No extra wire run required*	5	*No extra wire run required*	2	*Large extension required*
Third Party Issues	4	*Land for sale*	1	*Dependent on Maidstone East*	3	*Implications to rowing club*
Deliverability	3	*Clearance required*	5	*Closed development site*	4	*Site appears clear*
Total Score (%)	**80%**		**78%**		**73%**	
Rank	**1**		**2**		**3**	

Figure 3: Results from quantitative site appraisal

The suitability scores for each section have been assessed in comparison to the other opportunities available. In terms of the calculation of the total score, each individual criterion has been weighted equally.

Conclusions & Next Steps

The comparative appraisal indicates that the site of the Hare & Hounds pub is the most appropriate alternative location for the primary EC, mainly because of the following benefits:

- It does not rely on the approval, coordination and programme with any 3rd party developer for the EC to be built;
- It is close to existing gas mains; and
- It is a sufficiently sized plot, and with adequate access, to locate the anticipated EC facility.

Based on these results the Pub Site will be used as the primary EC locations for the planned updates to the Technical and Economic Modelling Assessments (TEM) that are to be conducted as part of the 'Feasibility Uplift' project.

The primary challenges that need to be accounted for in the development of the design of the facility in this location are as follows:

- Minimising the pumping energy required to transport to river water from the Medway canal to the site;
- Detailed investigation into the pipe route between the canal and the energy centre.
- Incorporating the EC into any redevelopment or extension of the carparking facility currently adjacent to the site;
- Ensuring the design of the EC, carparking facility and gas combustion flueing equipment is in keeping with the aesthetic of the local area and meets local planning requirements;
- Suitable provision is made for vehicular access and tracking in and around the site;
- Suitable provision is made for all the site's utility demand requirements; and
- Environmental impact of the site is kept to a minimum – noise and air quality studies are carried out to assess the baseline and design the Energy centre to suit.

Appendix A – Identified Sites

Hare & Hounds Pub Redevelopment Site

The Hare & Hounds is a pub adjacent to the Invicta House car park. KCC are currently in the process of purchasing the site with the intention of extending the car parking facilities. KCC have suggested that this redevelopment represents an opportunity to integrate the proposed EC into the design. The site is approximately 1,180 m^2.

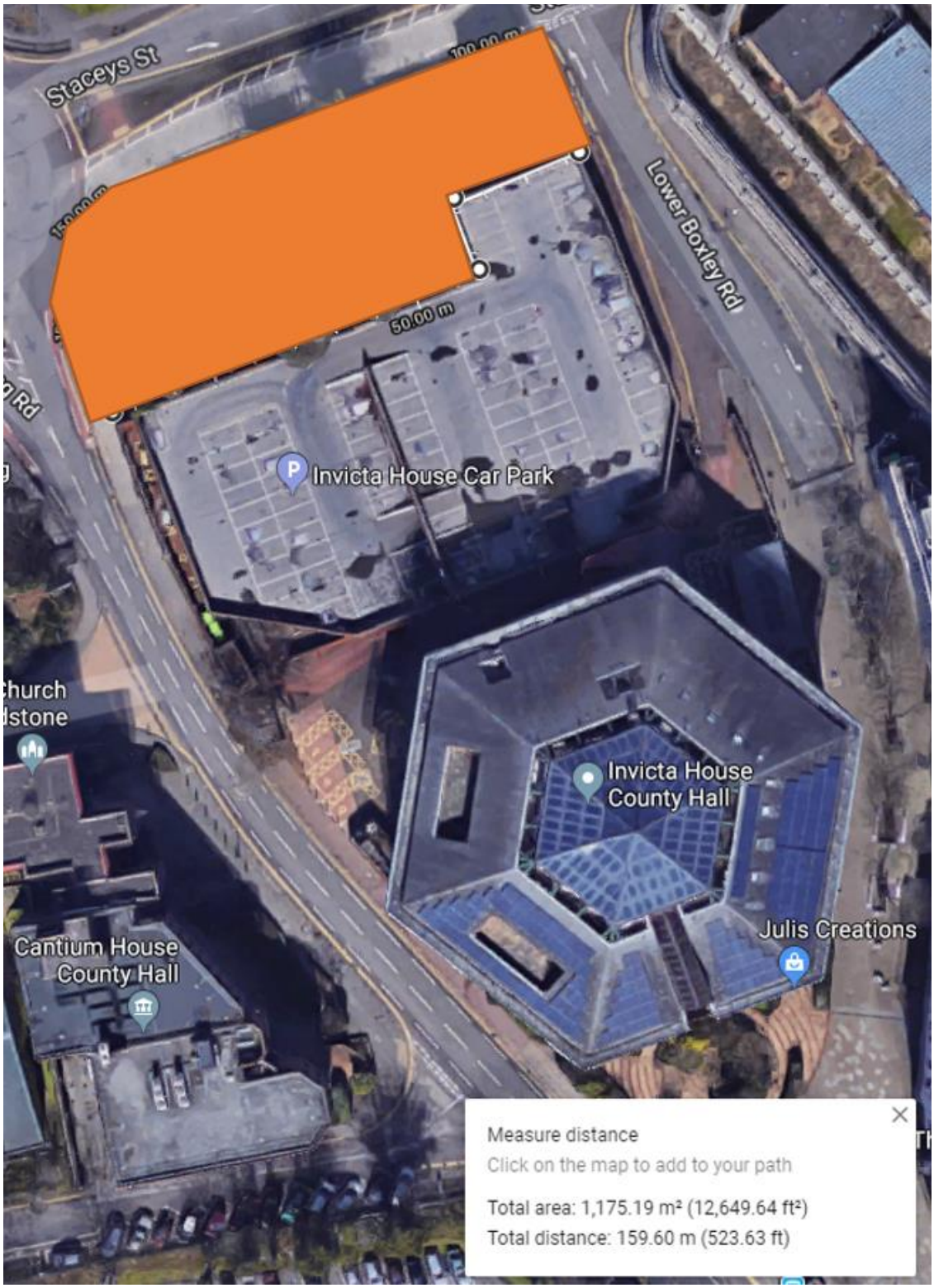

Figure 4: Satellite view of the Hare & Hounds redevelopment opportunity site

Maidstone East Site – Undercroft Car Park

Within the Maidstone East development site there is an existing undercroft car park located beneath the current site of the Post Office sorting office. Due to the changes in levels between the River Medway / A229 and the development site, this undercroft facility is due to be retained to maintain a level site; however, the use of the site is as yet undecided and could therefore present an opportunity for locating the EC.

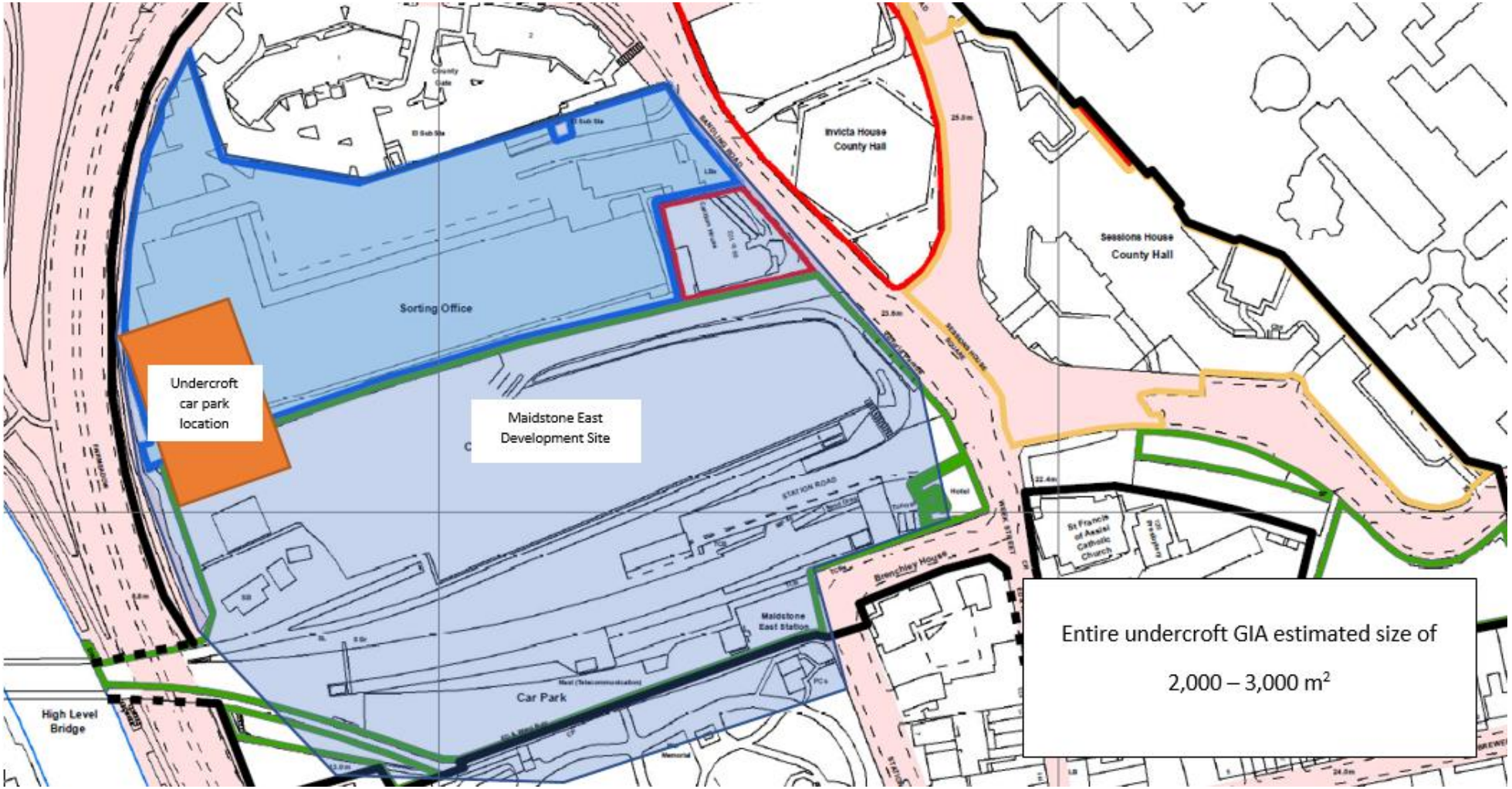

Figure 5: Maidstone Undercroft Car Park Location

Maidstone Rowing Club Carpark

Following on from a high-level consultation between KCC and the Maidstone rowing club, it is understood that the club are open to making the land available behind the main clubhouse building available for the DEN SPV to purchase and redevelop. The site measures approximately 870 m^2.

Figure 6: Satellite view of the Maidstone Rowing Club car park site

Appendix B – Map of Potential Sites

The figure below presents the potential locations for the energy centre and the position of the WSHP abstraction point for the different energy centre sites. ***Note the blue lines are to compare the relative distances of the EC to the abstraction points, not the proposed pipework route.***

Appendix C – Map of Gas Infrastructure

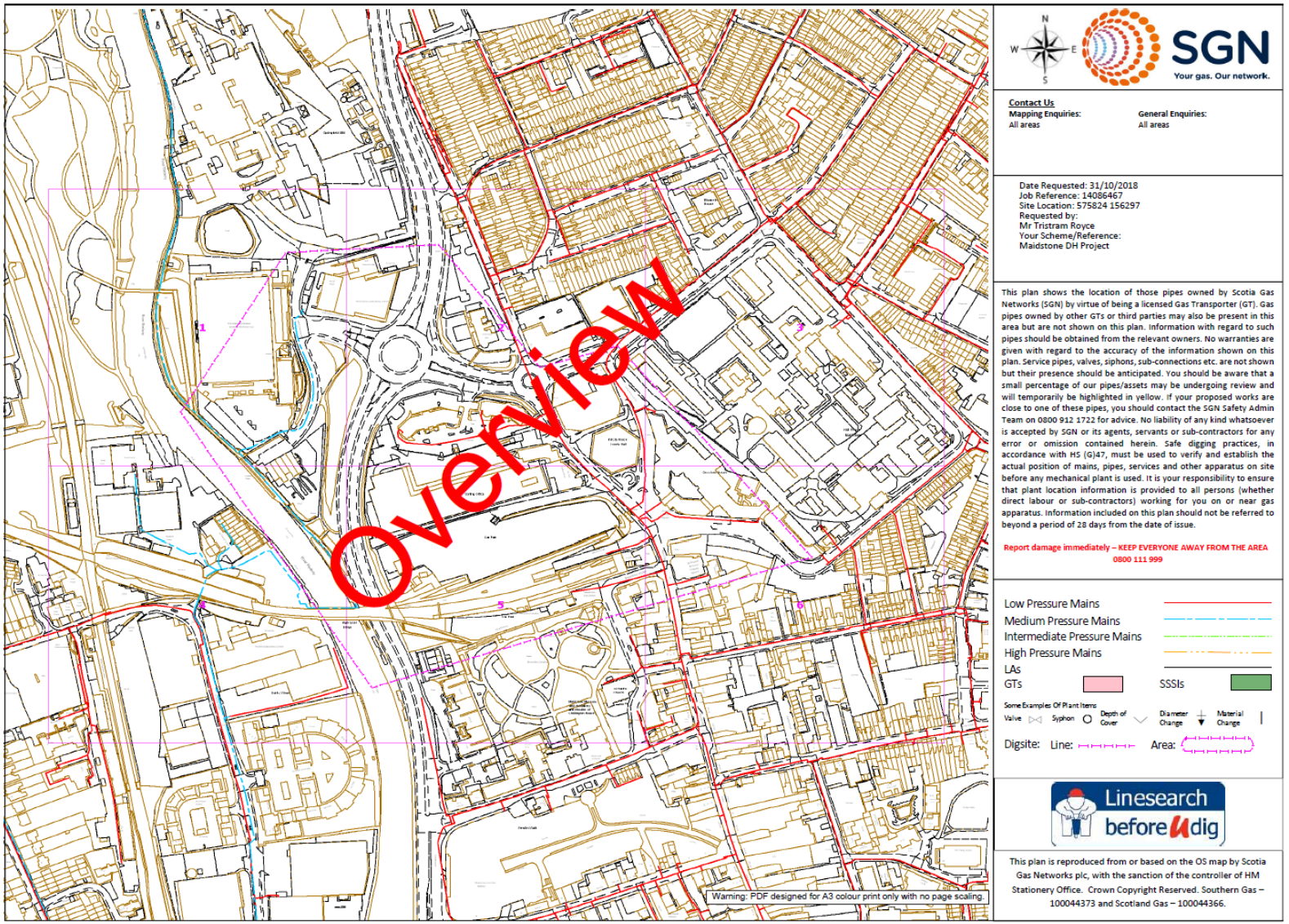

Figure 7: Gas infrastructure map used in appraisal of each site. Source: SGN, provided 2018.

Appendix D – RIBA 2 Design of EC Layout

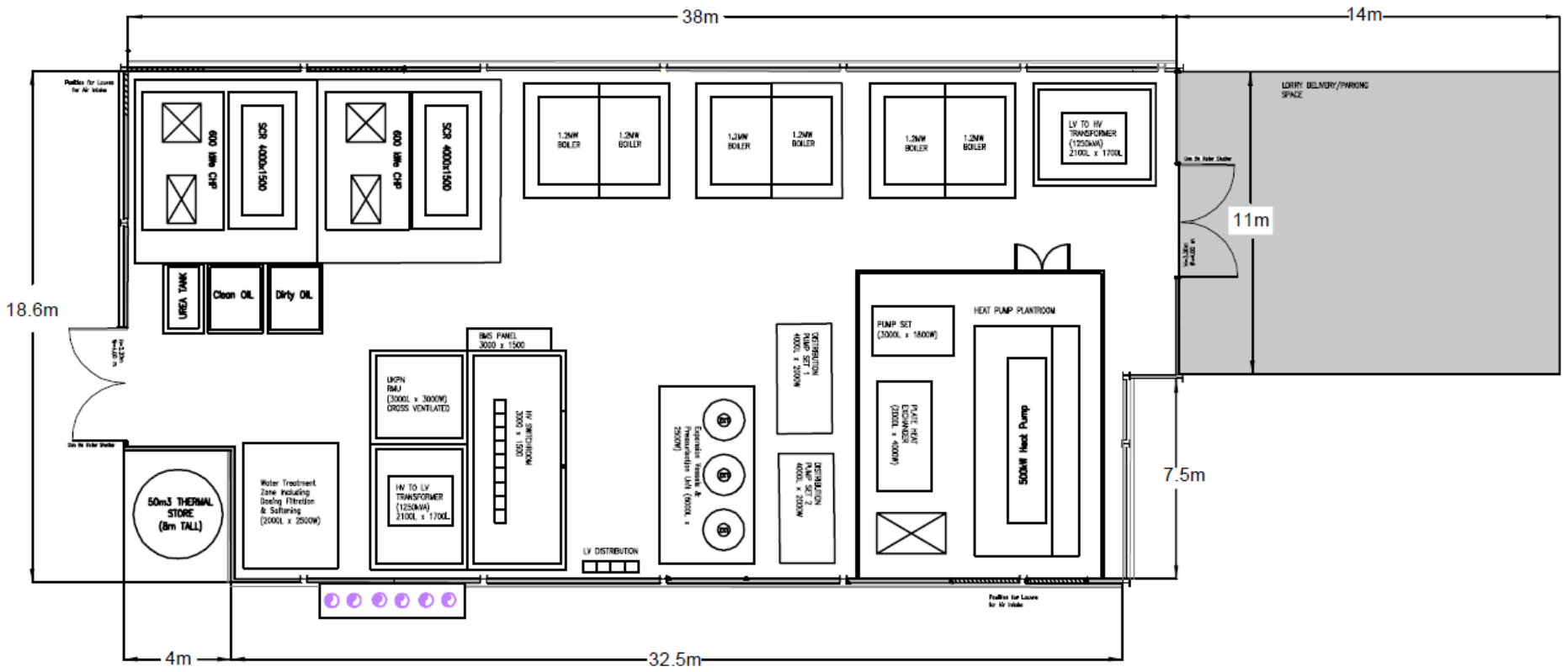

Figure 8: Proposed Energy Centre General Arrangement drawing.

Appendix E – River Water Abstraction Pumping Energy Calculation

When selecting the energy centre location, it is crucial to consider the pumping distance and the elevation of the energy centre location relative to the river water abstraction point. This section presents the methodology used to calculate the pumping power required to abstract water from the river and transport it to the energy centre locations identified and presented in the previous sections.

The pumping energy consumption calculation consists of the power required to pump the water upwards over a vertical distance and the power required to move the water horizontally through the pipe.

Horizontal pumping of the water requires power as a result of the pressure drop due to the friction in the pipe. The friction within the pipework were calculated using the Darcy-Weisbach equation. The Darcy-equation was essentially used to translate the horizontal pumping energy to an equivalent head loss [m], this was consequently added to the vertical distance to be pumped [m].

The following parameters were assumed for this calculation.

Table 2. Assumptions used in the pumping energy calculation

Parameter	Value	Unit
Nominal pipe size	150	mm
Absolute pipe roughness	0.007	mm
Max. allowable velocity	2	m/s
Estimated annual operating hours	4500	hours
Abstraction Temperature	11	DegC
Discharge Temperature	14	DegC
Pump Efficiency %	65.7%	%
Motor Efficiency %	88%	%

The table below shows the results of the pumping energy calculation for each potential energy centre location. The map in Appendix B shows the locations of three identified energy centre sites.

Table 3. Pumping Energy Calculation

Energy Centre	Total Pipe work Length [m]	Pumping House Elevation (relative to sea level) [m]	Total Flow Differential Head Loss (incl. head loss due to friction) [m]	Total Return Differential Head Loss (incl. head loss due to friction) [m]	Total Differential Head Loss (flow and return, incl. head loss due to friction) [m]	Total Differential Pressure [Pa]	Total Hydraulic Power Required [kW]	Estimated Annual Pumping Energy Consumption [kWh]
EC1	365	8	37.06	9.06	46.1	452,093	18.25	142,030
EC2	66	8	10.28	1.28	11.56	113,319	4.57	35,600
EC3	60	6	2.166	1.66	3.332	32,662	1.32	10,261

The estimated pumping energy consumption calculation takes into account the energy required to abstract the water from the river and to discharge it back. The annual pumping power is based around the assumption that the heat pump would operating for 4,500 hour per year and that the system would achieve a temperature difference between abstract and discharge of 3 DegC. EC1 requires the most pumping energy with approximately 142MWh per year, this is followed by EC2 with 35MWh per. EC3 requires the least energy pumbing with roughly 10MWh per year.

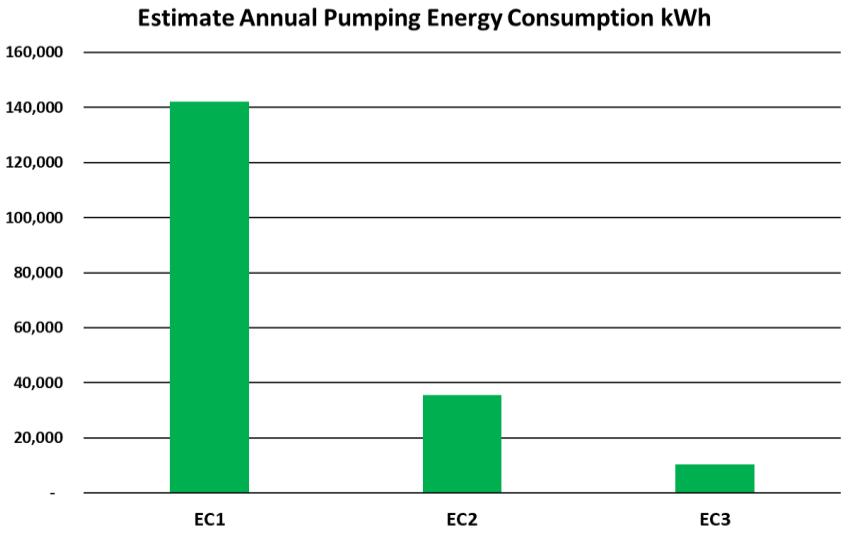

Figure 9: Estimated annual pumping power for each potential energy centre location

The pumping energy required is dependent on the system differential temperature. Wider temperature differences allow more heat energy to be carried through the pipework and require less pumping power. The graph below presents the relationship between the pumping energy and the differential temperature.

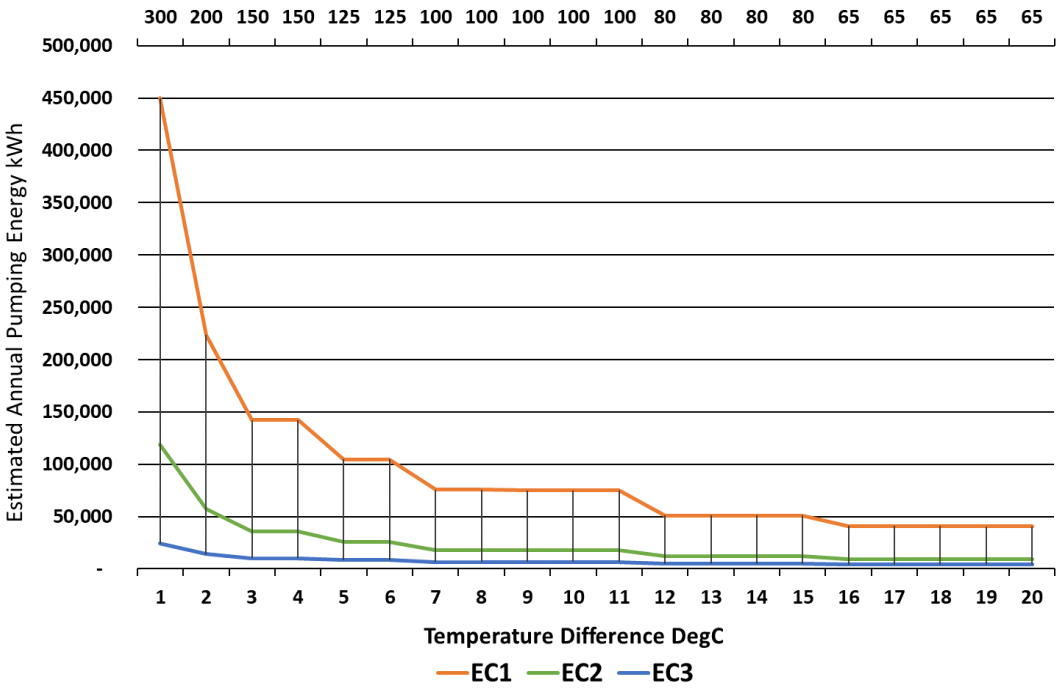

Figure 10: Relationship between temperature differential and estimated annual pumping energy (upper x-axis shows the nominal pipe size required for each temperature differential)