Donmar Warehouse
Appendix 1
February 2017

Haworth Tompkins

Appendix 1.1

Renewables Feasibility Report

SKELLY&COUCH

Donmar Warehouse Theatre Renewables Feasibility Study

Revision 2.0 - 01/02/2017 – Information

Project

1309 – Donmar Warehouse Theatre

On behalf of:

Donmar Warehouse Theatre

Skelly & Couch Ltd

Building Environmental & Services Engineering Consultants

www.skellyandcouch.com

Units 6-9 Union Wharf
23, Wenlock Road
London
N1 7SB

Contents

Audit History

Rev	Date of Issue	Status	Issued By	Checked By	Summary of Changes
2.0	**01/02/2017**	**Information**	**GD**	**SW**	**Planning**
1.0	13/09/2016	Information	GD	SW	Initial Issue

Executive Summary

Due to building and site constraints, few opportunities for utilizing renewable energy are feasible. Planning issues, neighbouring buildings, and space constraints mean than most types of commercially viable renewable energy installations cannot be installed on the site. This includes district heating, CHP, wind, biomass, and ground source heat pump.

A sun path model has shown that the proposed dormer roof area (approximately 31m^2) is most suitable for solar energy collection. This is the only area of the building's roof that receives adequate sunlight throughout the year.

Photovoltaic panels (PV) to generate electricity and solar thermal panels to generate heat both have a payback period less than 20 years and offset the carbon footprint of the building by approximately 4% and 6% respectively.

Access to maintain this roof mounted array would need to be considered to ensure that it could be safely maintained.

Another system that has been analysed in this study is a variable refrigerant flow (HVRF) system with a heat pump boiler. This has been sized to provide active cooling to all spaces with high process heat loads, and recovering and redistributing this heat to preheat the building's domestic hot water. Though the system is not strictly renewable and does not qualify for the RHI scheme, it reduces the buildings carbon footprint by approximately 7% and has a payback period of 15 years.

The recommended technologies to achieve this are therefore the VRF / heat pump boiler system and PV array due to their lower capital cost.

Introduction

Historically, the Government has supported the implementation of renewable energy generating technologies on non-commercial buildings by providing grants of up to 50% of the initial capital expenditure. In recent years however, this strategy has changed by withdrawing Government supported grants and replacing them with a longer term repayment mechanism based on the energy actually generated. These new schemes are called the 'Feed-in Tariffs' and the 'Renewable Heat Incentive'. The purpose of these schemes is to increase renewable demand and increase renewable production resulting in a capital cost decrease and ultimately a reduction in emissions.

Feed-In Tariffs

The government introduced feed-in tariffs and renewable heat Incentive payments for electricity production by renewable sources from April 2010. The payments are adjusted regularly in line with the changing economics of the various options, and due to wider political factors. These tariffs are for energy produced and are in addition to any export tariff that the user may agree with the electricity company should energy be fed back into the National Grid. They are paid irrespective or not of whether the energy is consumed on site or sold to the grid.

Where these rates are shown, the 'higher rate' prevails if neither of the following two conditions apply.

The 'lower rate' is payable where:

- The system provides power to a building, and the building does not have an EPC certificate showing its energy efficiency in bands A to D. (this may be the case at the Donmar as the Building Fabric is not new)
- There is multiple ownership of the building.

The 'medium rate' is payable where:

- The system owner has a total of 25 FIT-registered PV installations (this is not expected to be the case)

Feed-In Tariffs – From July 1st 2016

Technology	Scale (size of peak energy production in kilowatts)	Proposed Initial Tariff (p/kWh)	Duration (Years)
PV	4 – 10kW	4.25	20
Wind	<100kW	6.85	20
Micro-CHP	<2kW	13.45	To 2027

Renewable Heat Incentive

Since November 2011, the government has also introduced the Renewable Heat Incentive scheme for heat production by renewable or low carbon sources. Heat metering is required on all renewable heat installations.

Renewable Heat Incentive – From July 1st 2016

Technology	Scale (size of peak energy production in kilowatts of heat)	Initial Tariff (p/kWh)	Duration (Years)
Biomass	>1000kWt	2.27	20
Solar Thermal	<200kWt	10.28	20
Air Source Heat Pump	All	2.57	20
Ground Source Heat Pump	All	8.95	20

Building Energy Consumption

The existing theatre and surrounding buildings have been modelled using TAS thermal analysis software. This has resulted in the following building annual energy demands per fuel type:

	kWh/m^2/yr	kgCO_2/m^2/yr
Electrical	46.6	24.2
Fossil Thermal	96.9	20.9
Total	143.6	45.1

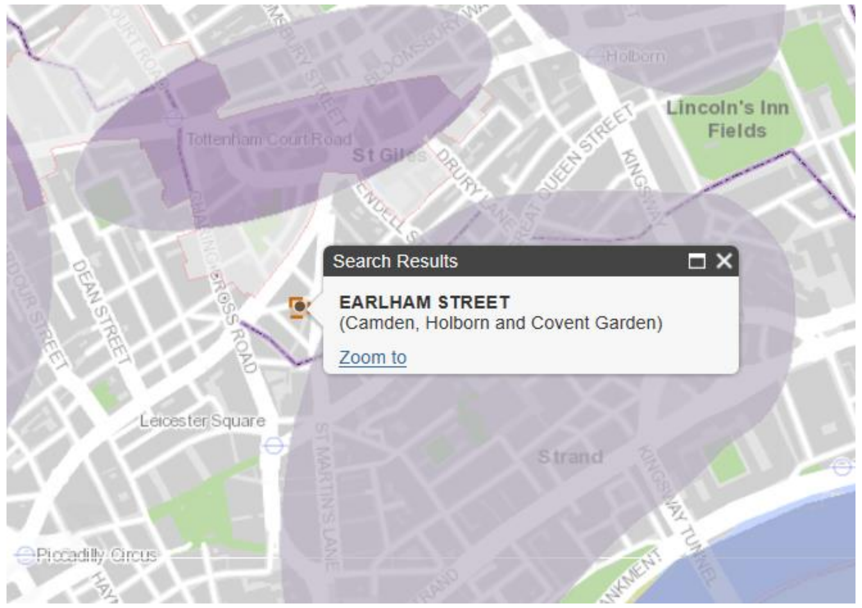
Decentralised Energy Networks and CHP

District Heating

The use of a centralised heating and domestic hot water system requires a central servicing strategy to provide the hot water and heating to each property within the network. This is usually termed district heating.

Connection to a district heating installation is preferred by the London Plan as it leads to more stable heating and cooling loads that can then enable combined heating and power, or combined cooling heating and power to become viable.

The London Heat Map reveals that there are no existing or proposed heat networks in place that could be used to serve this development.



Hence, for this project the connection to a district system is not feasible. In the future, Shaftesbury might be a suitable organisation to institute a district heating installation and the Donmar could connect onto their system. However, when Skelly and Couch proposed this to Shaftesbury they were not interested in pursuing it.

Combined Heat and Power (CHP)

In the absence of a feasible means of utilising a decentralised energy system, the option of an on-site Combined Heat and Power has been considered. This generates electricity and heat on-site from a generator from which heat is recovered and used in the building.

For an on-site CHP to be a viable means of providing heat to the proposed building, a relatively constant heat demand is required. This is because CHP engines run most efficiently when they don't have to vary their output.

For a CHP engine to be suitable for use in the proposed scheme, a base heating load must be established throughout the year. The proposed building is expected to have a low base domestic hot water load throughout the year. A small scale natural gas CHP engine, such as the ENER-G 4Y unit (with an 8kWth heat output) might otherwise have been an appropriate solution in this case, however due to the small daily peak hot water load that has been estimated at this stage that even the smallest unit available would be oversized which would negate the effectiveness of the system.

The impact of including a CHP engine sized to meet the estimated domestic hot water load has been assessed within the dynamic thermal simulation, to give an idea of the impact this has on the overall CO2 emissions of the development.

As set out in the previous section, in order for CHP to be viable the Donmar would need to connect to a larger heat network, such as if the Theatre was served from a heating system shared with the larger Shaftesbury development adjacent to the theatre.

Incentives for CHP

To encourage the use of CHP the government has put the following financial incentives in place:

- Exemption from the Climate Change Levy for all good quality CHP fuel inputs and electricity outputs.
- Eligibility for Enhanced Capital Allowances (ECAs) to stimulate investment
- Business rates exceptions for CHP power generation plant and machinery
- Reduced VAT on certain domestic micro-CHP installations, currently 5%
- Eligibility for Renewable Heat Incentive for the biomass or municipal waste e.g. incinerators fuelled CHP

In addition to this the Government is providing the following support through a regulatory framework:

- Changes to the licensing regime, benefiting smaller generators
- Ensuring fair and easy access to the grid for smaller generators
- Emphasising CHP benefits when reviewing or introducing new guidance for planning or sustainable development projects
- Revised guidance on power station consents applications, to ensure full consideration is given to CHP possibilities
- Looking into offering incentives for CHP projects under Carbon Emissions Reduction Targets (CERTs)
- Encouraging CHP through Building Regulations
- Addressing the administrative burdens for smaller generators and offering incentives for using distributed generation

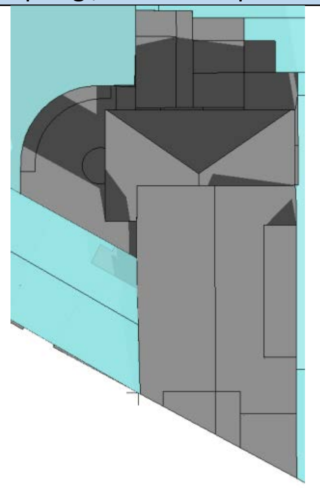
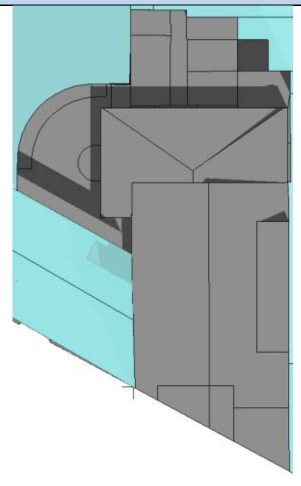
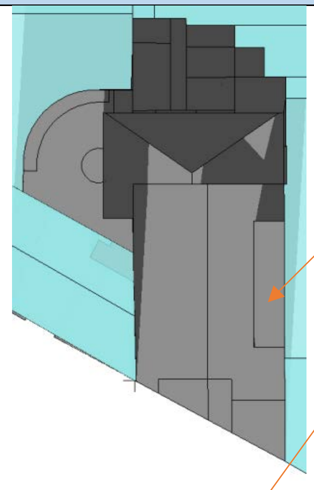
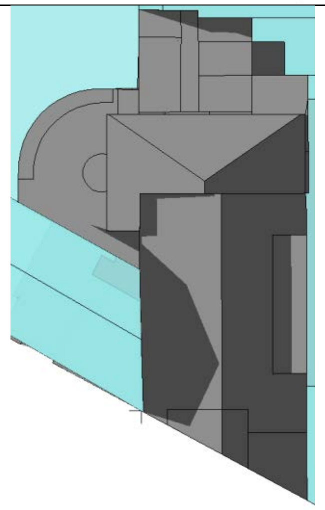
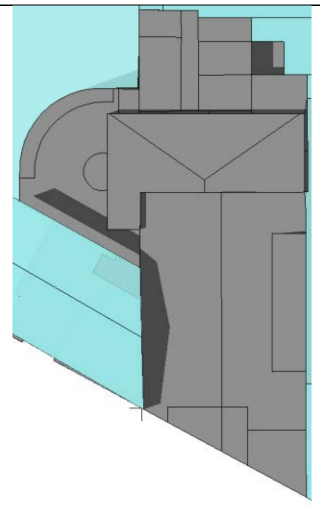
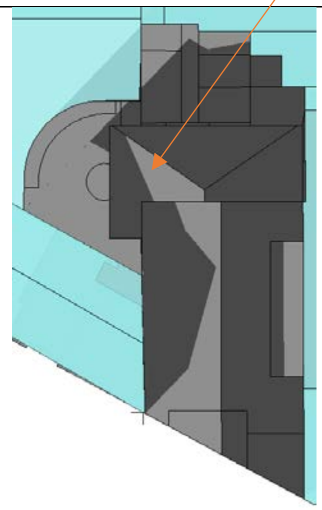
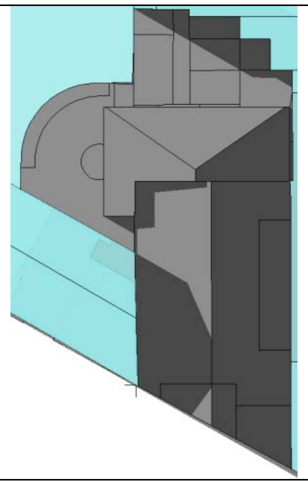
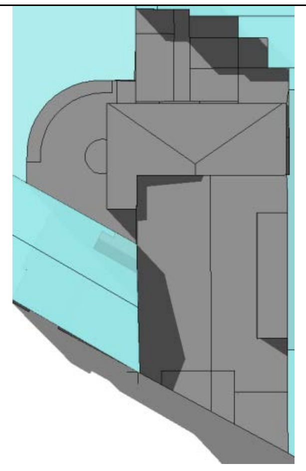
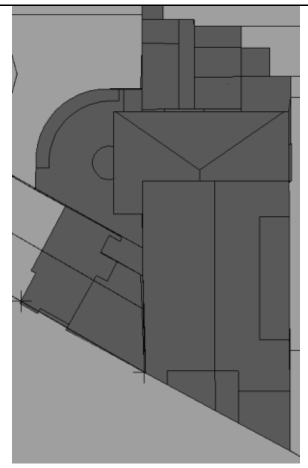
Application

- The building has a relatively low domestic hot water demand, which peaks over a short interval (during or after performances) – this is not very compatible with CHP engines, which perform better when there is a high, continuous hot water demand.
- The building's domestic hot water load is lower than required by the smallest CHP engines available on the market. Installing such a system is likely to reduce its efficiency.
- CHP engines are big. There is not likely to be a suitable location within the refurbished building.
- CHPs generate a lot of noise, which is likely to affect performances and neighbouring buildings.
- CHP technology is **NOT PROPOSED** for this building.

Low and Zero Carbon Technologies

Solar Energy

A sun path model of the theatre and surrounding buildings has been created to understand suitable roof areas for harvesting solar energy such as photovoltaics and solar thermal. Images of the model throughout the year are shown below:

	Spring / Autumn Equinox	Summer Solstice	Winter Solstice
9 am			
1 pm			
5 pm			

The adjacent images from the sun path model shows that the majority of the roof is heavily shaded during the autumn, winter, and spring seasons. Installing any solar energy generating equipment in shaded areas risks greatly reducing the system's efficiency.

The roof area most suitable for solar energy collection appears to be the proposed dormer, which is least shaded throughout the year, and is flat, thus allowing a higher density of energy generating equipment. This roof area is approximately 31.7m^2. Access to maintain installations must be considered carefully.

Another roof area which could potentially be utilized for solar energy collection is the East facing pitch of the proposed plant room roof. However, access and maintenance to this area would prove challenging, and given the east facing pitch, it is unlikely that a significant number of units could be installed in such a constrained area. Therefore this roof area has been excluded from the solar energy feasibility study at present.

Photovoltaic Panels

Photovoltaic panels (PV) generate electrical energy from sunlight. There are three main types of photovoltaic system available and some hybrid systems:

Monocrystalline Silicon Cells

- These are a single crystal of electronically pure silicon.
- They have high costs but also have a high efficiency (14 - 15%).
- These perform badly under part load and very badly if any part of the array becomes shaded.
- Cost approx. £400-£500/m^2

Polycrystalline Cells

- These are formed from shards of silicon cells.
- They are still efficient but are cheaper than monocrystalline cells.
- 12 – 13% efficiency.
- These perform badly under part load and the output from the whole array is greatly reduced if any part of the array becomes shaded.
- Cost approx. £300 - 400/m^2

Thin Film/Amorphous Cell

- These are formed by an amorphous layer of silicon being deposited on a substrate. This allows for the production of flexible/semi-transparent cells (solar transmittance is approx. 10%).
- Their efficiency is the worst of the silicon PV cell types and is typically in the region of 5%.
- Although their peak efficiencies are lower than the other two, the part load efficiency is good and shading only reduces the output on the part that is shaded.
- The yearly output is often the same as for the other two types depending on the site.
- They can be used as shades to stop glare and overheating in place of Brise Soleil or expensive high performance glazing.
- Cost approx. £300/m^2

The analysis has been based on the most expensive and efficient monocrystalline PV cells.

Inverters and protection devices are required to connect the PV panels to the building electrical distribution system. Any excess power may be transferred to the grid to generate extra income however it is not worth over sizing the system with this in mind as the price paid for exported power is lower than the cost of imported power and the cost of the meter.

Advantages

- Produces clean (pollution free) renewable electrical energy
- Can be high visibility, therefore excellent educational and PR value
- Once built the energy is virtually free.
- Mechanically simple, no moving parts, therefore low maintenance requirements and operating costs and long life
- Architecturally inoffensive if considered carefully
- High public acceptance
- May offset the cost of roof or cladding
- Modular in nature so easy to size appropriately and extend
- Easy to integrate with battery storage
- Good safety record
- Can be integrated into new or existing buildings

Disadvantages

- Need sunlight to work effectively, don't produce energy at night, and output is heavily reduced in overcast conditions
- Solar energy is not constant and is difficult to predict.
- May require planning permission in conservation areas such as here.
- There is a risk of future overshadowing
- PV cells produce DC electricity which must be converted to AC
- The efficiency drops as temperature rises
- Low-voltage output can be difficult to transmit
- There has historically been poor reliability of auxiliary (balance of system) components and storage devices, although this has largely been overcome.
- There are long paybacks as the installation is still relatively inefficient and expensive.
- Require large area compared to other technologies.
- Some materials used in the PV production process are toxic like cadmium and arsenic.
- Renewable technologies tend to require a high initial capital investment that often falls outside capital budgets.

Application

- The Dormer roof might support a 23 m^2 active array
- Capable of a 4% Carbon emission reduction
- 3,496 kWh generated per annum
- £4,570 capital cost expected
- Simple payback period of 9 years with FIT
- Sufficient roof area available.
- Photovoltaic technology is **RECOMMENDED** for this building.

Typical Roof Mounted Solar PV Array

Solar Thermal

Introduction

Solar thermal collectors use heat from the sun to warm up water, thus helping provide hot water for the building.

A conventional system uses a mains powered circulation pump to couple a hot water storage tank with the solar panels. The storage tank is placed inside the building, and thus requires a controller that measures when the water is hotter in the panels than in the tank.

Types of Solar Thermal Panels

Evacuated Tubes

Evacuated tube collectors are made of a series of modular tubes, mounted in parallel, whose number can be added to or reduced as hot water delivery needs change. This type of collector consists of rows of parallel transparent glass tubes, each of which contains an absorber tube (in place of the absorber plate to which metal tubes are attached in a flat-plate collector). The tubes are covered with a special light-modulating coating. In an evacuated tube collector, sunlight passing through an outer glass tube heats the absorber tube contained within it.

Evacuated tube panels are generally more expensive but suffer less with heat losses and are less affected by some parts of the panel being shaded and are therefore more efficient.

Panel Collectors

A flat plate collector consists of a thin absorber sheet (of thermally stable polymers, aluminum, steel or copper, to which a black or selective coating is applied) backed by a grid or coil of fluid tubing and placed in an insulated casing with a glass or polycarbonate cover.

Advantages

- Produces clean (pollution free) renewable heat energy
- High Recognisability, therefore excellent educational and PR value
- Once built the energy is virtually free to run.
- Low maintenance and operating costs
- High public acceptance
- Unobtrusive plumbing
- May offset the cost of roof or cladding
- Modular in nature so easy to size appropriately and extend
- Good safety record
- Can be integrated into new or existing buildings

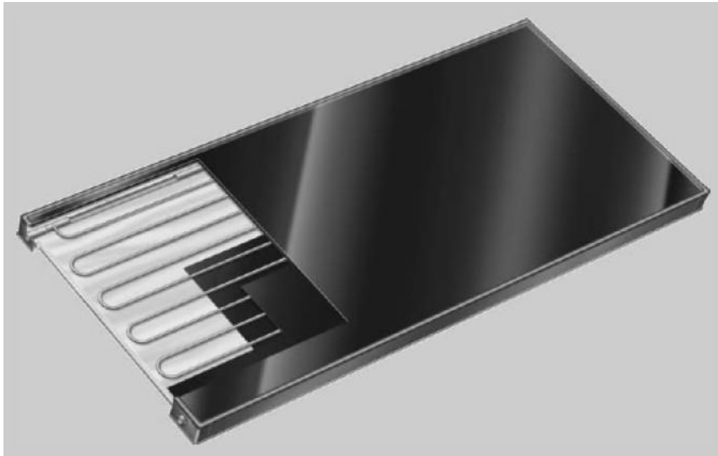
Disadvantages

- Need sunlight to work effectively, don't produce energy at night, and output reduced in overcast conditions
- Solar energy is not constant and is difficult to predict.
- May require planning permission in conservation areas
- Risk of future overshadowing
- Low grade heat produced
- Water may require softening
- Requires an electrical pump
- Storage is required, as the solar source does not often match the hot water requirement
- Limited by hot water demand in summer and hence carbon savings are small if the overall demand is low
- Can overheat in summer if not used e.g. summer dark periods
- They require large area compared to other technologies.
- Renewable technologies tend to require a high initial capital investment that often falls outside capital budgets.

Application

- A solar thermal array could provide a 6% Carbon emission reduction
- 12,600 kWh of heat might be generated per annum
- £20,500 capital cost expected
- 17 year simple payback with RHI
- The Heat energy produced by a small array would not be sufficient to export.
- Solar Thermal technology should be **CONSIDERED** for this building.

Typical Evacuated Tube Collector



Typical Flat Plate Collector

Wind Turbines

Introduction

A wind turbine harnesses the power of the wind to produce electricity. The power of the wind is proportional to the cube of the wind speed thus higher wind speeds significantly increase the power output.

The turbine rotor converts linear air movement to rotation, which drives a generator. The most common rotor design is for three blades mounted on a horizontal axis but many types are available:

Types of Wind Turbines

Wind turbines are available in a wide range of sizes, from large 'wind-farm' scale turbines to small domestic roof-mounted versions. The output of a turbine is proportional to the area swept by the rotor, and therefore to the square of rotor radius, so larger turbines can produce a lot more power.

Horizontal Axis Wind Turbines

Horizontal-axis wind turbines (HAWT) have the main rotor shaft and electrical generator at the top of a tower, and must be pointed into the wind. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator.

Since a tower produces turbulence behind it, the turbine is usually pointed upwind of the tower. Turbine blades are made stiff to prevent the blades from being pushed into the tower by high winds. Additionally, the blades are placed a considerable distance in front of the tower and are sometimes tilted up a small amount.

Vertical Axis Wind Turbines

Vertical-axis wind turbines (or VAWTs) have the main rotor shaft arranged vertically. Key advantages of this arrangement are that the turbine does not need to be pointed into the wind to be effective. This is an advantage on sites where the wind direction is highly variable. VAWTs can utilize winds from varying directions, and are thus able to deal with more turbulent conditions

The electricity generated can be used directly, stored in batteries or fed to the grid. The electricity may be sold to the grid when not used on site. The safety requirements are laid out in document G83 for small-scale turbines and G59 for larger scale.

Advantages

- Produces clean (pollution free) renewable electrical energy
- High visibility, therefore excellent educational and PR value
- It is relatively abundant (UK one of the windiest countries in Europe), plus it is windier in winter when demand is higher.
- Good payback periods where wind exposure is high and consistent
- Once built the energy is virtually free.
- Wind turbines come in many sizes, from small domestic turbines to large commercial turbines.
- Requires smaller area in plan per kWh of energy produced compared to most other renewable technologies, but more area than traditional power stations.

Disadvantages

- Considered by some to have a negative visual impact.
- A turbine would require Planning permission
- A turbine would generate noise which would be a challenge for the theatre to manage.
- Require negotiations with wildlife groups (birds and insects)
- Wind energy is not constant and is difficult to predict. Also the storage of energy is difficult.
- Wind energy is often better in more remote locations and is less appropriate in urban environments.
- Turbines can cause slight electromagnetic interference that can affect television or radio signals and other communications equipment if within the line of sight.
- Wind turbines require specialist maintenance that can be costly.
- The rotation of the turbine blades can cause shadow flicker
- Renewable technologies tend to require a high initial capital investment that often falls outside capital based build projects.
- Although the probability is small, there is a risk of catastrophic failure

Application

- Local planning restrictions would be expected to prevent a turbine from being installed.
- The urban local topography would create turbulence, greatly reducing the turbine's efficiency.
- There is no suitable location for a turbine structure.
- The noise generation might affect theatre performances.
- Wind turbines are **<u>NOT PROPOSED</u>** for this development.

Vertical Axis Wind Turbine

Ground Source Heat Pump

Introduction

Ground source heating involves extracting heat from the ground to heat the building, by circulating water through buried pipes. The length of the pipe depends on the buildings energy requirements.

The low grade heat extracted from the ground is passed through a heat pump, which provides high grade heat (in the form of hot water) to the building. The system can also be used in reverse to provide cooling in summer. By coupling the heat pump with the ground, a much higher Coefficient of Performance (COP) is achieved than the air coupled heat pumps commonly used in cooling systems.

The ground's temperature at around 2m deep remains at a steady 11°C. In the winter, this relatively high temperature can be taken advantage of as a heat source.

Heat pumps can be a very efficient way of obtaining heat. A typical COP is 3, which means for every kW of electricity used in the heat pump 3 kW of heat will be transferred to the building. The system must be designed to optimise the heat pump, best efficiencies for heat pumps are achieved when the difference in temperature between the heated water and the ground are lowest. Therefore heat pump technology is especially suited to low temperature heating systems such as under floor heating. A COP of 4 can be achieved where the required temperature is 35deg, but drops to 3 where the required temperature is 45deg.

There are four basic types of ground loop array or collector systems:

- Horizontal (slinky)
- Vertical
- Pond/Lake
- Open Loop

Three of these—horizontal, vertical, and pond/lake—are closed-loop systems. The fourth type of system is the open-loop option. Which one of these is best depends on the climate, soil conditions, available land, and local installation costs at the site. All of these approaches can be used for residential and commercial building applications.

Advantages

- Unobtrusive
- Despite using electricity (which has a higher carbon content than gas) their efficiency means that they are lower carbon emitters than gas boilers.
- There is the option of not providing gas or oil infrastructure to the building.
- If a reversible unit is used the heat pump can be used to provide both heating in the winter and cooling in the summer.
- The use of the low grade heat with either under-floor heating or warm air heaters mean that the plumbing is less obtrusive.
- The return from the heat pump can be used for free cooling in winter.

Disadvantages

- Low-grade heat is produced which means that heat emitters must be larger and hot water generation difficult.
- Boilers will normally still be required.
- Requires electrical energy, which is rising in cost and thus this affects paybacks
- Storage vessel is required, to prevent heat pump cycling too often.
- They are complex pieces of machinery and maintenance engineers are not as readily available as with boilers
- Maintenance costs are higher compared to boilers
- Water in closed loop circuits needs to contain glycol which is a hazardous substance.
- They can be noisy.
- They are not very visible and thus have limited marketing potential.

Application

- The site constraints and neighbouring buildings mean there is no suitable location for a horizontal or vertical ground array, or a suitable nearby water source that could be utilized.
- There are no proposed ground works within the project.
- The site is surrounded by neighbouring buildings, many of which are listed.
- GSHP technology is **NOT PROPOSED** for this building.

Illustrative example of Ground Source Heat Pump Arrangement

Air Source Heat Pumps

Introduction

Air-source heat pumps are similar in operation to ground-source heat pumps, except that heat is extracted from the external air rather than the ground. Air-source heat pumps are classified as either air-to-air or air-to-water depending on whether the heat distribution system in the building uses air or water.

It can extract heat from the air even when the outside temperature is as low as minus 15° C, albeit at reduced electrical efficiencies. Heat pumps have some impact on the environment as they need electricity to run, but the heat they extract from the air is constantly being renewed naturally and the electricity can be sustainably sourced.

Unlike gas boilers, heat pumps deliver heat at lower temperatures over much longer periods. This means that during the winter they may need to be left on longer to work effectively.

Types of Air Source Heat Pump

There are two main types of air source heat pump system:

- An air-to-water system distributes heat via the wet central heating system. Heat pumps work much more efficiently at a lower temperature than a standard boiler system would. So they are more suitable for underfloor heating systems or larger radiators, which give out heat at lower temperatures over longer periods of time.
- An air-to-water system distributes heat via the wet central heating system. Heat pumps work much more efficiently at a lower temperature than a standard boiler system would. So they are more suitable for underfloor heating systems or larger radiators, which give out heat at lower temperatures over longer periods of time.

Heat from the air is absorbed into a fluid which is pumped through a heat exchanger in the heat pump. Low grade heat is then extracted by the refrigeration system and, after passing through the heat pump compressor, is concentrated into a higher temperature useful heat capable of heating water for the heating and hot water circuits. For cooling, this cycle works in reverse.

Advantages

- A cheaper and more suitable option than ground source
- Compatible with cooling as well as heating. This makes the system much more efficient and more suitable here.
- Less risky than ground source systems
- No gas supply required, although the gas boilers still required would mean gas is still needed.
- No ground works required
- No local emissions
- Relatively long life

Disadvantages

- The COP must be 3 or better to be more efficient than a gas boiler. This means the external temperature needs to be above 10°C which only occurs 15% of the occupied period during the heating season.
- There can be noise issues
- There are lower rates on the RHI as it can barely be regarded as a renewable during the coldest periods.
- It uses significant amounts of electric if not operating at optimum conditions
- More suited to smaller installations where smaller loads and lower flow temperatures are acceptable
- Not well suited to AHU heating/cooling which requires high grade heat/coolth
- They are complex pieces of machinery and maintenance engineers are not as readily available as with boilers
- A storage vessel often required, to prevent heat pump cycling too often
- Often does not meet Planning requirements for carbon saving.

Performance issues

A potential downside of using air as a heat source is the heat pump's coefficient of performance (COP). During the heating season the outside air temperature is often less than the ground temperature (at a depth at which heat is extracted by a ground-source heat pump). This lower temperature has the effect of reducing the COP.

The relevant test standard for most packaged heat pumps is BS EN 14511. For an air-to-water heat pump the standard specifies test conditions of 7°C outdoor air temperature. At external air temperatures lower than this, the COP will fall, as will the heating output of the heat pump. Depending on the application this reduction may be significant, such as during a cold winter morning when building pre-heat is needed.

A further factor influencing the COP of a heat pump is the sink temperature. For an air-to-water heat pump BS EN 14511 specifies a return and flow temperature of 40°C and 45°C respectively.

At temperatures higher than these the COP (and heat output) will fall. This means that heat pumps, although potentially suited to low temperature heating systems (such as underfloor heating), have poor COPs when used with conventional hydronic heating systems with high circulation temperatures, such as 60oC or higher. High flow temperatures will result in a lower heat pump COP, while lower flow temperatures will require greater radiator surface area.

Test conditions (and hence manufacturers' quoted COP data) can therefore differ significantly from actual design and operating conditions.

Application

- Payback period greater than service life of the equipment.
- Noisy, large plant – no suitable location.
- Low COP
- This technology is **NOT PROPOSED** for space heating, but recovering the heat extracted from the building may be sensible, see below.

VRF Systems with Heat Pump Boilers

Introduction

Throughout the year, many buildings including the Theatre require cooling in some areas and heating in others – even in adjacent rooms. When a room requires cooling due to high process loads, the extracted heat could be recovered and redistributed to other parts of the building where it may then be utilized for space heating or domestic hot water pre heating.

A variable refrigerant flow system uses separate indoor units to move energy around the building for maximum efficiency, as well as a branch controller and single heat recovery outdoor unit. Chilled or LTHW pipes feed to each indoor unit, while two refrigerant pipes feed from the branch controller to the outdoor unit. The system operates under the same principle as a ground source heat pump or air source heat pump, but absorbs heat from active areas of the building and emits it to other areas.

The heat recovered from overheating spaces (eg the dimmer room) can be transferred into stored domestic hot water in the same way, with an indoor unit which redistributes the heat. This would involve installing a heat pump boiler and a matched hot water cylinder to store the heat until it was required.

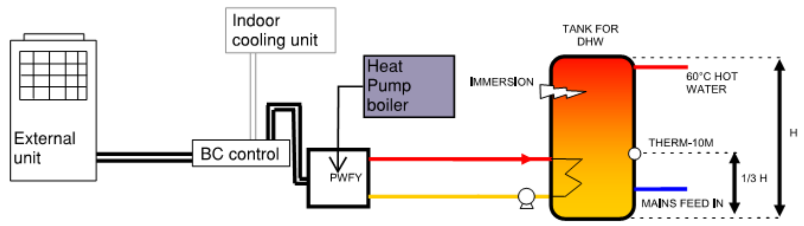
The heat pump boiler / variable refrigerant flow system is a relatively new technology, and does not yet qualify for the RHI scheme, mainly because the heat source is not necessarily renewable. Nevertheless, it has been included in this report because of its potential for energy / building operational cost reduction.

Advantages

- Provides the active cooling already required while recovering and redistributing otherwise wasted heat to where it is needed.
- No ground works required, simple unobtrusive installation
- Compact equipment, most of which is a prerequisite for active cooling.

Disadvantages

- Not recognised as a source of renewable energy as it relies on active process loads within the building to redistribute heat.
- Does not qualify for the RHI or FIT schemes.
- There is a potentially noisy outdoor unit, but this would be needed for the cooling system in any case.



VRF System with Heat Pump Boiler Schematic

Application

- Several spaces within the building have continuous process loads and therefore require active cooling: The office, wardrobe, laundry, and dimmer room. These spaces have a peak cooling load of 25.4kW.
- The indoor cooling units serving these spaces could be connected to a BC controller, and reject the unwanted heat to a heat pump boiler to pre heat domestic hot water before it is heated to required temperature within the main calorifier. When the heat is not useful it would be rejected to outside as usual.
- This would preheat the incoming water from approximately 10°C to 45C, before it would be pumped into a hot water calorifier, thus reducing the heat required to heat hot water, and therefore the annual hot water energy consumption.
- Additional heat would still be required to ensure that the water was hot enough to use, this would be via gas or electric heating in the same manner as existing. If this option were pursued we would assess the relative benefits of local electric domestic hot water generation against the alternative of a central gas- fired electrical hot water calorifier. Gas fired energy would retain as much electrical capacity as possible for production purposes.
- Weekly pasteurisation cycles would be needed to ensure that the system remained safe, in the same way that is done with other calorifiers. Again, this might be done with electrical energy.
- We estimate a 7% reduction in the buildings carbon emissions, through a saving on gas consumed.
- Worst case payback period of 21 years.
- £7,000 capital cost.
- Heat recovery to a heat pump boiler is <u>**PROPOSED**</u> for this building.

Biomass

Introduction

Biomass refers to living or recently living biological material which can be used to fuel energy production. Biomass can consist of wood products or non-wood products which include bio-degradable. Biomass can only be considered as a renewable energy if it comes from a sustainable source.

You can convert biomass into useful electricity or heat using generator and boiler technologies. The electricity generating technologies associated with biomass are still relatively unproven and unavailable at this scale, therefore in this section Will focus on burning biomass to create heat.

Types of Biomass Fuel

In the case of a city location, virgin wood (from forestry, arboriculture activities or from wood processing) or industrial waste (from manufacturing processes) are the only suitable types of biomass fuel. This will come in the form of wood chips or wood processed wood pellets.

Wood pellets have more advantages than the wood chips. However the cost of wood pellet is 0.05 £/kWh; the cost of wood chip is roughly 0.021 £/kWh while the cost of gas is only 0.017 £/kWh. The price of fuel often dependent on local supply chain and is often subject to fluctuations.

Theatres can generate significant volumes of scrap wood from old sets; the recovery of this wood for use in a biomass boiler has been examined recently by Skelly and Couch for a different theatre and the use of set timber was considered for the stoves installed at Dryden Street. However, the processing of the old sets is time consuming and the amount of suitable wood that can be salvaged once paint and other finishes are removed does not make the process financially viable.

Biomass fuel can be burnt in specially designed boilers to provide heat to cover the base heating load throughout the year. Poor responsiveness to meet fluctuating loads means that it is preferable to use biomass boilers as part of a hybrid multiple boiler installation, with gas boilers to take up the rest of the load.

Biomass is a very effective way to reduce carbon emissions when considering just capital cost, but the client would need to be aware of and committed to the extra work required in the daily and yearly running of the plant. Biomass also requires a large amount of maintenance and management.

The supply chain is difficult to control and subject to change over the life of the installation, this is key to the operation and success of the scheme and is likely to require significant time and effort. The difficulties in setting up the supply chain could prove prohibitive to a biomass scheme.

The additional space required for the plant and to store the fuel can end up being a significant extra cost pushing up the initial outlay and lengthening the payback time.

Advantages

- Lower carbon emission, when compared to fossil fuels, as carbon absorbed when re-growing balances the carbon used.
- Coppiced plantations can actually absorb more carbon dioxide than mature trees - since carbon dioxide absorption slows once a tree nears maturity.
- Fewer nutrients from the soil are required compared with other food crops.
- The crop's root structure can absorb contamination from soil.
- Recycled biomass reduces waste to landfill.
- There is the option of not providing gas or oil infrastructure to the building.
- Low initial capital cost
- Possible increased afforestation

Disadvantages

- Requires wood fuel, which can be more expensive than gas, thus biomass boiler often never pay for themselves. Also Biomass fuel prices can fluctuate depending on availability.
- The supply of the fuel is subject to availability. Thus a large storage facility can be used to combat the unpredictability of the supply chain, but large deliveries less feasible in dense urban areas.
- Deliveries have a carbon impact, so local supply better. This is not compatible with the location.
- Planning issues due to increased transport and local air quality degradation. Air quality concerns would be likely to prevent biomass being installed here.
- Biomass boilers require regular maintenance. Thus maintenance contracts with the suppliers will have to be considered.
- A buffer vessel is required, to prevent boiler cycling.
- The NOx emissions of Biomass boilers are higher than gas boilers
- The 0.5-5% ash content by mass created by burning the fuel will have to be disposed of.

Application

- The Payback period is greater than service life of the equipment
- Biomass is not considered suitable for this site given its urban location and the issues associated with additional traffic and pollution.
- A large biomass store required which is not feasible given the site constraints.
- The boiler requires large, frequent fuel orders, which would be logistically challenging and expensive given congestion charges in the city.
- Biomass boilers are **NOT PROPOSED** for this building.

Section of Hopper Fed Biomass Boiler

Summary and Recommendations

A sun path analysis has shown that the majority of the building is poorly shaded by neighbouring building. The new dormer roof appears to be the most suitable location for solar energy collection.

Photovoltaic panels to the new dormer roof could be installed to provide a 4% CO2 offset. This will require an active array of 23 m^2, which leaves 13 m^2 for access and maintenance. The PV array will have an approximate capital cost of £4,570, with a payback period of 9 years.

The building modelling process has shown that several of the building's spaces will require active cooling units to deal with process heat loads. Energy recovery from this cooling could be delivered to a heat pump boiler to provide domestic hot water heating. Though not included in the renewable heat incentive scheme, this technology will provide a 7% CO2 offset and cost approximately £7,000 – which will be paid back through gas savings over a 21 year period. This is however a worst case estimate, the actual payback is likely to be shorter.

The proposed technologies should provide a combined 10% - 11% energy offset approx. (to be confirmed through further modelling). This is not strictly in accordance with London Plan limitations on acceptable technology as heat recovery to provide DHW is not included as a renewable technology. The estimated total cost of this would be £9,570 and the payback would be estimated to be 15 years.

Appendix 1.2
Noise Impact Assessment

Report No:
Donmar Warehouse Noise Impact Assessment 01022017

Date:
01/02/2017

For:
Haworth Tompkins Architects

Report Title:

DONMAR WAREHOUSE

NOISE IMPACT ASSESSMENT

By:
Gillieron Scott Acoustic Design
Studio 3
130 Brixton Hill
London SW2 1RS

t - 020 8671 2223
e - info@gsacoustics.org
w - www.gsacoustics.org

REVISION SCHEDULE

Document Revision	Date	Document Title	Details	Prepared by	Approved by
00	03/10/2016	Donmar Warehouse Environmental Survey Results 03102016	DRAFT FOR COMMENT	Nitin Katiyar N. Katiyar 03/10/2016	Tim Scott 03/10/2016
01	30/01/2017	Donmar Warehouse Noise Impact Assessment 30012017	DRAFT FOR COMMENT	Nitin Katiyar N. Katiyar 30/01/2017	Tim Scott 30/01/2017
02	01/02/2017	Donmar Warehouse Noise Impact Assessment 01022017	ISSUED	Nitin Katiyar N. Katiyar 01/02/2017	Tim Scott 01/02/2017

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Introduction

Donmar Warehouse is a small not-for-profit theatre, located adjacent to Seven Dials, on Earlham Street within the London Borough of Camden. The theatre is undergoing refurbishment works which include the replacement of old externally mounted services equipment and the introduction of new unit(s). Gillieron Scott Acoustic Design (GSAD) have been commissioned to undertake a plant noise impact assessment in line with the Local Authority's adopted noise policy.

GSAD have undertaken a background noise survey from 1300 Friday 8th July to 1445 Monday 11th July 2016 at a single fixed monitoring location that was positioned 1m from the nearest residential window.

It is assumed operational hours of any newly proposed externally mounted plant items will be daytime hours only 0700-2300.

Calculations demonstrating plant noise levels reaching any residential dwelling comply with the London Borough of Camden's adopted noise policy will be undertaken once the full schedule of plant and locations are finalised.

The site location, plant area and nearest residential receptors are indicated in Appendices A, B and C.

1.0 Brief

- Undertake noise measurements at a fixed monitoring location over an extended period of time;

- Undertake weather measurements;

- Identify noise sensitive dwellings located in the vicinity of the site and assess the topography of the intervening ground;

- Analyse the site-acquired data and determine the appropriate criteria to adopt from the London Borough of Camden Council's noise policy.

- Using representative measured data from the survey and manufacturer's data for the proposed items of plant where possible, verify the impact of the development, to satisfy Local Authority's noise policy.

- Provide a technical report detailing findings of the noise survey.

2.0 Context

Donmar Warehouse is located in Earlham Street, adjacent to the Seven Dials in the London Borough of Camden. Buildings surrounding the theatre are largely commercial in nature, however, two residential properties have been identified which have view of the existing partially enclosed plant area on the roof of the building which serves the theatre.

The theatres existing plant area is enclosed from all four sides with an open roof to allow sufficient air flow to service the units. Residential receptors do not have line of sight to any of the units within this plant area.

Numerous third party plant items are located in the immediate area. The most prominent third party item is a kitchen extract which belongs to the Flesh and Buns restaurant, vents to atmosphere at high level and is in continuous operation during their opening hours.

The acoustic environment at the residential receptors located near Donmar Warehouse is relatively quiet given their central London location and sources of noise include road traffic and air traffic noise, sirens, building works near and far, noise from theatre performances and externally mounted services equipment, both third party and from the theatre.

Subjectively, when the theatre's services equipment is switched off, the dominant source of noise that defines the immediate acoustic environment at local residential dwellings is from the kitchen extract servicing the Flesh and Buns restaurant.

3.0 Summary

A background noise survey was undertaken from 1300 Friday 8th July to 1445 Monday 11th July 2016 at a single fixed monitoring location positioned adjacent to the worst case residential façade.

It was noted while installing the environmental noise survey that numerous third party plant items were located in close proximity to the Donmar Warehouse and would operate intermittently.

Care was taken in selecting a microphone position that afforded the greatest amount of acoustic screening from third party plant items.

The hours of operation for new items of plant replacing existing items of plant servicing Donmar Warehouse will remain unchanged as 0700-2300 hours.

Using methodology outlined in BS4142: 2014, a representative background sound level of 50 dB $L_{A90,15min}$ has been determined over the proposed operational hours.

Noise from mechanical ventilation with all plant operating shall be designed to satisfy the relevant statutory criteria at 1m from the façade of any noise sensitive properties in accordance with Camden Council's requirements and BS4142 'Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'. These noise criteria will be used in all attenuator calculations, once plant is selected.

The site location, measurement position and measured results are presented in the following Sections and Appendices.

4.0 Plant Noise Assessment Criteria

The London Borough of Camden Council's standard noise policy requires an assessment in line with British Standard BS4142: 2014 and DP28 to be undertaken. BS4142: 2014 is the most suitable assessment methodology for assessing the potential impact of plant noise on any local residents.

BS4142: 2014 provides methods for rating and assessing industrial and commercial sound. The standard is used to rate sound from fixed installations. The standard requires a "Specific Sound Level", in terms of L_{Aeq}, is determined either by measurement or calculation at a receptor location. This Specific Sound Level may then be corrected for the character of sound and is then termed the "Rating Level".

Once the Rating Level has been determined, the background sound level is subtracted from it and the greater the difference, the greater the likelihood of an 'adverse impact'. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact. The standard advocates that each site and situation should take the context of the scenario into consideration and that "not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact".

The standard provides reference periods over which the assessment should take place which have been reproduced in the table below.

Table 1 – Reference Periods

Period	Hours	Assessment Period
Typical Daytime	0700 – 2300	1 hour assessment period
Typical Night-time	2300 – 0700	15 minute assessment period

5.0 Survey Details and Results

A background noise survey was undertaken from 1300 Friday 8th July to 1445 Monday 11th July 2016 at a single fixed monitoring location that was suspended approximately 1.5m from the nearest residential window.

The levels were recorded as A-weighted and octave band L_{eq}, L_{max} and L_{90}. The clock on the sound level meter was synchronised to the correct time before deployment. The meter was then set to integrate sound levels over 15-minute periods in synchronisation mode.

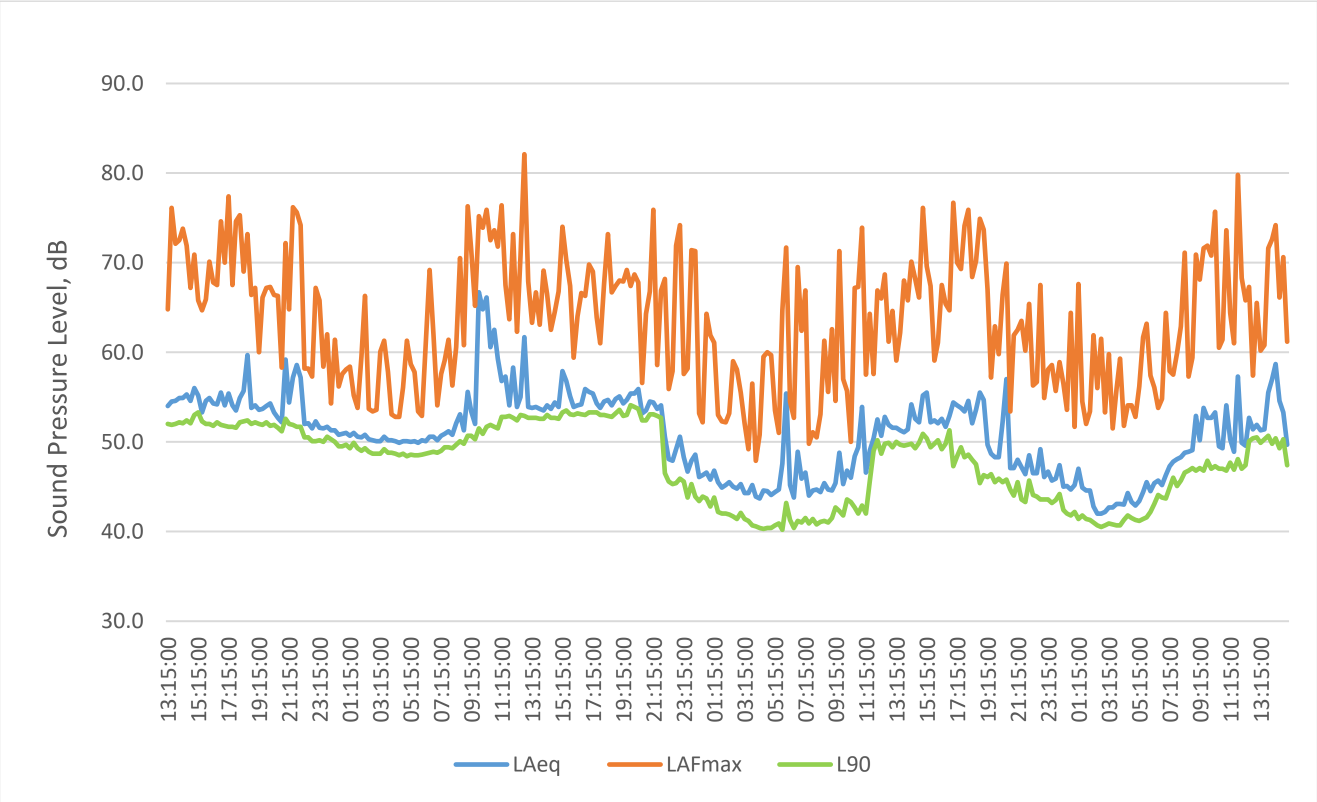
The measurement position was located between the theatre's rooftop plant area and the nearest noise sensitive residential dwelling. The microphone was positioned approximately 1m from the worst affected window of this receptor. The microphone position is shown in Appendices B and C.

The equipment was calibrated at the beginning and end of the survey period and no drift in calibration was noted.

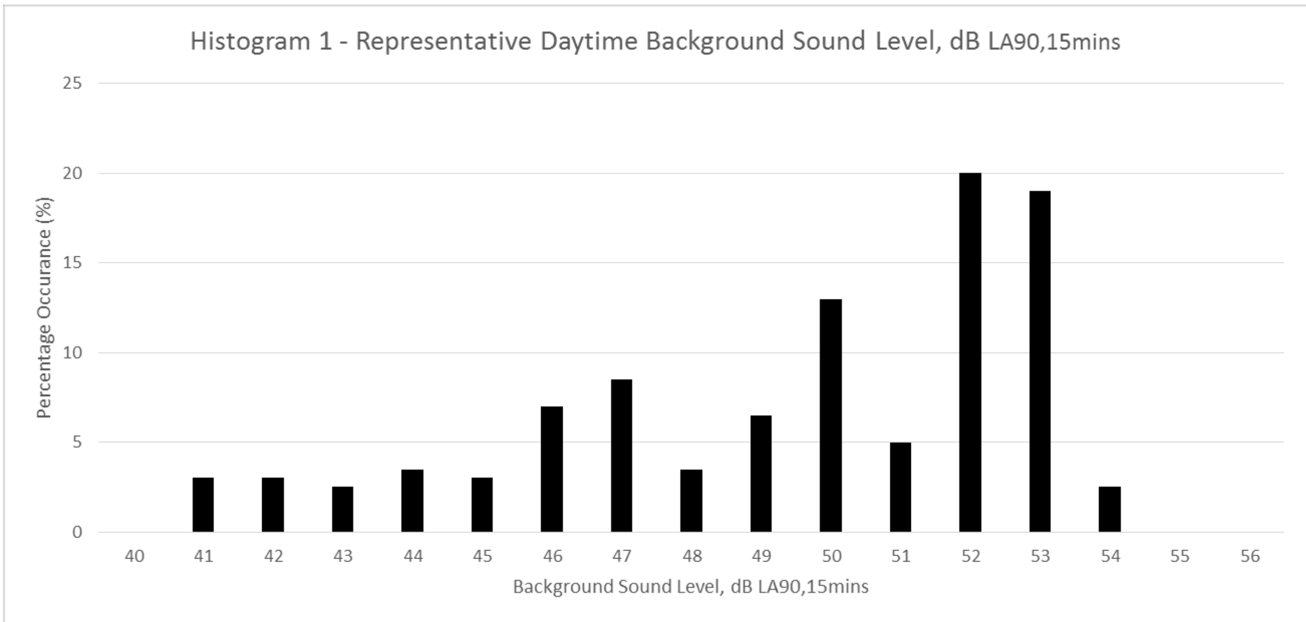
An automatic logging weather station was deployed as part of the assessment to ensure all data used in the detmination of the representative background sound level occurred during conditions that are considered conducive to acoustic measurement. Weather data is presented in Appendix E.

Full survey results to one decimal place are presented in the Appendix. A graphical representation of the results is presented below.

Noise Time History – Donmar Warehouse



Logged background sound levels over proposed operational hours, 0700-2300, have been plotted in the histogram below to determine the representative daytime L_{A90}.



From the above histogram, a representative daytime background sound level of 50 dB $L_{A90,15min}$ has been determined. This background sound level will be used in the assessment of noise from plant items in the following section.

6.0 Plant Noise Assessment

The full schedule of proposed plant items and their associated manufacturer noise levels have not been finalised, therefore, a detailed plant noise impact assessment that shows the method by which the council's criteria will be met will be carried out once the full schedule of plant is known.

The proposed externally mounted air condenser unit(s) serving the Theatre will operate between 0700-2300 hours and a representative daytime background sound level of 50 dB $L_{A90,\ 15min}$ will be used to assess noise from proposed externally mounted units once the full schedule of plant and their locations are finalised.

All inlets/outlets and breakout noise from plant will be attenuated to meet Camden Council's planning conditions.

7.0 Statement of Competence

The assessment has been undertaken by the author of this report: Nitin Katiyar BSc (Hons), AMIOA, an acoustic consultant with Gillieron Scott Acoustic Design with 5 years' experience since completing the Institute of Acoustics PG Diploma in Acoustics and Noise Control. The author of this report has undertaken numerous assessments according to the 1997 revision of the British Standard and twelve or more assessments according to the most recent 2014 revision of the Standard.

The assessment has been checked by: Tim Scott BSc (Hons.), MIOA a senior acoustic consultant with Gillieron Scott Acoustic Design with 15+ years' experience since completing a degree in Audio Technology at the University of Salford in the late 1990's. The author of this report has undertaken numerous assessments according to the 1997 revision of the British Standard and the most recent 2014 revision of the Standard.

8.0 Conclusion

Donmar Warehouse is undergoing refurbishment works which include the replacement of old externally mounted services equipment and the introduction of new unit(s). GSAD has undertaken a background noise survey at the site and the survey results are presented within this report.

A representative background sound level of 50 dB $L_{A90,15min}$ has been determined over the proposed operational hours of the plant items, 0700-2300.

When specifying new items of plant the following will be assessed in detail once final plant selections have been made and locations are known.

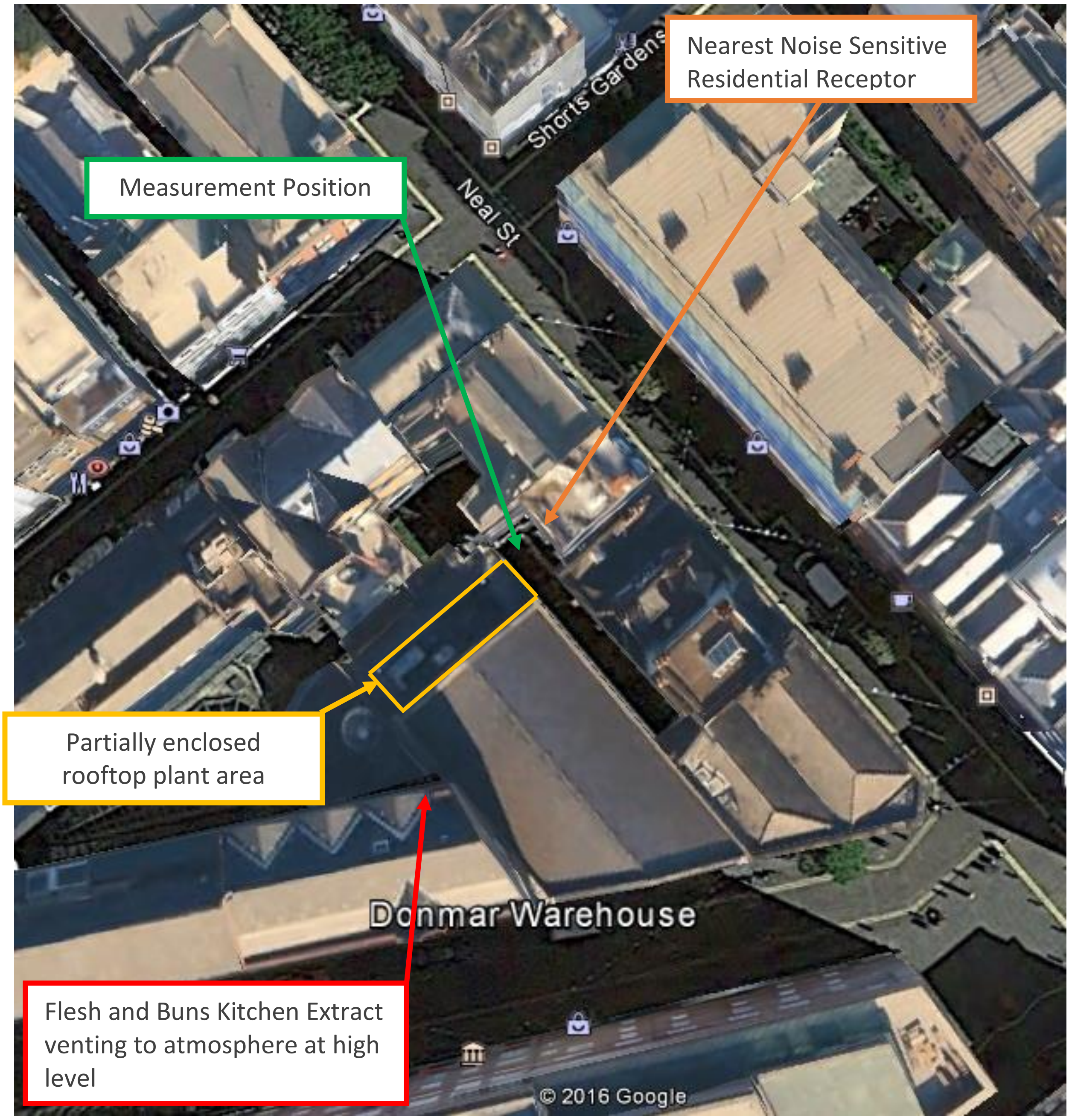
- The distance between the proposed plant and the nearest noise sensitive windows
- Operational hours of the plant
- Number of plant items
- Location of plant
- Proposed plant noise levels
- Calculations for the predicted noise level at the window of the nearest sensitive property
- Predictions showing that noise levels outside the nearest noise sensitive windows will satisfy the relevant criteria
- Details of proposed mitigation measures including calculations and product datasheets where applicable.

APPENDICES

GILLIERON SCOTT
ACOUSTIC DESIGN

APPENDIX A: Site Demise

APPENDIX B: Measurement Position, Receptor Location & Rooftop Plant Area



APPENDIX C: Measurement Position Photograph

APPENDIX D: Survey Results

Date	Time	L_{Aeq}	L_{AFmax}	L_{AF90}
08/07/2016	13:15:00	54.0	64.8	52.0
08/07/2016	13:30:00	54.5	76.1	51.9
08/07/2016	13:45:00	54.6	72.1	52.0
08/07/2016	14:00:00	54.9	72.5	52.2
08/07/2016	14:15:00	54.9	73.8	52.1
08/07/2016	14:30:00	55.3	71.9	52.4
08/07/2016	14:45:00	54.6	67.2	52.1
08/07/2016	15:00:00	56.0	70.9	53.0
08/07/2016	15:15:00	55.2	65.8	53.3
08/07/2016	15:30:00	53.3	64.7	52.3
08/07/2016	15:45:00	54.6	65.9	52.0
08/07/2016	16:00:00	54.9	70.1	52.0
08/07/2016	16:15:00	54.3	67.8	51.8
08/07/2016	16:30:00	54.2	67.5	52.2
08/07/2016	16:45:00	55.5	74.6	51.9
08/07/2016	17:00:00	54.1	70.0	51.8
08/07/2016	17:15:00	55.4	77.4	51.7
08/07/2016	17:30:00	54.1	67.5	51.7
08/07/2016	17:45:00	53.5	74.6	51.6
08/07/2016	18:00:00	54.9	75.3	52.2
08/07/2016	18:15:00	55.7	69.0	52.3
08/07/2016	18:30:00	59.7	73.2	52.4
08/07/2016	18:45:00	53.8	66.4	52.0
08/07/2016	19:00:00	54.1	67.2	52.2
08/07/2016	19:15:00	53.6	60.0	52.0
08/07/2016	19:30:00	53.7	66.1	51.9
08/07/2016	19:45:00	54.0	67.2	52.2
08/07/2016	20:00:00	54.3	67.3	51.8
08/07/2016	20:15:00	53.3	66.4	51.9
08/07/2016	20:30:00	52.7	66.3	51.6
08/07/2016	20:45:00	52.2	58.3	51.2
08/07/2016	21:00:00	59.2	72.2	52.6
08/07/2016	21:15:00	54.4	64.8	52.0
08/07/2016	21:30:00	57.2	76.2	51.9
08/07/2016	21:45:00	58.6	75.6	51.7
08/07/2016	22:00:00	57.2	74.2	51.7
08/07/2016	22:15:00	52.0	58.2	50.5
08/07/2016	22:30:00	52.1	58.2	50.5
08/07/2016	22:45:00	51.5	57.3	50.1
08/07/2016	23:00:00	52.3	67.2	50.1
08/07/2016	23:15:00	51.6	65.8	50.2
08/07/2016	23:30:00	51.5	58.4	50.0

Date	Time	L_{Aeq}	L_{AFmax}	L_{AF90}
08/07/2016	23:45:00	51.7	62.0	50.6
09/07/2016	00:00:00	51.3	54.3	50.3
09/07/2016	00:15:00	51.3	61.4	50.0
09/07/2016	00:30:00	50.8	56.2	49.5
09/07/2016	00:45:00	50.9	57.6	49.5
09/07/2016	01:00:00	51.0	58.1	49.7
09/07/2016	01:15:00	50.7	58.4	49.3
09/07/2016	01:30:00	51.0	55.2	49.9
09/07/2016	01:45:00	50.6	53.8	49.3
09/07/2016	02:00:00	50.5	59.5	49.0
09/07/2016	02:15:00	50.8	66.3	49.3
09/07/2016	02:30:00	50.3	53.7	48.9
09/07/2016	02:45:00	50.2	53.4	48.7
09/07/2016	03:00:00	50.1	53.6	48.7
09/07/2016	03:15:00	50.1	60.1	48.7
09/07/2016	03:30:00	50.6	61.3	49.2
09/07/2016	03:45:00	50.2	57.8	48.8
09/07/2016	04:00:00	50.2	53.1	48.8
09/07/2016	04:15:00	50.1	52.8	48.7
09/07/2016	04:30:00	49.9	52.8	48.5
09/07/2016	04:45:00	50.1	56.1	48.7
09/07/2016	05:00:00	50.1	61.3	48.4
09/07/2016	05:15:00	50.0	58.7	48.6
09/07/2016	05:30:00	50.1	57.8	48.5
09/07/2016	05:45:00	49.9	53.4	48.5
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09/07/2016	07:15:00	50.7	57.6	49.0
09/07/2016	07:30:00	50.9	59.1	49.4
09/07/2016	07:45:00	51.2	61.4	49.4
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09/07/2016	08:30:00	53.1	70.5	50.1
09/07/2016	08:45:00	51.3	60.8	49.8
09/07/2016	09:00:00	55.6	76.3	50.7
09/07/2016	09:15:00	53.4	71.4	50.7
09/07/2016	09:30:00	52.0	65.2	50.3
09/07/2016	09:45:00	66.7	75.2	51.5
09/07/2016	10:00:00	64.8	73.9	50.9
09/07/2016	10:15:00	66.1	75.9	51.7
09/07/2016	10:30:00	60.6	72.5	51.9

Date	Time	L_{Aeq}	L_{AFmax}	L_{AF90}
09/07/2016	10:45:00	62.5	73.6	51.7
09/07/2016	11:00:00	59.3	71.8	51.5
09/07/2016	11:15:00	56.8	76.4	52.8
09/07/2016	11:30:00	57.3	67.5	52.8
09/07/2016	11:45:00	54.1	63.7	52.9
09/07/2016	12:00:00	58.3	73.2	52.7
09/07/2016	12:15:00	53.9	62.3	52.4
09/07/2016	12:30:00	55.0	70.8	53.0
09/07/2016	12:45:00	61.7	82.1	52.9
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09/07/2016	13:15:00	53.8	63.3	52.7
09/07/2016	13:30:00	53.9	66.7	52.7
09/07/2016	13:45:00	53.7	63.1	52.6
09/07/2016	14:00:00	53.5	69.1	52.6
09/07/2016	14:15:00	54.1	66.5	53.0
09/07/2016	14:30:00	53.7	62.5	52.7
09/07/2016	14:45:00	54.4	64.5	52.7
09/07/2016	15:00:00	53.9	66.8	52.6
09/07/2016	15:15:00	57.9	74.0	53.3
09/07/2016	15:30:00	56.8	70.3	53.5
09/07/2016	15:45:00	55.1	67.4	53.1
09/07/2016	16:00:00	53.9	59.4	53.0
09/07/2016	16:15:00	54.1	64.0	53.2
09/07/2016	16:30:00	54.2	66.6	53.1
09/07/2016	16:45:00	55.9	66.3	53.0
09/07/2016	17:00:00	55.6	69.8	53.3
09/07/2016	17:15:00	55.4	69.0	53.3
09/07/2016	17:30:00	54.3	63.9	53.3
09/07/2016	17:45:00	53.8	61.0	53.0
09/07/2016	18:00:00	54.5	67.6	53.0
09/07/2016	18:15:00	54.7	73.2	52.9
09/07/2016	18:30:00	54.1	66.7	52.8
09/07/2016	18:45:00	54.8	67.4	53.2
09/07/2016	19:00:00	55.1	68.0	53.6
09/07/2016	19:15:00	54.3	67.9	52.9
09/07/2016	19:30:00	54.7	69.2	53.0
09/07/2016	19:45:00	55.4	67.4	54.1
09/07/2016	20:00:00	55.4	68.7	53.9
09/07/2016	20:15:00	55.9	67.8	53.7
09/07/2016	20:30:00	53.2	56.6	52.4
09/07/2016	20:45:00	53.5	64.3	52.4
09/07/2016	21:00:00	54.5	66.8	53.1
09/07/2016	21:15:00	54.4	75.9	53.1
09/07/2016	21:30:00	53.7	58.6	52.9

Date	Time	L_{Aeq}	L_{AFmax}	L_{AF90}
09/07/2016	21:45:00	54.1	66.9	52.7
09/07/2016	22:00:00	50.6	68.2	46.5
09/07/2016	22:15:00	48.1	55.9	45.6
09/07/2016	22:30:00	47.9	57.9	45.3
09/07/2016	22:45:00	49.2	71.9	45.4
09/07/2016	23:00:00	50.6	74.2	45.9
09/07/2016	23:15:00	48.3	57.6	45.6
09/07/2016	23:30:00	46.7	58.2	43.8
09/07/2016	23:45:00	47.9	71.4	45.3
10/07/2016	00:00:00	48.6	71.3	43.9
10/07/2016	00:15:00	46.1	53.2	43.4
10/07/2016	00:30:00	46.3	52.2	43.9
10/07/2016	00:45:00	46.6	64.3	43.7
10/07/2016	01:00:00	45.8	61.9	42.8
10/07/2016	01:15:00	46.8	61.1	43.8
10/07/2016	01:30:00	45.5	53.0	42.2
10/07/2016	01:45:00	44.9	52.3	42.0
10/07/2016	02:00:00	45.2	52.2	42.0
10/07/2016	02:15:00	45.5	53.2	41.9
10/07/2016	02:30:00	45.0	59.0	41.7
10/07/2016	02:45:00	44.8	58.1	41.4
10/07/2016	03:00:00	45.3	55.5	42.1
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10/07/2016	03:30:00	44.3	49.2	41.2
10/07/2016	03:45:00	45.2	56.5	40.7
10/07/2016	04:00:00	43.9	47.9	40.6
10/07/2016	04:15:00	43.7	50.8	40.4
10/07/2016	04:30:00	44.6	59.5	40.3
10/07/2016	04:45:00	44.5	60.0	40.4
10/07/2016	05:00:00	44.1	59.7	40.4
10/07/2016	05:15:00	44.4	53.5	40.7
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10/07/2016	07:30:00	44.0	49.8	40.9
10/07/2016	07:45:00	44.6	51.1	41.4
10/07/2016	08:00:00	44.7	50.5	40.8
10/07/2016	08:15:00	44.4	53.1	41.1
10/07/2016	08:30:00	45.4	61.3	41.2

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10/07/2016	11:00:00	53.9	73.9	42.9
10/07/2016	11:15:00	46.6	57.5	42.0
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11/07/2016	00:00:00	47.4	58.9	44.2
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11/07/2016	07:15:00	47.3	57.9	44.9
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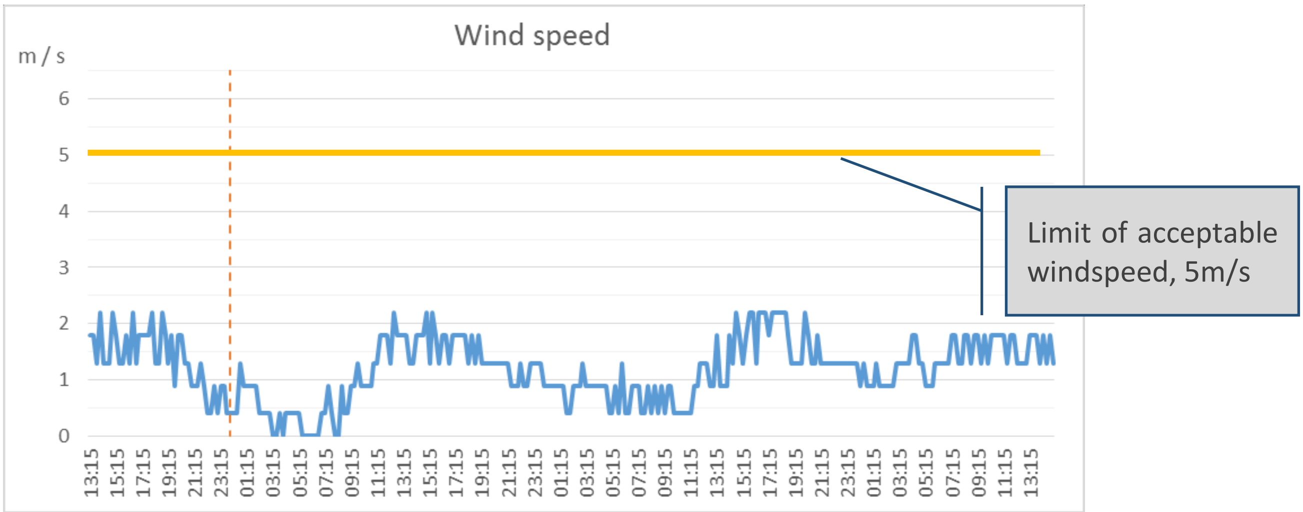
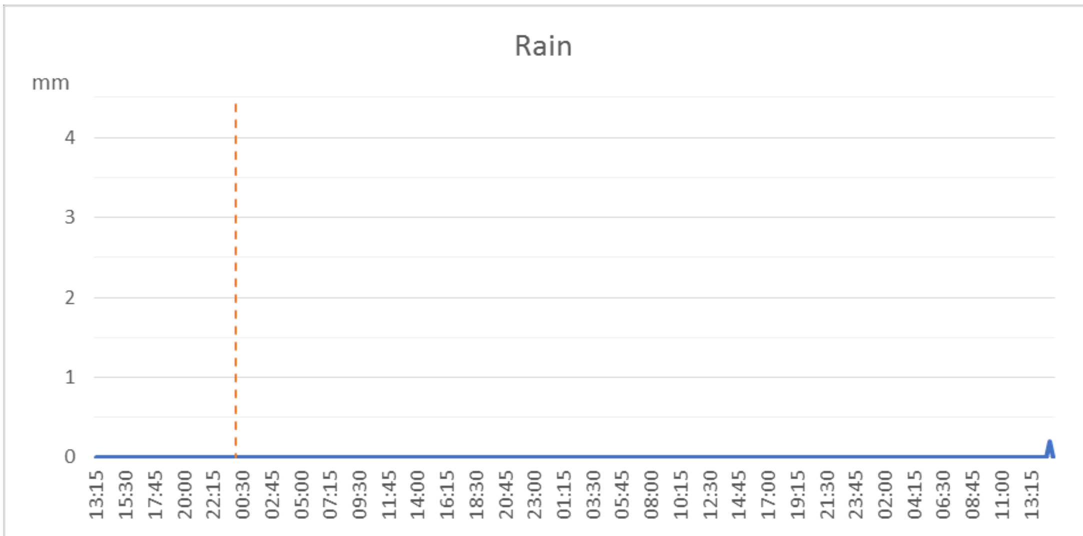
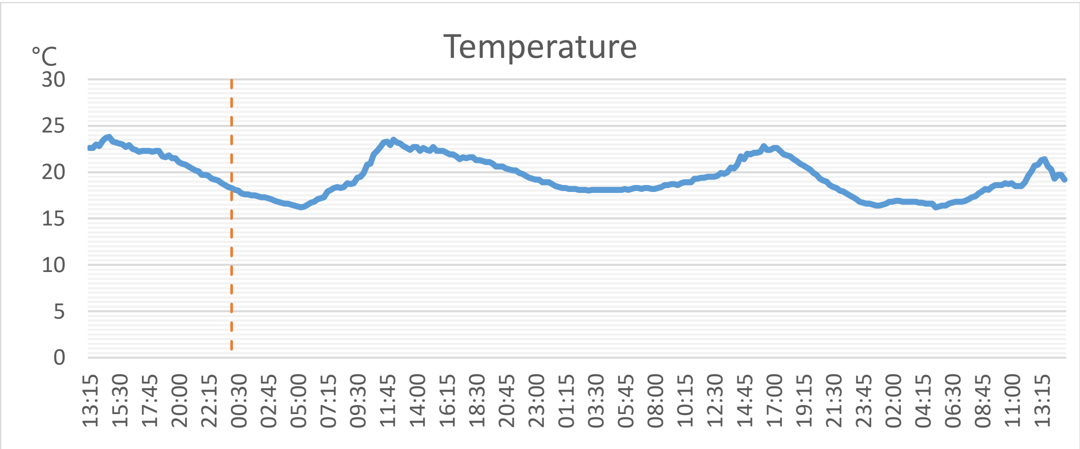
11/07/2016	11:45:00	57.3	79.8	48.1
11/07/2016	12:00:00	49.9	68.3	47.0
11/07/2016	12:15:00	49.6	65.8	47.4
11/07/2016	12:30:00	52.7	67.3	50.1
11/07/2016	12:45:00	51.4	57.4	50.4
11/07/2016	13:00:00	51.9	65.5	50.5
11/07/2016	13:15:00	51.3	60.2	49.9
11/07/2016	13:30:00	51.4	60.8	50.3
11/07/2016	13:45:00	55.5	71.6	50.7
11/07/2016	14:00:00	57.0	72.6	49.8
11/07/2016	14:15:00	58.7	74.2	50.4
11/07/2016	14:30:00	54.6	66.1	49.3
11/07/2016	14:45:00	53.3	70.6	50.3
11/07/2016	14:55:42	49.7	61.2	47.4

APPENDIX E: Weather Data





No rainfall logged during the measurement time interval



APPENDIX F: Camden Development Policy 28 – Noise and Vibration

Table E, Page 133, *"Camden Development Policies 2010-2015"*

Table E: Noise levels from plant and machinery at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise at 1 metre external to sensitive façade where LA90>60dB	Day, evening and night	0000-2400	55dBL_{Aeq}

APPENDIX G: Glossary of Acoustic Terms

DECIBEL (dB) - A unit of sound pressure measurement
Sound Pressure Level in dB (Lp) = 20 log (Measured sound pressure/Reference sound pressure = 20 µPa)

dB(A) - The A -weighted sound pressure level, the weighting network reduces low frequency sound in a similar way to the human ear.

REVERBERATION TIME (RT or T) – decay of sound in rooms
The time taken for a sound, once terminated, to fall through 60dB i.e. to one millionth of its original sound intensity. T30 – RT for first 30dB of decay. RT_{500} - Mid frequency RT.
HERTZ (Hz) - a unit of frequency measurement. The normal range of hearing is from 20Hz to about 15kHz.

ABSORPTION COEFFICIENT – degree to which a material absorbs sound.
The ratio of absorbed to incident sound energy (perfect absorber = 1)

SOUND REDUCTION INDEX R – quantity which describes a material's ability to reduce the sound pressure level across it (e.g. a wall or floor)

$R = L1 – L2 + 10\log (S/A)$

L1 - Average sound pressure level in source room (averaged from 100 Hz – 3150 Hz)
L2 - Average sound pressure level in receiving room (averaged from 100 Hz – 3150 Hz)
S – Wall Area (m^2)
A – Total absorption in receiving room (m^2 units)

Rw – weighted sound reduction index

AVERAGE ROOM TO ROOM LEVEL DIFFERENCE – D, dB = L1 – L2, averaged 1/3 octave bands from 100Hz – 3150kHz.

Dw – weighted value of D (usually 2 - 3dB higher)

DnT, w – Dw corrected for reverberation time of receiving room

NOISE RATING CURVES (NR CURVES) – set of curves used to describe optimum background noise levels for different tasks.

L10/90 LEVEL (dB) - The level in dB of a time varying sound pressured level (e.g. traffic) exceeded for 10%/90% of the time of measurement.
L90 is usually called the BACKGROUND NOISE LEVEL.

Leq AVERAGE SOUND PRESSURE LEVEL – level dB of a time varying sound pressure level with equal amounts of energy above and below it, for the time of measurement.

TONAL NOISE – noise of a single frequency (or a narrow band of frequencies that can be perceived as a tone), audible above the broad band noise background. Noise which is at least 5dB above the average of the 1/3 octave band sound pressure levels immediately on either side of it.

Appendix 1.3

Daylight, Sunlight and Overshadowing Report

DAYLIGHT, SUNLIGHT & OVERSHADOWING

Donmar Warehouse Theatre

Produced by XCO2 for Haworth Tompkins

October 2016

XCO2
17-18 Hayward's Place
London EC1R 0EQ

+44 (0)20 7700 1000
mail@xco2.com
xco2.com

CONTENTS

Remarks	draft						
Prepared by	MS						
Checked by	KM						
Authorised by	RM						
Date	28/10/16						
Project reference	8.815						

EXECUTIVE SUMMARY

The daylight, sunlight and overshadowing analysis indicates that there will not be a significant impact on surrounding properties arising from the proposed refurbishment and dormer extension at Donmar Warehouse Theatre.

Daylight and Sunlight analysis was carried out for the proposed refurbishment and dormer extension at Donmar Warehouse Theatre, located within the London Borough of Camden. This report outlines the results of the analysis for the planning application, assessing the daylight and sunlight impacts on surrounding developments.

The methodology set out in this report is in accordance with BRE's "Site Layout Planning for Daylight and Sunlight, A Guide to Good Practice" by PJ Littlefair (2011) which is accepted as good practice by Planning Authorities.

The following assessments were carried out:

- Daylight: 25 Degree Line
- Daylight: Vertical Sky Component
- Daylight: No Sky Line
- Sunlight: Sunlight Access
- Sunlight: Sunlight Overshadowing

Computer modelling software was used to carry out the assessments. The model used was based on drawings and a 3D model provided by the design team in October 2016, together with desktop research on neighbouring properties.

DAYLIGHT ASSESSMENT

A total of 74 windows from buildings surrounding the site were highlighted as being in close proximity to, and facing the proposed scheme.

Daylighting levels for potentially affected windows of surrounding developments by the proposed refurbishment and dormer extension at Donmar Warehouse Theatre were found to be acceptable.

In summary,

- 13 out of 74 windows achieved VSCs greater than 27%;
- 57 of the remaining 61 windows achieved relative VSCs over 0.8 of their former values
- 3 of the remaining windows were found to meet the no skyline test;
- 1 remaining window was found to achieve relative VSC and no skyline tests marginally below the BRE daylight access criteria.

The majority of the windows were found to display adequate daylight values in line with the BRE criteria for daylight, given the constrained nature of the given context. Where transgressions of the guidance occur, the windows retain levels that are consistent with the levels normally seen in dense urban locations. Hence, the proposed refurbishment and dormer extension is not anticipated to have a notable impact on the daylight received by neighbouring properties.

SUNLIGHT ASSESSMENT

A total of 55 south-facing windows from buildings surrounding the site were assessed for sunlight access. The analysis indicated the 51 windows satisfied the BRE criteria for annual probable sunlight hours (APSH) and winter probable sunlight hours (WPSH).

The majority of the windows were found to display adequate sunlight values in line with the BRE criteria, taking into account the constrained nature of the context. Where transgressions of the guidance occur, the windows retain levels that are consistent with the levels normally seen in dense urban locations.

Hence, the proposed refurbishment and dormer extension at Donmar Warehouse Theatre will not have a significant impact on the sunlight access to the windows of the neighbouring properties.

OVERSHADOWING ASSESSMENT

A solar access analysis was undertaken for two amenity spaces for on the 21st of March. The amenity spaces are not affected by the proposed refurbishment and dormer extension and receive no less than 0.8 times the sunlight received in the existing case on March 21, hence satisfying the BRE criteria for overshadowing.

The proposed refurbishment and dormer extension is therefore not considered to have a significant impact on sunlight access to the amenity spaces surrounding the site.

Table 1: Daylight results summary

Number of windows tested	**74**
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	13
Number of windows with a VSC of at least 0.8 of existing value	57
Number of windows that belong to rooms meeting the NSL test	3
Number of windows that do not meet any of the above criteria	1

Table 2: Sunlight results summary

Total number of windows facing within 90° of south	**55**
Number of south facing windows passing the 25°/45° initial test	0
Number of south facing windows with APSH greater than 25% and WPSH greater than 5%, or of at least 0.8 of their former existing value	49
Number of south facing windows with less than 4% reduction in annual sunlight	2
Number of windows that do not meet any of the above criteria	4

INTRODUCTION

The site is located in a dense urban environment and the interpretation of the results requires careful consideration of the BRE guidance.

This report assesses the daylight, sunlight and overshadowing impacts the proposed extension at Donmar Warehouse Theatre may have on the existing properties and open spaces surrounding the site.

The approach is based on the BRE's "*Site Layout Planning for daylight and sunlight, a Guide to good practice*" PJ Littlefair 2011, which is generally accepted as good practice by Town and Country Planning authorities.

It should be noted that although the numerical values stated by the BRE provide useful guidance to designers, consultants and planning officials, these are purely advisory and may vary depending on context. Dense urban areas, for example, may often experience greater site constraints when compared to low-rise suburban areas, and thus a high degree of obstruction is often unavoidable. Appendix F of the BRE document is dedicated to the use of alternative values and it also demonstrates the manner in which the criteria for skylight was determined for the summary given above, i.e. the need for 27% vertical sky component for adequate daylighting.

This figure of 27% was achieved using the following methodology: a theoretical road was created with two storey terraced houses upon either side, approximately twelve metres apart. The houses have windows at ground and first floor level, and a pitched roof with a central ridge. Thereafter, a reference point was taken at the centre of a ground floor window of one of the properties and a line was drawn from this point to the central ridge of the property on the other side of the road.

The angle of this line equated to 25 degrees (the 25 degrees referred to in the summaries given with reference to the criteria for skylight). This 25-degree line obstructs 13% of the totally unobstructed sky available, leaving a resultant figure of 27% which is deemed to give adequate daylighting. This figure of 27% is the recommended criteria referred to in this report. It will be readily appreciated that in a dense urban setting such as the current proposal, this kind of urban form and setting is unlikely and impractical.

Furthermore, the BRE guidance also focuses on 'relative change' which is likely to be exaggerated given close proximity of the existing structures on site to the neighbouring buildings. Where there is more than a 20% reduction in VSC, this does not mean that the level of daylight will be unacceptable but, rather, that there may be a noticeable change in daylight levels to the occupants.

Therefore, it is important to take into account that, although the 27% VSC target is the standard criterion available, it is not fully applicable to the development and that a lower VSC target is acceptable.

SITE

The proposed extension is part of the refurbishment plan of the roof top enclosure and dormer extension of the Donmar Warehouse Theatre, located at Earlham Street, within the London borough of Camden.

Site analysis was carried out to identify any potential daylight and sunlight impacts on the surrounding development. Relevant properties tested in this report adjacent to the proposed development are annotated in the figure below.

The following neighbouring buildings were tested in detail:

- 25A Neal Street
- 27 Neal Street
- 29 Neal Street
- 31 Neal Street
- 33 Neal Street
- 35-37 Neal Street
- Buildings on Shorts Gardens
- Buildings on Earlham Street

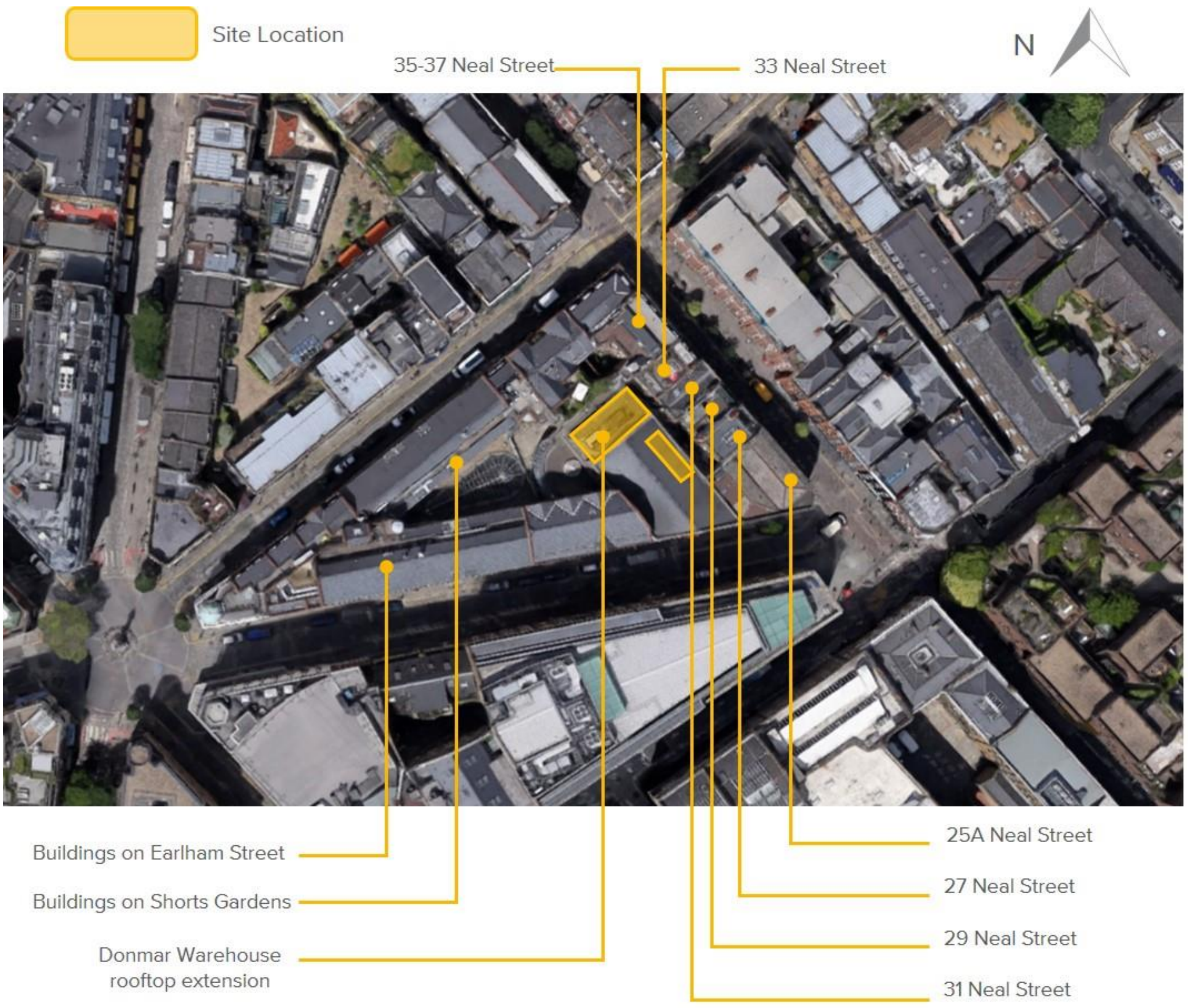


Figure 1: Site location and neighbouring buildings assessed

METHODOLOGY

The assessment is based on guidelines set out in the BRE "Site Layout Planning for Daylight and Sunlight, A Guide to Good Practice" (2011).

DAYLIGHT

DAYLIGHT TO SURROUNDING WINDOWS

A plane is drawn at 25 degrees from the horizontal, at the centre of an existing window. If the new development intersects with this plane, the internal daylight levels of the surrounding windows may be reduced. When an obstruction of the 25-degree plane occurs, a more detailed assessment involving the Vertical Sky Component of the affected window would need to be carried out.

ABSOLUTE VERTICAL SKY COMPONENT (VSC)

The Vertical Sky Component is the ratio of the direct sky illuminance falling on the vertical wall at a reference point, to the simultaneous horizontal illuminance under an unobstructed sky. To maintain good levels of daylight, the Vertical Sky Component of a window needs to be 27% or greater. If the VSC is less than 27%, then a comparison of existing and proposed levels of VSC level would need to be calculated.

RELATIVE VERTICAL SKY COMPONENT

Good levels of daylighting can still be achieved if VSC levels are within 0.8 of their former value.

% OF ROOM WITH VIEW OF THE SKY (NSL)

Rooms connected to the windows assessed will not experience a noticeable loss in daylight if the percentage (%) of the room's working plane with view of the sky is over 0.8 of its former value. The former value could refer either to the existing development in place or the mirror image buildings for properties with windows close to site boundaries.

SUNLIGHT

ACCESS TO SUNLIGHT (APSH)

The BRE test relates mainly to existing living room windows, although care should be taken to ensure that kitchens and bedrooms receive reasonable amounts of sunlight. Annual Probable Sunlight Hour (APSH) assessment is carried out when there is an obstruction within the 25-degree line and the window is facing within 90 degrees due south. The APSH assessment states that the existing living room window should receive at least:

- 25% of annual probable sunlight hours (APSH) throughout the year;
- 5% of annual probable sunlight hours during the winter months;
- not less than 80% of its former sunlight hours during either period;
- not more than a 4% reduction in sunlight received over the whole year (APSH).

The term 'annual probable sunlight hours' refers to the long-term average of the total of hours during a year in which direct sunlight reaches the unobstructed ground (when clouds are taken into account). The 'winter probable sunlight hours' is used to mean the same but only for the winter period (21 September – 21 March).

OVERSHADOWING

SUNLIGHT TO AMENITY SPACES

Open spaces should retain a reasonable amount of sunlight throughout the year. The BRE states that for an amenity space to "appear adequately sunlit throughout the year, at least half of the area should receive at least 2 hours of sunlight on 21 March". Where this is not achieved, the difference between the area achieving 2 hours of sun on 21 March should be no less than 0.8 times its former value.

DAYLIGHT ASSESSMENT

The analysis indicates that the proposed development is unlikely to have a significant impact on neighbouring windows in terms of daylight. The following subsections detail the findings for each neighbouring building individually.

25A NEAL STREET

This property is located to the south east of the proposed extension. Figure 2 shows the potentially affected windows on the first and second floor of the building. Detailed window references are presented in the appendix of this report.

A total of 2 windows were tested for daylight access. The results show that both the tested windows achieve VSC levels exceeding 0.8 of their former value.

Therefore, the proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at 25A Neal Street.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 2: 25A Neal Street windows

Table 3: Daylight results summary for 25A Neal Street

Number of windows tested	2
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	0
Number of windows with a VSC of at least 0.8 of existing value	2
Number of windows that belong to rooms meeting the NSL test	0
Number of windows that do not meet any of the above criteria	0

27 NEAL STREET

This property is located to the southeast of the proposed extension. Figure 3 shows the potentially affected facade. Detailed window references are presented in the appendix of this report.

A total of 7 windows were tested for daylight access. The results show that all tested windows achieve VSC levels exceeding 0.8 of their former value.

Therefore, the proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at 27 Neal Street.

The table below summarises the findings. Detailed results are presented in the appendix.

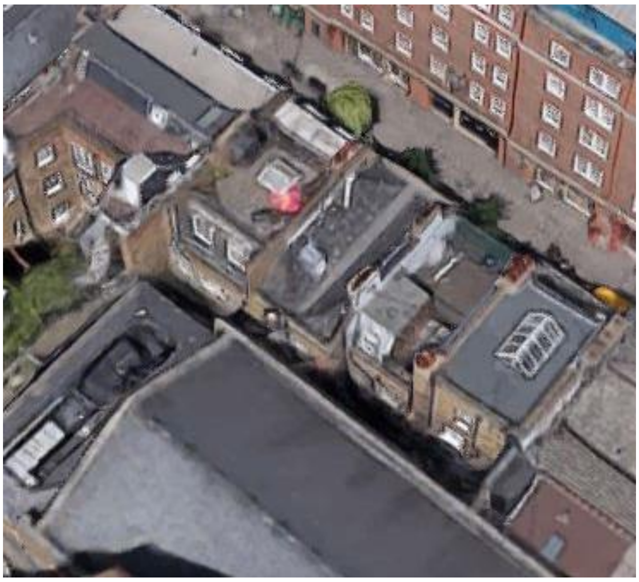


Figure 3: 27 Neal Street windows

Table 4: Daylight results summary for 27 Neal Street

Number of windows tested	7
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	0
Number of windows with a VSC of at least 0.8 of existing value	7
Number of windows that belong to rooms meeting the NSL test	0
Number of windows that do not meet any of the above criteria	0

29 NEAL STREET

This property is located to the southeast of the proposed extension. Figure 4 shows potentially affected windows. Detailed window references are presented in the appendix of this report.

A total of 5 windows were tested for daylight access. The results show that all tested windows achieve VSC levels exceeding 0.8 of their former value.

Therefore, the proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at 29 Neal Street.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 4: 29 Neal Street windows

Table 5: Daylight results summary for 29 Neal Street

Number of windows tested	5
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	0
Number of windows with a VSC of at least 0.8 of existing value	5
Number of windows that belong to rooms meeting the NSL test	0
Number of windows that do not meet any of the above criteria	0

31 NEAL STREET

This property is located to the southeast of the proposed extension. Figure 5 shows potentially affected windows. Detailed window references are presented in the appendix of this report.

A total of 5 windows were tested for daylight access. The results show that 4 of the 5 windows tested achieve VSC levels exceeding 0.8 of their former value and the remaining window belongs to a room which satisfies the no sky line criteria, therefore meeting the BRE criteria for daylight access

Therefore, the proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at 31 Neal Street.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 5: 31 Neal Street windows

Table 6: Daylight results summary for 31 Neal Street

Number of windows tested	**5**
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	0
Number of windows with a VSC of at least 0.8 of existing value	4
Number of windows that belong to rooms meeting the NSL test	1
Number of windows that do not meet any of the above criteria	0

33 NEAL STREET

This property is located to the east of the proposed extension. The figure to the right shows potentially affected windows. Detailed window references are presented in the appendix of this report.

A total of 8 windows were tested for daylight access. The results show that 1 of the 8 windows achieves a VSC above 27%, 4 of the remaining 7 windows tested achieve VSC levels exceeding 0.8 of their former values. 2 of the remaining windows belong to rooms which satisfy the no sky line criteria, therefore meeting the BRE criteria for daylight access. One remaining window was found to achieve relative VSC and no skyline tests marginally below the BRE daylight access criteria.

The majority of the windows were found to display adequate daylight values in line with the BRE criteria for daylight, given the constrained nature of the context surrounding the development. Hence, it can be concluded that the proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not anticipated to have a notable impact on the daylight received by neighbouring windows at 33 Neal Street.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 6: 33 Neal Street windows

Table 7: Daylight results summary for 33 Neal Street

Number of windows tested	8
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	1
Number of windows with a VSC of at least 0.8 of existing value	4
Number of windows that belong to rooms meeting the NSL test	2
Number of windows that do not meet any of the above criteria	1

35-37 NEAL STREET

This property is located to the northeast of the proposed extension. Figure 7 shows the potentially affected windows. Detailed window references are presented in the appendix of this report.

A total of 12 windows were tested for daylight access. The results show that all the 12 windows tested achieve VSC levels exceeding 0.8 of their former values, therefore meeting the BRE criteria for daylight access.

The proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at 35-37 Neal Street.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 7: 35-37 Neal Street windows

Table 8: Daylight results summary for 35-37 Neal Street

Number of windows tested	12
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	0
Number of windows with a VSC of at least 0.8 of existing value	12
Number of windows that belong to rooms meeting the NSL test	0
Number of windows that do not meet any of the above criteria	0

PROPERTIES ON SHORTS GARDENS

This property is located to the northwest of the proposed refurbishment and dormer extension to Donmar Warehouse Theatre. Figure 8 shows the potentially affected windows.

A total of 20 windows were tested for daylight access. The results show that 3 of the 12 windows achieve a VSC of over 27% and the remaining 17 windows achieve VSC levels exceeding 0.8 of their former values, therefore meeting the BRE criteria for daylight access

Therefore, the proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at the properties on Shorts Gardens facing development.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 8: Properties on Shorts Gardens

Table 9: Daylight results summary for properties on Shorts Gardens

Number of windows tested	20
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	3
Number of windows with a VSC of at least 0.8 of existing value	17
Number of windows that belong to rooms meeting the NSL test	0
Number of windows that do not meet any of the above criteria	0

PROPERTIES ON EARLHAM STREET

This property is located to the southwest of the proposed extension. Figure 9 shows the potentially affected windows.

The results show that 9 of the 15 windows achieve a VSC of over 27% and the remaining 6 windows achieve VSC levels exceeding 0.8 of their former values, therefore meeting the BRE criteria for daylight access

The proposed refurbishment and dormer extension to Donmar Warehouse Theatre is not expected to have any significant impact to the tested windows at the properties on Earlham Street.

The table below summarises the findings. Detailed results are presented in the appendix.

Figure 9: Properties on Earlham Street

Table 10: Daylight results summary for properties on Earlham Street

Number of windows tested	15
Number of windows passing the 25°/45° initial test	0
Number of windows with a VSC higher than 27%	9
Number of windows with a VSC of at least 0.8 of existing value	6
Number of windows that belong to rooms meeting the NSL test	0
Number of windows that do not meet any of the above criteria	0

SUNLIGHT ASSESSMENT

The analysis indicates that the proposed development is unlikely to have a significant impact on neighbouring south facing windows in terms of sunlight.

The BRE guide states that:

> *"if a living room of an existing dwelling has a main window facing within 90° of due south, and any part of a new development subtends an angle of more than 25° to the horizontal measured from the centre of the window in a vertical section perpendicular to the window, then the sunlighting of the existing dwelling may be adversely affected"*

A total of 55 windows from buildings surrounding the proposed development were highlighted as facing the development and within 90° of due south. The windows belonging to the following properties were included within this assessment.

- 27 Neal Street
- 29 Neal Street
- 31 Neal Street
- 33 Neal Street
- 35-37 Neal Street
- Buildings on Shorts Gardens

The analysis indicated that 51 of the 55 windows within 90° due south satisfy the BRE criteria for sunlight. The 4 remaining windows, belonging to 27 Neal Street and 33 Neal Street, receive sunlight levels below the BRE recommendations.

It must be noted that the BRE criteria apply to living room windows only, while the assessment includes all south facing windows to present an overall impact. Where transgressions of the guidance occur, the windows retain sunlight access levels that are consistent with the levels normally seen in dense urban locations. As such, the majority of the windows tested were found to display adequate sunlight values in line with the BRE criteria, given the constrained nature of the development and surrounding context.

The table below shows the results summary. The detailed results can be found in the appendix.

Overall, the proposed extension and refurbishment at Donmar Warehouse Theatre will not have a significant impact on the sunlight access to the windows of the neighbouring properties.

Table 11: Sunlight results summary

Total number of windows facing within 90° of south	55
Number of south facing windows passing the 25°/45° initial test	0
Number of south facing windows with APSH greater than 25% and WPSH greater than 5%, or of at least 0.8 of their former existing value	49
Number of south facing windows with less than 4% reduction in annual sunlight	2
Number of windows that do not meet any of the above criteria	4

OVERSHADOWING ASSESSMENT

The analysis indicates that the proposed development is unlikely to have a significant impact on the sunlight received by neighbouring amenity spaces.

A review of the site plan showed that there are two amenity or open spaces in close proximity to the proposed extension and refurbishment at Donmar Warehouse Theatre, as shown in the figure below. A Solar Access Analysis was undertaken on these amenity areas on the 21st of March as set out by the BRE.

The amenity spaces are not affected by the proposed refurbishment and dormer extension and receive no less than 0.8 times the sunlight received in the existing case on March 21, hence satisfying the BRE criteria for overshadowing. The figures on the following page illustrate shadow paths for the amenity spaces.

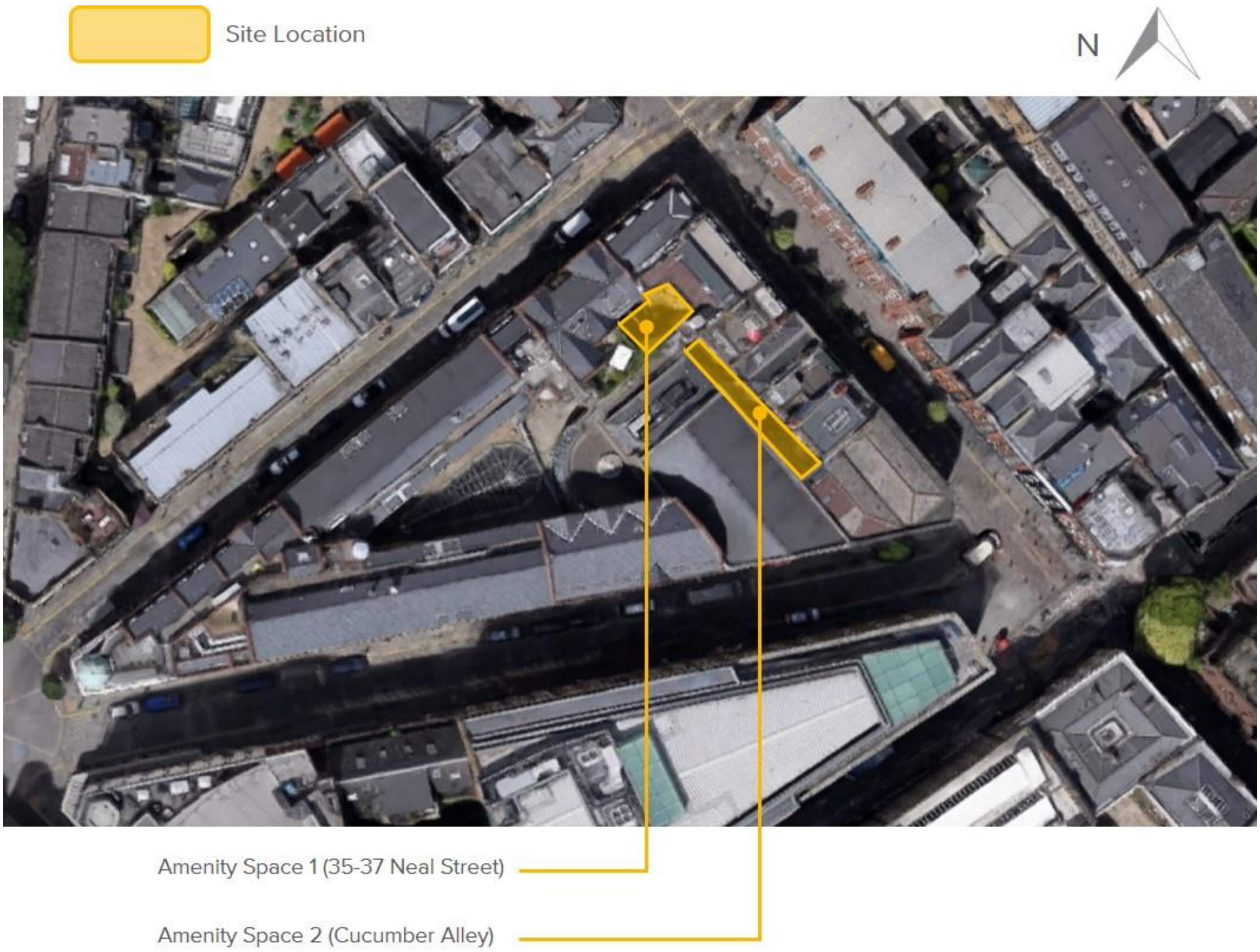


Figure 10: Amenity and open spaces in close proximity to development site

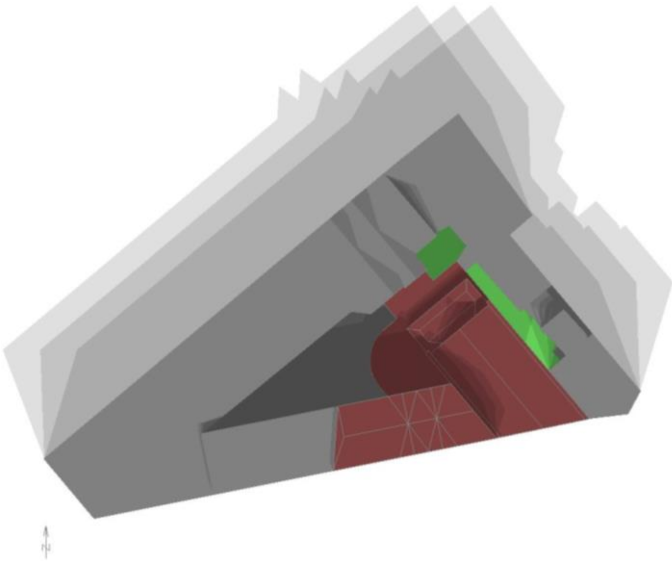


Figure 11: Overshadowing results for existing (left) and proposed (right) scenario for amenity space at 35-37 Neal street between 11am and 1pm on 21 March

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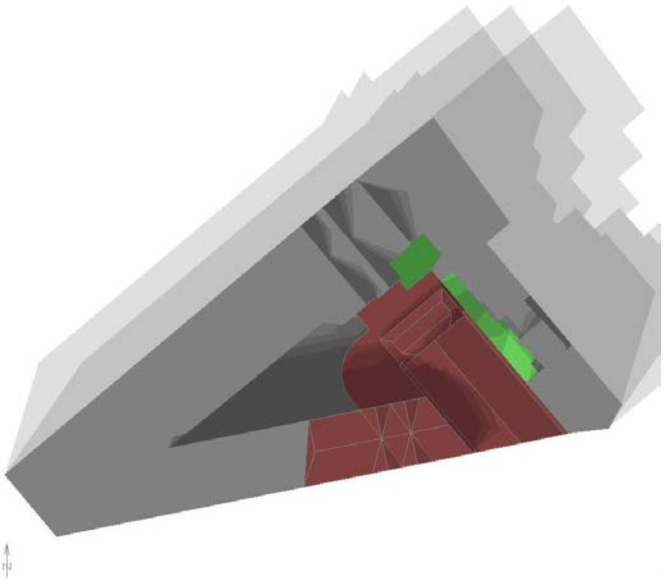


Figure 12: Overshadowing results for existing (left) and proposed (right) for amenity space at cucumber alley, adjoining properties 25a – 33 Neal street, between 1pm and 3pm on 21 March.

CONCLUSION

The daylight, sunlight and overshadowing analysis indicates that there will not be a significant impact on surrounding properties arising from the proposed refurbishment and dormer extension at Donmar Warehouse Theatre.

DAYLIGHT ASSESSMENT

A total of 74 windows from buildings surrounding the site were highlighted as being in close proximity to, and facing the proposed development.

In summary,

- 13 out of 74 windows achieved VSCs greater than 27%;
- 57 of the remaining 61 windows achieved relative VSCs over 0.8 of their former values
- 3 of the remaining windows were found to meet the no skyline test;
- 1 remaining window was found to achieve relative VSC and no skyline tests marginally below the BRE daylight access criteria.

The majority of the windows were found to display adequate daylight values in line with the BRE criteria for daylight, given the constrained nature of the given context. Where transgressions of the guidance occur, the windows retain levels that are consistent with the levels normally seen in dense urban locations. Hence, the proposed refurbishment and dormer extension is not anticipated to have a notable impact on the daylight received by neighbouring properties.

Hence, the proposed refurbishment and dormer extension is not anticipated to have a notable impact on the daylight received by neighbouring properties.

SUNLIGHT ASSESSMENT

A total of 55 south-facing windows from buildings surrounding the site were assessed for sunlight access. The analysis indicated the 51 windows satisfied the BRE criteria for annual probable sunlight hours (APSH) and winter probable sunlight hours (WPSH).

The majority of the windows were found to display adequate sunlight values in line with the BRE criteria, taking into account the constrained nature of the context. Where transgressions of the guidance occur, the windows retain levels that are consistent with the levels normally seen in dense urban locations.

Hence, the proposed refurbishment and dormer extension at Donmar Warehouse Theatre will not have a significant impact on the sunlight access to the windows of the neighbouring properties.

OVERSHADOWING ASSESSMENT

A solar access analysis was undertaken for two amenity spaces on the 21st of March. The amenity spaces are not affected by the proposed refurbishment and dormer extension and receive no less than 0.8 times the sunlight received in the existing case on March 21, hence satisfying the BRE criteria for overshadowing.

The proposed refurbishment and dormer extension is therefore not considered to have a significant impact on sunlight access to the amenity spaces surrounding the site.

APPENDIX A - WINDOW REFERENCE

DO NOT SCALE

BACKGROUND DRAWING INFORMATION

FILE NAME	ORIGINATOR NAME	DESCRIPTION NAME	REV	DATE REC'D

Notes

Rev	Date	Description	Chk'd	Appr

ISSUE TYPE

XCO2
17-18 Hayward's Place
London, EC1R 0EQ
+44 (0) 20 7700 1000
mail@xco2.com
www.xco2.com

Client
Hawthorn Tompkins

Architect
Hawthorn Tompkins

Project
Donmar Warehouse Theatre

Title
Window References
25a, 27, 29, 31, and 33 Neal Street

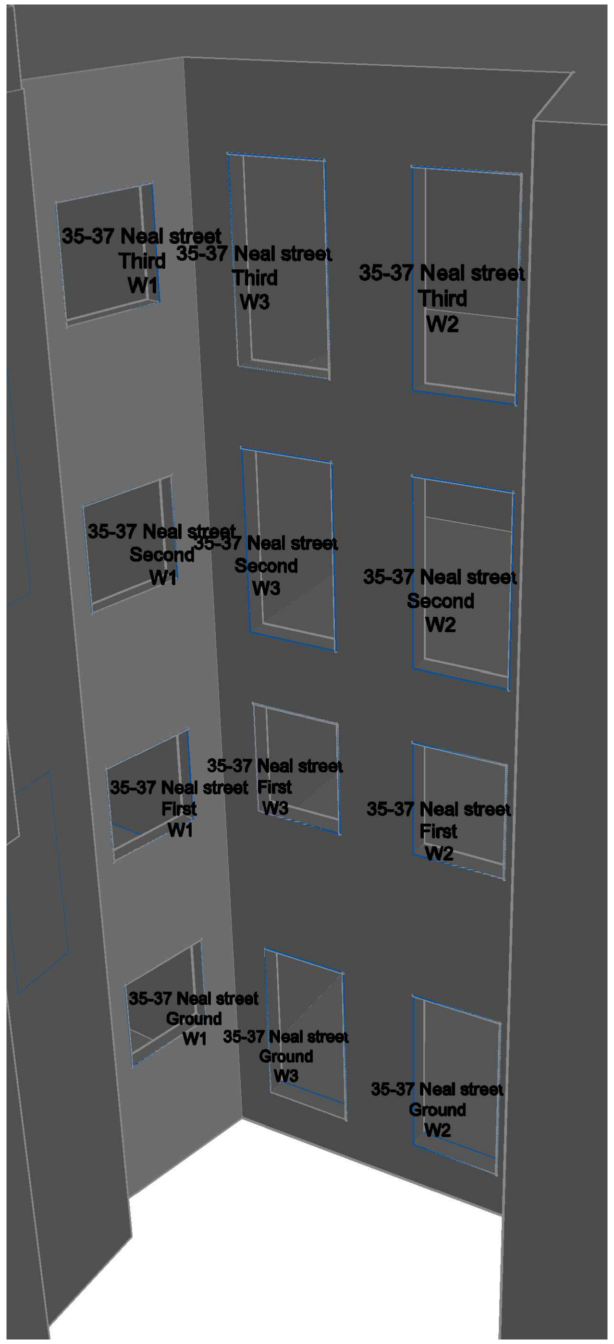
Scale@A3	Drawn	Checked	Date
N.T.S	MS	KM	28.10.16

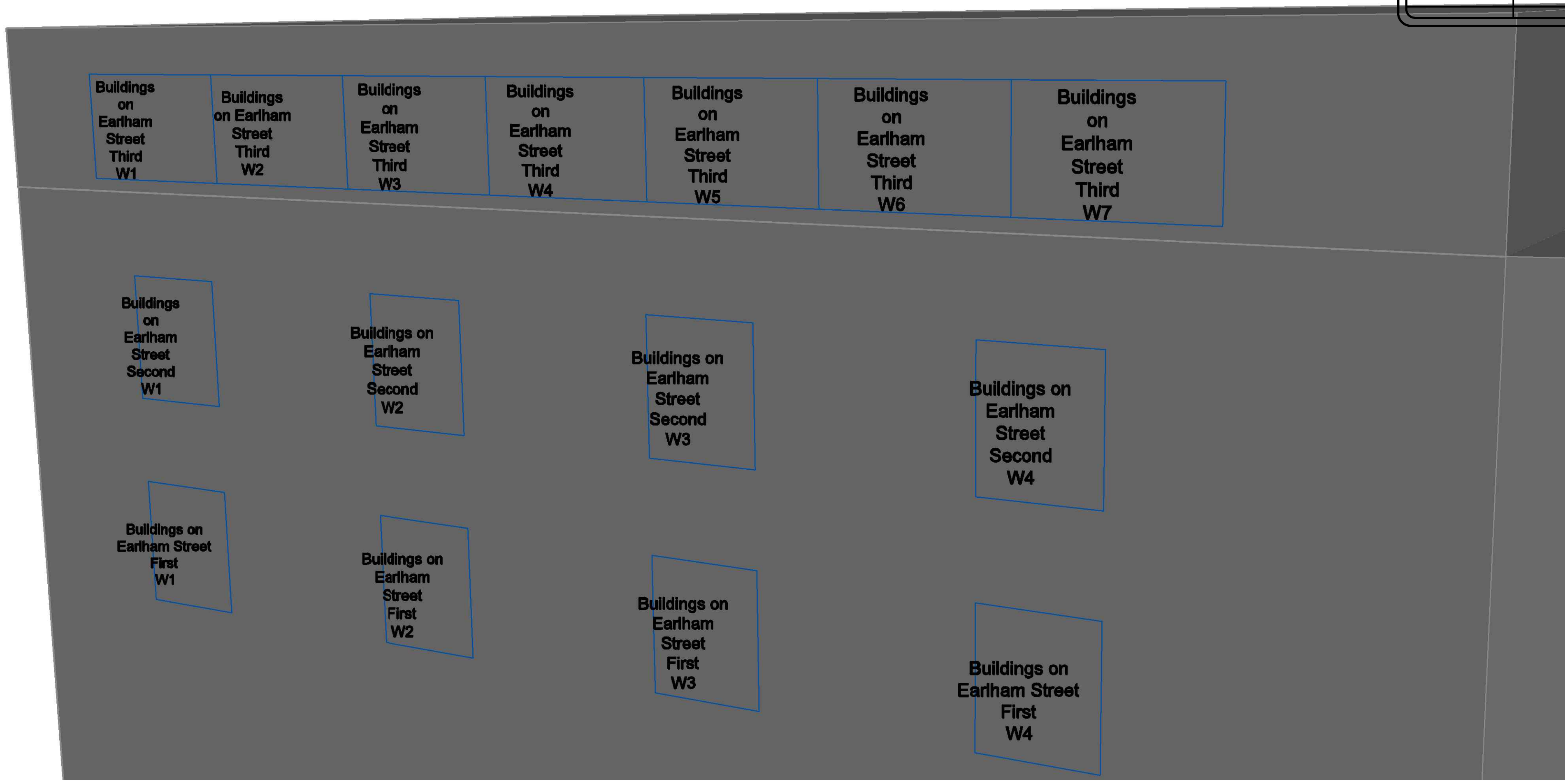
Drawing Number	Revision
8815-1-0001	0

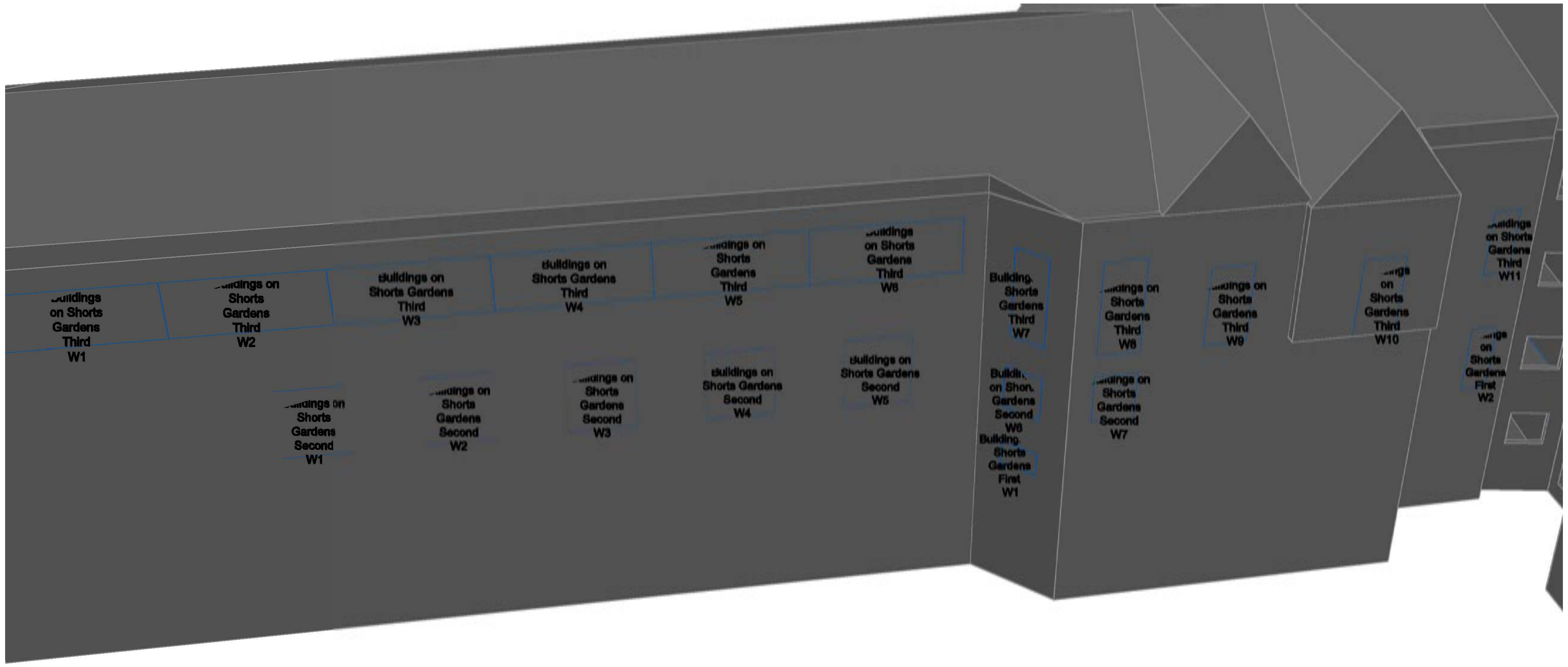
DO NOT SCALE

BACKGROUND DRAWING INFORMATION

FILE NAME	ORIGINATOR NAME	DESCRIPTION NAME	REV	DATE REC'D







Notes

Rev	Date	Description	Chk'd	Appr

ISSUE TYPE

XCO2

17-18 Hayward's Place
London, EC1R 0EQ
+44 (0) 20 7700 1000
mail@xco2.com
www.xco2.com

Client
Hawthorn Tompkins

Architect
Hawthorn Tompkins

Project
Donmar Warehouse Theatre

Title
Window References
35-37 Neal Street, Buildings on Earlham Street and Shorts Gardens

Scale@A3	Drawn	Checked	Date
N.T.S	MS	KM	28.10.16

Drawing Number	Revision
8815-1-0002	0

APPENDIX B - DETAILED DAYLIGHT RESULTS

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
25A Neal Street	Ground	R1	Landing	W1	Further testing required	6.7%	6.7%	1.00	95.8%	95.8%	1.00	Window meets BRE criteria
25A Neal Street	First	R1	Landing	W1	Further testing required	15.6%	16.2%	0.96	95.3%	95.4%	1.00	Window meets BRE criteria
27 Neal street	Ground	R1	Storage	W1	Further testing required	0.9%	0.9%	1.00	1.0%	1.0%	1.00	Window meets BRE criteria
27 Neal street	Ground	R2	Ensuite	W2	Further testing required	2.2%	2.3%	0.98	27.0%	27.7%	0.97	Window meets BRE criteria
27 Neal street	First	R1	Landing	W1	Further testing required	3.8%	4.2%	0.91	49.6%	54.8%	0.91	Window meets BRE criteria
27 Neal street	First	R2	Ensuite	W2	Further testing required	4.7%	5.1%	0.92	50.5%	53.4%	0.95	Window meets BRE criteria
27 Neal street	Second	R1	Landing	W1	Further testing required	9.9%	12.2%	0.82	98.8%	98.8%	1.00	Window meets BRE criteria
27 Neal street	Second	R2	Study	W2	Further testing required	11.2%	13.5%	0.83	51.6%	62.8%	0.82	Window meets BRE criteria
27 Neal street	Third	R1	Kitchen Dining	W2	Further testing required	24.5%	27.5%	0.89	99.8%	99.8%	1.00	Window meets BRE criteria
29 Neal street	Ground	R1	Unknown	W1	Further testing required	2.4%	2.5%	0.97	7.3%	7.7%	0.94	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
29 Neal street	Ground	R2	Landing	W2	Further testing required	2.9%	3.0%	0.97	47.3%	51.2%	0.92	Window meets BRE criteria
29 Neal street	First	R1	Unknown	W1	Further testing required	5.0%	5.4%	0.92	13.7%	14.3%	0.95	Window meets BRE criteria
29 Neal street	First	R2	Landing	W2	Further testing required	5.9%	6.5%	0.90	53.6%	58.9%	0.91	Window meets BRE criteria
29 Neal street	Second	R1	Unknown	W2	Further testing required	10.1%	11.7%	0.87	98.0%	98.0%	1.00	Window meets BRE criteria
31 Neal Street	Ground	R1	Unknown	W1	Further testing required	2.0%	2.2%	0.90	6.0%	7.9%	0.76	Window meets BRE criteria
31 Neal Street	Ground	R2	Landing	W2	Further testing required	3.1%	3.7%	0.84	35.3%	42.5%	0.83	Window meets BRE criteria
31 Neal Street	First	R1	Unknown	W1	Further testing required	4.5%	5.1%	0.89	8.7%	11.8%	0.74	Window meets BRE criteria
31 Neal Street	First	R2	Landing	W2	Further testing required	8.1%	10.3%	0.79	94.9%	95.1%	1.00	Window meets BRE criteria
31 Neal Street	Second	R1	Unknown	W1	Further testing required	10.6%	11.8%	0.90	13.3%	17.0%	0.78	Window meets BRE criteria
33 Neal street	Ground	R1	Unknown	W1	Further testing required	1.6%	2.0%	0.82	9.0%	9.7%	0.93	Window meets BRE criteria
33 Neal street	Ground	R2	Bedroom	W2	Further testing required	1.4%	1.7%	0.82	13.8%	15.2%	0.91	Window meets BRE criteria
33 Neal street	First	R1	Kitchen	W1	Further testing required	4.0%	5.2%	0.76	11.6%	12.3%	0.95	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
33 Neal street	First	R2	Bedroom	W2	Further testing required	3.6%	4.5%	0.79	17.5%	19.2%	0.91	Window meets BRE criteria
33 Neal street	Second	R1	Kitchen	W1	Further testing required	9.9%	14.4%	0.69	20.7%	26.2%	0.79	Windows marginally below BRE criteria
33 Neal street	Second	R2	Unknown	W2	Further testing required	11.9%	14.9%	0.80	70.0%	76.8%	0.91	Window meets BRE criteria
33 Neal street	Third	R1	Unknown	W1	Further testing required	>27.0%	-	-	96.3%	98.0%	0.98	Window meets BRE criteria
33 Neal street	Third	R1	Unknown	W2	Further testing required	26.1%	27.6%	0.95	96.3%	98.0%	0.98	Window meets BRE criteria
35-37 Neal street	Ground	R1	Kitchen	W1	Further testing required	4.5%	4.5%	1.00	29.4%	29.4%	1.00	Window meets BRE criteria
35-37 Neal street	Ground	R2	Living	W2	Further testing required	3.5%	3.5%	1.00	22.6%	22.6%	1.00	Window meets BRE criteria
35-37 Neal street	Ground	R2	Living	W3	Further testing required	3.7%	3.7%	1.00	22.6%	22.6%	1.00	Window meets BRE criteria
35-37 Neal street	First	R1	Kitchen	W1	Further testing required	8.4%	9.0%	0.94	38.8%	45.4%	0.85	Window meets BRE criteria
35-37 Neal street	First	R2	Living	W2	Further testing required	8.5%	8.5%	1.00	66.6%	66.6%	1.00	Window meets BRE criteria
35-37 Neal street	First	R2	Living	W3	Further testing required	8.5%	8.6%	0.99	66.6%	66.6%	1.00	Window meets BRE criteria
35-37 Neal street	Second	R1	Kitchen	W1	Further testing required	13.5%	13.8%	0.98	70.4%	70.5%	1.00	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
35-37 Neal street	Second	R2	Living	W2	Further testing required	14.1%	14.1%	1.00	95.0%	95.0%	1.00	Window meets BRE criteria
35-37 Neal street	Second	R2	Living	W3	Further testing required	12.2%	12.3%	0.99	95.0%	95.0%	1.00	Window meets BRE criteria
35-37 Neal street	Third	R1	Kitchen	W1	Further testing required	24.2%	24.2%	1.00	97.5%	97.5%	1.00	Window meets BRE criteria
35-37 Neal street	Third	R2	Living	W2	Further testing required	22.4%	22.4%	1.00	99.2%	99.2%	1.00	Window meets BRE criteria
35-37 Neal street	Third	R2	Living	W3	Further testing required	20.2%	20.2%	1.00	99.2%	99.2%	1.00	Window meets BRE criteria
Buildings on Shorts Gardens	First	-	-	W1	Further testing required	13.5%	13.6%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	First	-	-	W2	Further testing required	9.7%	10.5%	0.92	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W1	Further testing required	9.1%	9.1%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W2	Further testing required	12.9%	12.9%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W3	Further testing required	16.0%	16.1%	1.00	-	-	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
Buildings on Shorts Gardens	Second	-	-	W4	Further testing required	18.4%	18.5%	0.99	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W5	Further testing required	19.4%	19.8%	0.98	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W6	Further testing required	17.9%	18.1%	0.99	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W7	Further testing required	15.2%	16.6%	0.92	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W1	Further testing required	9.1%	9.1%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W2	Further testing required	18.0%	18.1%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W3	Further testing required	23.7%	23.8%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W4	Further testing required	26.7%	26.8%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W5	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
Buildings on Shorts Gardens	Third	-	-	W6	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W7	Further testing required	25.0%	25.0%	1.00	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W8	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W9	Further testing required	26.5%	28.1%	0.94	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W10	Further testing required	26.3%	28.3%	0.93	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W11	Further testing required	21.3%	21.8%	0.98	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	First	-	-	W1	Further testing required	22.9%	23.0%	1.00	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	First	-	-	W2	Further testing required	19.1%	19.2%	1.00	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	First	-	-	W3	Further testing required	13.6%	13.6%	1.00	-	-	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
Buildings on Earlham Street	First	-	-	W4	Further testing required	7.1%	7.2%	1.00	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Second	-	-	W1	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Second	-	-	W2	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Second	-	-	W3	Further testing required	24.7%	24.7%	1.00	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Second	-	-	W4	Further testing required	15.2%	15.2%	1.00	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Third	-	-	W1	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Third	-	-	W2	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Third	-	-	W3	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Third	-	-	W4	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	25/45-degree plane test	VSC tests			NSL tests			Comments
						Proposed VSC 27%?	Existing VSC (%)	Relative VSC >0.8?	Proposed NSL (%)	Existing NSL (%)	Relative NSL >0.8?	
Buildings on Earlham Street	Third	No-Room	Unknown	W5	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Third	No-Room	Unknown	W6	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria
Buildings on Earlham Street	Third	No-Room	Unknown	W7	Further testing required	>27.0%	-	-	-	-	-	Window meets BRE criteria

APPENDIX C - DETAILED SUNLIGHT RESULTS

Building	Floor	Room no.	Room use	Window no.	Orientation	25/45 degree plane test	APSH test			WPSH test			Total reduction <4%?	Comments
							Proposed APSH >25%?	Existing APSH (%)	Relative APSH >0.8?	Proposed WPSH >5%?	Existing WPSH (%)	Relative WPSH >0.8?		
25A Neal Street	-	-	-	All windows	North	n/a	-	-	-	-	-	-	-	Window meets BRE criteria
27 Neal street	Ground	R1	Storage	W1	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
27 Neal street	Ground	R2	Ensuite	W2	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
27 Neal street	First	R1	Landing	W1	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
27 Neal street	First	R2	Ensuite	W2	South	Further testing required	2.0%	2.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
27 Neal street	Second	R1	Landing	W1	South	Further testing required	6.0%	11.0%	55%	0.0%	0.0%	100%	5.0%	Window meets BRE criteria
27 Neal street	Second	R2	Study	W2	South	Further testing required	13.0%	18.0%	72%	0.0%	0.0%	100%	5.0%	Window meets BRE criteria
27 Neal street	Third	R1	Kitchen Dining	W2	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
29 Neal street	Ground	R1	Unknown	W1	South	Further testing required	2.0%	2.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	Orientation	25/45 degree plane test	APSH test			WPSH test			Total reduction <4%?	Comments
							Proposed APSH >25%?	Existing APSH (%)	Relative APSH >0.8?	Proposed WPSH >5%?	Existing WPSH (%)	Relative WPSH >0.8?		
29 Neal street	Ground	R2	Landing	W2	South	Further testing required	6.0%	6.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
29 Neal street	First	R1	Unknown	W1	South	Further testing required	5.0%	7.0%	71%	0.0%	0.0%	100%	2.0%	Window meets BRE criteria
29 Neal street	First	R2	Landing	W2	South	Further testing required	11.0%	11.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
29 Neal street	Second	R1	Unknown	W2	South	Further testing required	12.0%	15.0%	80%	0.0%	1.0%	0%	3.0%	Window meets BRE criteria
31 Neal Street	Ground	R1	Unknown	W1	South	Further testing required	5.0%	5.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
31 Neal Street	Ground	R2	Landing	W2	South	Further testing required	7.0%	7.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
31 Neal Street	First	R1	Unknown	W1	South	Further testing required	10.0%	10.0%	100%	1.0%	1.0%	100%	-	Window meets BRE criteria
31 Neal Street	First	R2	Landing	W2	South	Further testing required	14.0%	15.0%	93%	2.0%	2.0%	100%	-	Window meets BRE criteria
31 Neal Street	Second	R1	Unknown	W1	South	Further testing required	15.0%	18.0%	83%	2.0%	2.0%	100%	-	Window meets BRE criteria
33 Neal street	Ground	R1	Unknown	W1	South	Further testing required	4.0%	4.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	Orientation	25/45 degree plane test	APSH test			WPSH test			Total reduction <4%?	Comments
							Proposed APSH >25%?	Existing APSH (%)	Relative APSH >0.8?	Proposed WPSH >5%?	Existing WPSH (%)	Relative WPSH >0.8?		
33 Neal street	Ground	R2	Unknown	W2	South	Further testing required	3.0%	4.0%	75%	0.0%	0.0%	100%	-	Window meets BRE criteria
33 Neal street	First	R1	Bedroom	W1	South	Further testing required	9.0%	11.0%	82%	1.0%	1.0%	100%	-	Window meets BRE criteria
33 Neal street	First	R2	Kitchen	W2	South	Further testing required	9.0%	12.0%	75%	1.0%	1.0%	100%	-	Window meets BRE criteria
33 Neal street	Second	R1	Bedroom	W1	South	Further testing required	19.0%	30.0%	63%	3.0%	3.0%	100%	11.0%	Window meets BRE criteria
33 Neal street	Second	R2	Kitchen	W2	South	Further testing required	>25%	-	-	3.0%	4.0%	75%	8.0%	Window meets BRE criteria
33 Neal street	Third	R1	Unknown	W1	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
33 Neal street	Third	R1	Unknown	W2	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
35-37 Neal street	Ground	R1	Kitchen	W1	South	Further testing required	10.0%	10.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
35-37 Neal street	Ground	R2	Living	W2	South	Further testing required	3.0%	3.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
35-37 Neal street	Ground	R2	Kitchen	W3	South	Further testing required	5.0%	5.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	Orientation	25/45 degree plane test	APSH test			WPSH test			Total reduction <4%?	Comments
							Proposed APSH >25%?	Existing APSH (%)	Relative APSH >0.8?	Proposed WPSH >5%?	Existing WPSH (%)	Relative WPSH >0.8?		
35-37 Neal street	First	R1	Living	W1	South	Further testing required	16.0%	16.0%	100%	3.0%	3.0%	100%	-	Window meets BRE criteria
35-37 Neal street	First	R2	Kitchen	W2	South	Further testing required	12.0%	12.0%	100%	1.0%	1.0%	100%	-	Window meets BRE criteria
35-37 Neal street	First	R2	Living	W3	South	Further testing required	16.0%	16.0%	100%	3.0%	3.0%	100%	-	Window meets BRE criteria
35-37 Neal street	Second	R1	Kitchen	W1	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
35-37 Neal street	Second	R2	Living	W2	South	Further testing required	20.0%	20.0%	100%	>5%	-	-	-	Window meets BRE criteria
35-37 Neal street	Second	R2	Kitchen	W3	South	Further testing required	23.0%	23.0%	100%	>5%	-	-	-	Window meets BRE criteria
35-37 Neal street	Third	R1	Living	W1	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
35-37 Neal street	Third	R2	Kitchen	W2	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
35-37 Neal street	Third	R2	Living	W3	South	Further testing required	>25%	-	-	>5%	-	-	-	Window meets BRE criteria
Buildings on Shorts Gardens	First	-	-	W1	South	Further testing required	1.0%	1.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	Orientation	25/45 degree plane test	APSH test			WPSH test			Total reduction <4%?	Comments
							Proposed APSH >25%?	Existing APSH (%)	Relative APSH >0.8?	Proposed WPSH >5%?	Existing WPSH (%)	Relative WPSH >0.8?		
Buildings on Shorts Gardens	First	-	-	W2	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W1	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W2	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W3	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W4	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W5	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W6	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Second	-	-	W7	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W1	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W2	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria

Building	Floor	Room no.	Room use	Window no.	Orientation	25/45 degree plane test	APSH test			WPSH test			Total reduction <4%?	Comments
							Proposed APSH >25%?	Existing APSH (%)	Relative APSH >0.8?	Proposed WPSH >5%?	Existing WPSH (%)	Relative WPSH >0.8?		
Buildings on Shorts Gardens	Third	-	-	W3	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W4	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W5	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W6	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W7	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W8	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W9	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W10	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Shorts Gardens	Third	-	-	W11	South	Further testing required	0.0%	0.0%	100%	0.0%	0.0%	100%	-	Window meets BRE criteria
Buildings on Earlham Street	First	-	-	All windows	North	n/a	-	-	-	-	-	-	-	Window meets BRE criteria

XCO2
17-18 Hayward's Place
London EC1R 0EQ

+44 (0)20 7700 1000
mail@xco2.com
xco2.com

Appendix 1.4

Earlham Street Door Survey

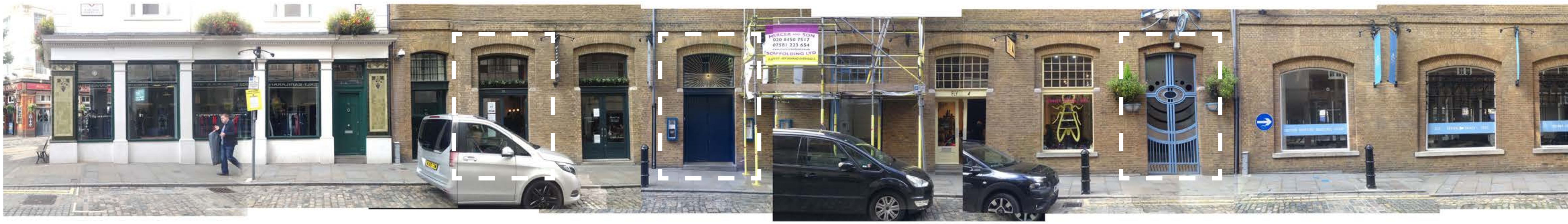
EARLHAM STREET PHOTOGRAPHIC ELEVATION

A new entrance door is proposed to the theatre from Earlham Street. This photographic survey has been carried out of the other entrance doors adjacent to the Donmar Warehouse. The survey revealed a level of consistency of timber and glass doors that contributes significantly to the character and materiality of the block and the street.

The proposal is intended to be consistent with this, but shows an increase to the extent of glazing with in the leaves, side screens and over-panel. This will maximise the visible connection with the street, and also increased the natural light penetration into the deep plan of the foyer.

A number of discussions and iterations have been discussed with the Conservation Officer to the detailed design of the new entrance door. Construction details will be developed in the design stages following the planning applicaiton, and we would hope to continue this discussion as the detail is finalised.

New signage is being considered to the Earlham Street entrance. It is anticpated that this would form a separate planning application once the designs have been developed. The new entrance will be upgraded with insulated double glazing and door seals, as well as providing a wheelchair accessible entrance.




DONMAR
THOMAS NEAL'S
THOMAS NEAL'S
DIESEL

INDIVIDUAL DOOR ELEVATIONS

No. 33

- Timber framed glazed doors
- Glazed over-panel
- No side screens

No. 35

- Timber match-boarded doors
- Decorative glazed over-panel
- No side screens

No. 29-41

- Painted metal gates with infil panels
- Painted metal over-panel
- No side screens

No. 29-41

- Timber framed glazed doors
- Glazed over-panel with downstand
- Glazed and panelled side screens

No. 41

- Timber framed glazed doors
- Solid over panel with signage
- Glazed side screens

No. 39

No. 41

No. 29-41

No. 41

No. 43

- Timber framed glazed doors
- Glazed over-panel with downstand
- Glazed and panelled side screens

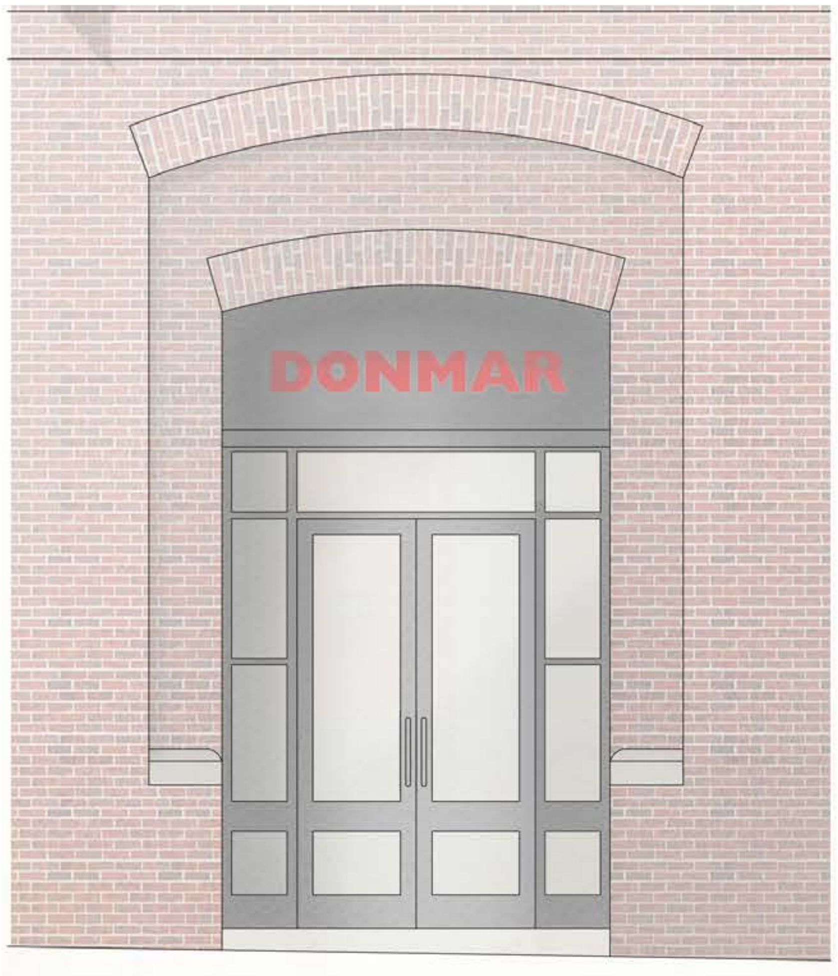
- Solid large format door
- Louvred over-panel
- No side screens
- Painted recessed brick arch

- Painted metal gates
- Painted metal over-panel
- Painted metal side screens
- Painted metal canopy and signage

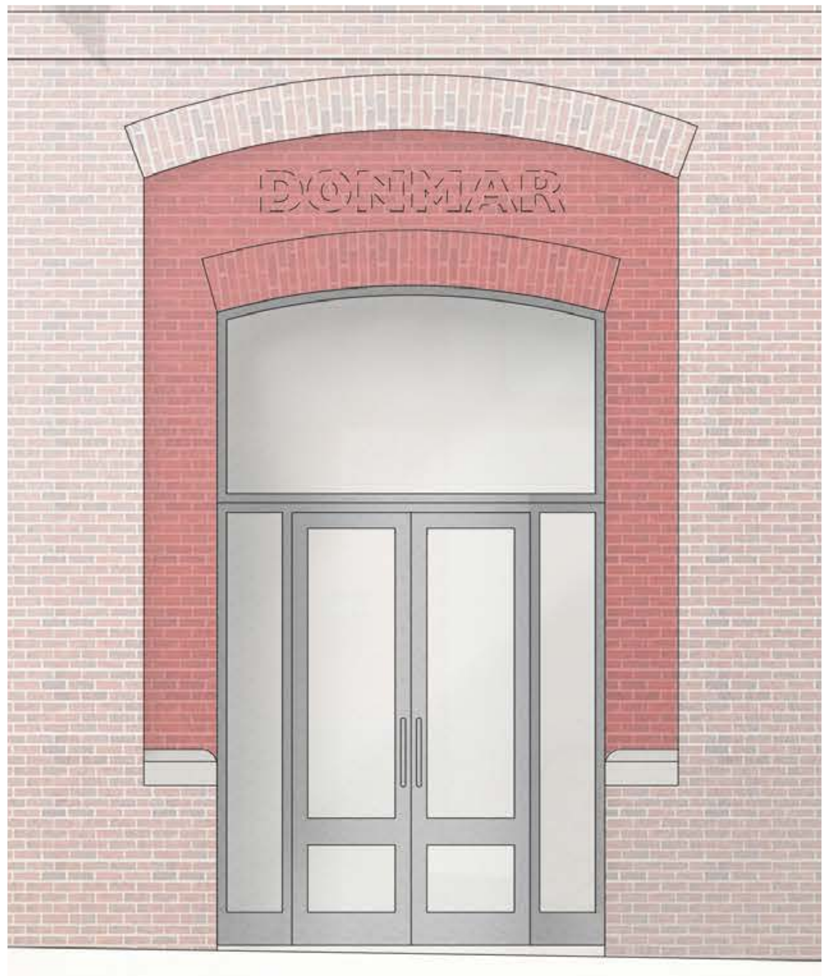
- Timber match-boarded doors
- Glazed over-panel
- Painted solid side screen

- Timber framed glazed doors
- Glazed over-panel with signage
- No side screens

EXISTING AND PROPOSED DONMAR WAREHOUSE ENTRACNE DOOR



Existing Donmar Warehouse entracne doors



Proposed Donmar Warehouse entracne doors

Changes to the existing entrance doors as follows:

- Over-panel to be glazed to maximise daylight into ground floor foyer
- Extent of framing to sidescreens to be reduced
- Recessed brick surround to be painted and to take signage above the door