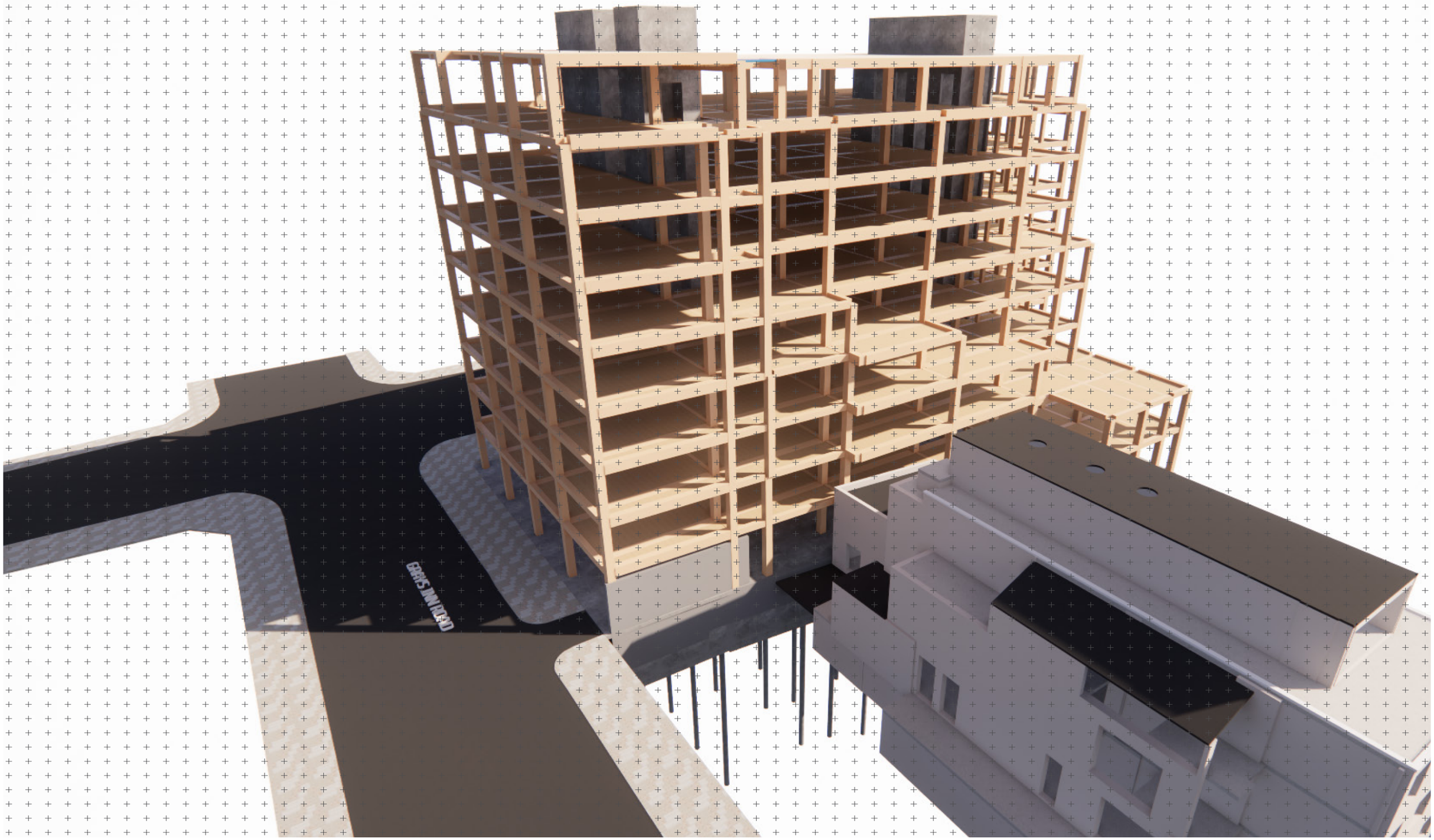
2423 - 100 Gray's Inn Road, Structural Methodology Statement



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Appendices

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Prepared by: Andrew Roberts
Approved by: Gustaf Granström-Steer

Executive Summary

This is a Structural Methodology Statement prepared by Heyne Tillett Steel (HTS) for their client, Lawnmist Limited, for the redevelopment of 100 Gray's Inn Road, 127 Clerkenwell Road and 88 Gray's Inn Road.

The report describes the current site conditions and history, identifying risks and opportunities for the development. Significant risks will include assets near the site boundary and interfaces with neighbouring sites.

The scheme includes the demolition of two existing buildings, 100 Gray's Inn Road (100 GIR) and 127 Clerkenwell Road (127 CR), and the refurbishment of the existing 88 Gray's Inn Road (88 GIR).

100 GIR and 127 CR will be replaced with a new eight storey office building. The new structure will cover the footprint of both 100 GIR and 127 CR with the existing basement lowered over most of the site.

Cores are required for vertical transportation and will be used for lateral stability, while columns are to be strategically placed along the building perimeter and internally within the structure. An engineered timber structure is currently proposed for the building and will consist of a glulam frame with cross-laminated timber (CLT) floors. The use of engineered timber has the following benefits:

+ A highly sustainable structural solution
+ Aesthetics
+ Lightweight, adaptable, and fast construction
+ Dry-construction
+ Reduced foundation requirements compared to traditional construction methods due to lightweight construction
+ Reduced crane size and time required for crane on site
+ Construction precision, safety, and prefabrication

The refurbishment works to 88 GIR include the conversion of the existing structure from office use to residential use. The existing top floor of the structure will be demolished and replaced with a lightweight structure with an arrangement better suited to residential use.

High level risks which have been considered with mitigation measures discussed include:

+ Seasonal variations in water table
+ The made ground on site
+ Site access and sequencing
+ Waterproofing to roof and terrace structures
+ Fire design

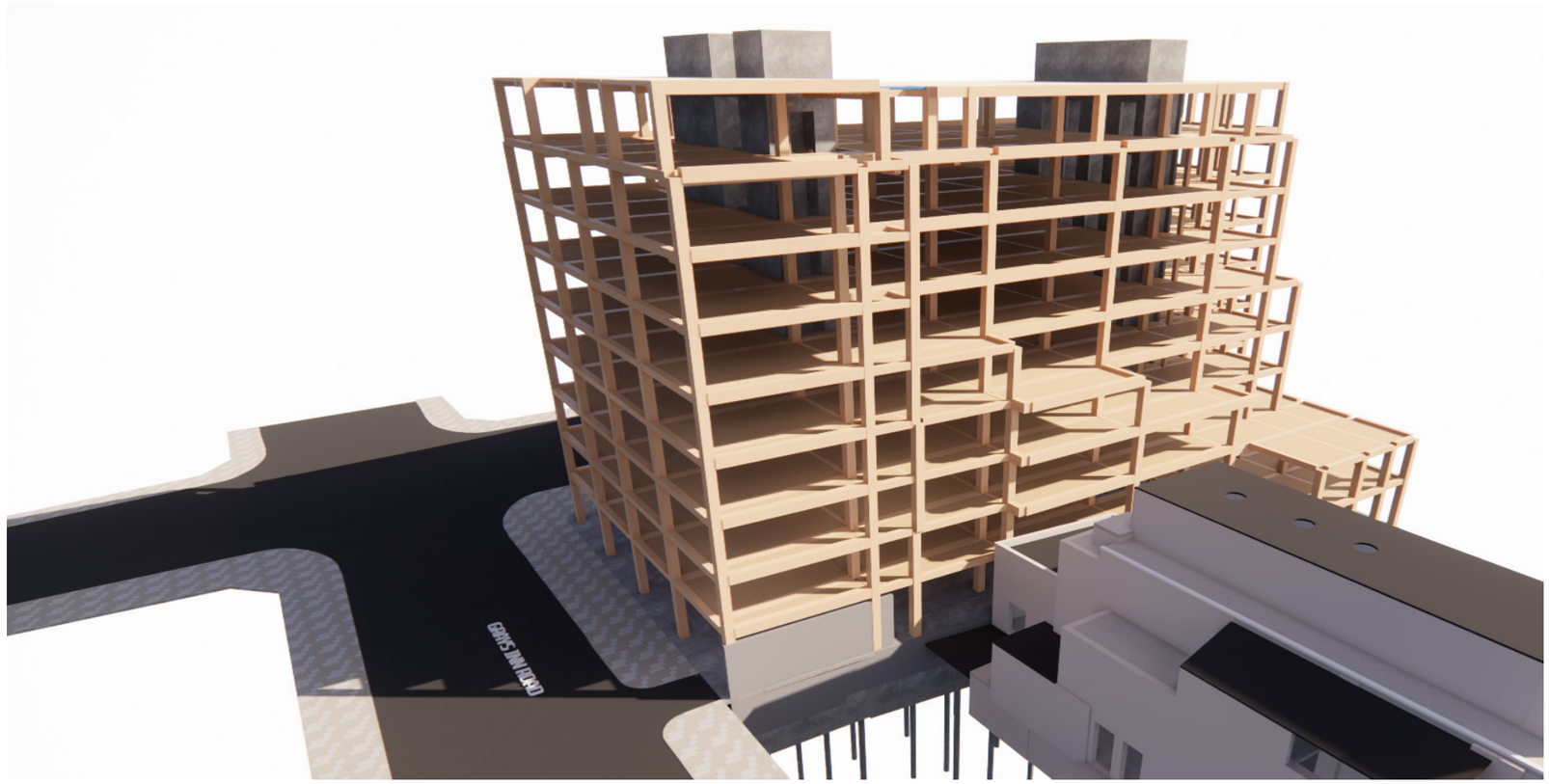


Image 1 - 3D Image

1. Introduction

Heyne Tillett Steel (HTS) have been appointed by Lawnmist Limited to carry out structural and civil engineering design services for the redevelopment of existing office buildings at 100 Gray's Inn Road (100 GIR), 127 Clerkenwell Road (127 CR) and 88 Gray's Inn Road (88 GIR). The site is located at 100 Gray's Inn Road, London, WC1X 8AL. This report provides a summary of the existing site characteristics and a discussion of the structural implications of the proposals.

Work has been undertaken to completion of RIBA Stage 2 design, with proposals presented in this report developed in collaboration with architect's Piercy & Company and mechanical and electrical consultants Max Fordham.

The proposal is to demolish the existing structures at 100 GIR and 127 CR and replace with a new engineered timber framed office structure. 88 GIR will be refurbished for a change of use to residential.

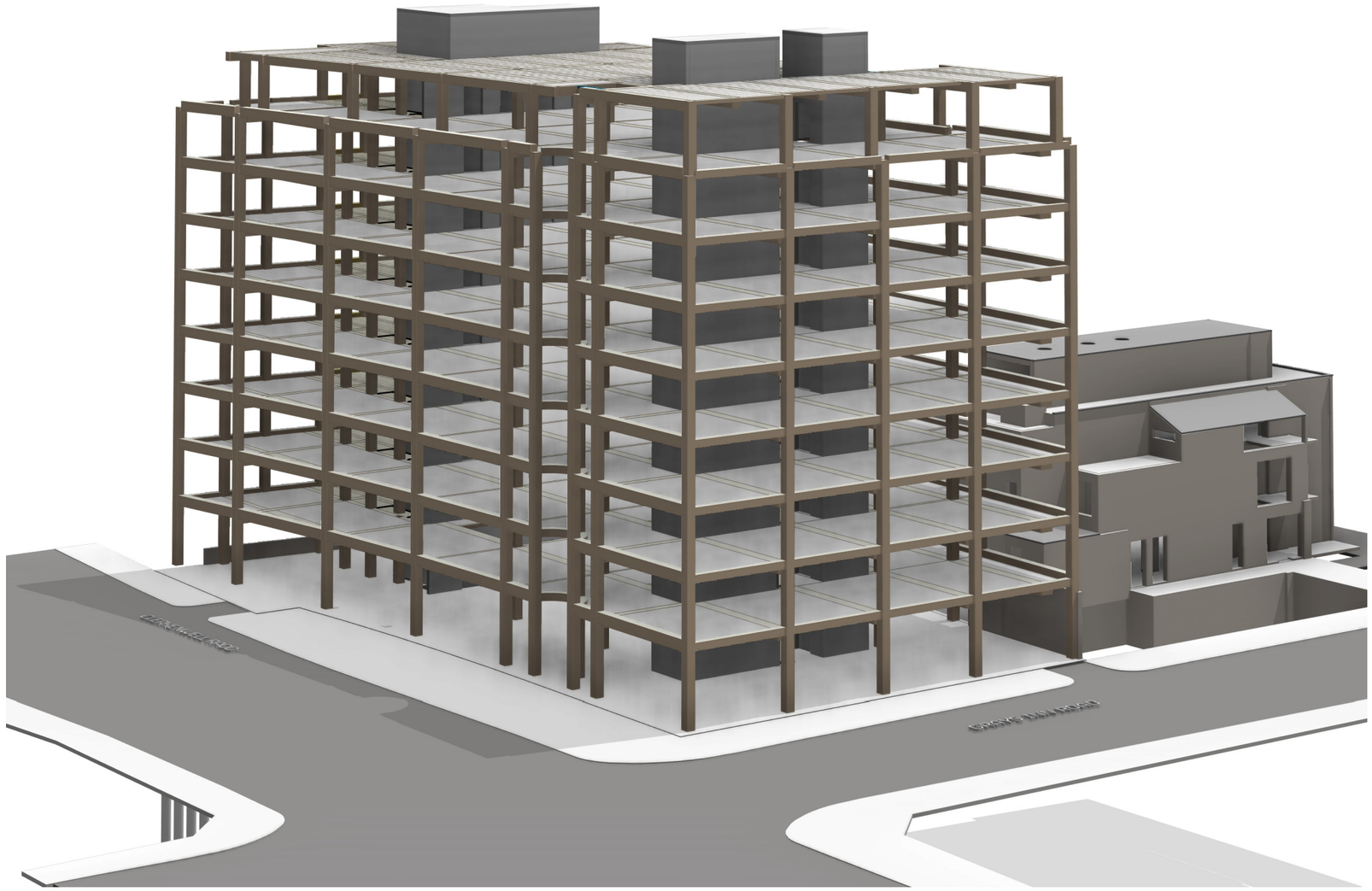


Image 2 - 3D Image

2. Site and Existing Buildings

2.1 Site

The development site is located at 100 Gray's Inn Road, London, WC1X 8AL. The site falls within the administrative boundary of the London Borough of Camden. The site is bound by Clerkenwell Road (A5201) to the north, Gray's Inn Road (A5200) to the west, and Portpool Road to the south. 125 Clerkenwell Road and the Bourne Estate are to the east of the site. 51 – 98 Gray's Inn Road border 88 Gray's Inn Road to the west.

The existing ground level for the development is at approximately 21.0mAOD.

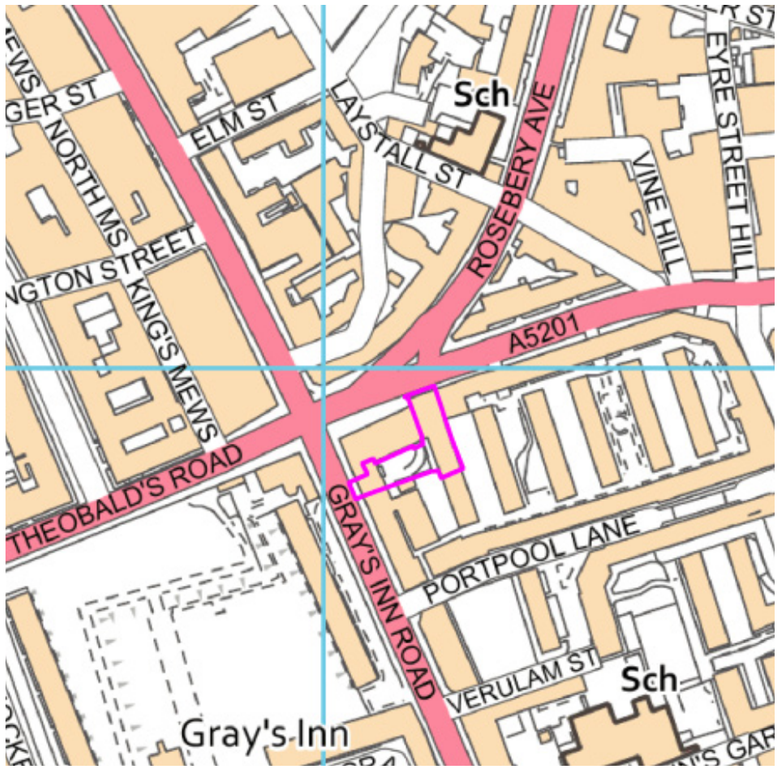


Image 3 - Location Plan

2.2 Site History

Historical information about the site has been gathered from Envirocheck Historical Maps.

The earliest map of the site from 1851 shows that the existing road network around the site had been established, although Clerkenwell Road was known as Liquor Pond Street at the time. The site was vacant and bordered the south by two irregular shaped buildings.

The next maps dated 1875, 1878 and 1896, show the surrounding area to have been developed with predominantly terraced houses. The site was occupied by numerous adjoining buildings, likely to have been small-scale commercial and residential properties, with the centre of the site labelled as a yard. A large brewery had also been constructed about 30m from the site's eastern boundary. Buildings to the northwest and south of the site were reconfigured between 1878 and 1896. Holborn Town Hall was previously on the site.

By 1916 the southwest corner of the site was a bank with the structures to the south of the site having been cleared. A public house has been constructed to the east of the site with the aforementioned brewery demolished.

Following bombing in the Second World War the majority of the structures to the south of the size were ruins. This is confirmed by bombing records and aerial photography from 1946. The ruins were cleared between 1954 and 1958 and were redeveloped into terraced houses of flats.

The site was redeveloped between 1968 and 1974 into its existing configuration and has remained unchanged since.

Historic building plans indicate former commercial uses on the site as a publisher and book warehouse, printers and a tobacco distributor.

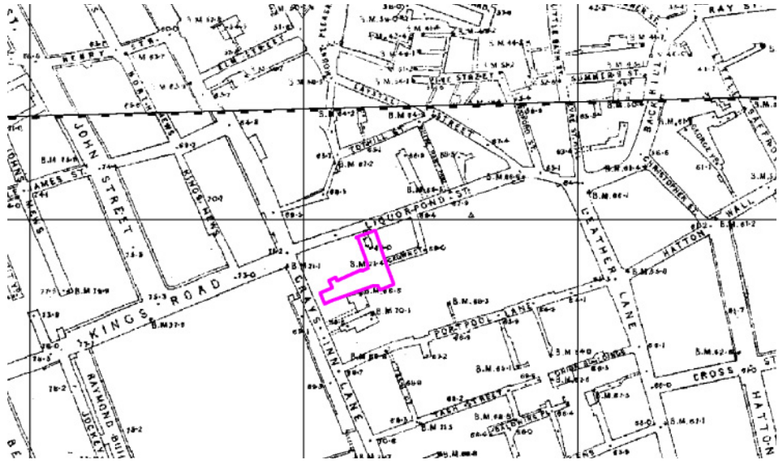


Image 4 - Historic Map 1851

Image 5 - Historic Map 1896

Image 6 - Historic Map 1916

2.3 Existing Constraints

2.3.1 Off-site Thames Water Infrastructure

There is a Thames Water trunk combined sewer along Clerkenwell Road in the vicinity of the site of at 100 Grays Inn Road. This trunk sewer drains from west to east along Clerkenwell Road. There are 2no. direct connections from this site to this sewer.

There is also one Thames Water public sewer in the vicinity of 88 Grays Inn Road. Within Grays Inn Road there is a 1245mm dia. combined sewer draining south to north that joins a 3200mm dia. combined trunk sewer draining west to east along Clerkenwell Road. There is also a direct connect from the site at 88 Grays Inn Road to the 1245mm combined sewer within Grays Inn Road

2.3.2 Neighbouring Buildings

Several buildings adjoin the site including a public house at 125 Clerkenwell Road to the east and the terrace of 90-98 Gray's Inn Road to the south. 90-98 Gray's Inn Road consists of retail at ground floor with office space above. The social housing to the east of 88 GIR is part of an estate that contains some Grade II listed buildings. The buildings neighbouring the development site are, however, not listed.

Investigations will be carried out to confirm the existing footing to the public house to ensure that the proposed works to do not cause any damage to this neighbouring property.

2.3.3 Unexploded Ordnance

A WWII bomb map identifies no bombing of the site but the buildings to the south were either 'damaged beyond repair' or 'total destruction' suggesting that unexploded ordnance is a risk. A UXO assessment has been carried out as part of the phase 1 geotechnical investigations, and it has identified a medium risk with the following recommendations:

+ Site specific UXO awareness briefings to all personnel conducting intrusive works
+ Open intrusive works (trial pits, service pits, open excavations, shallow foundations etc.)
+ UXO specialist on-site support

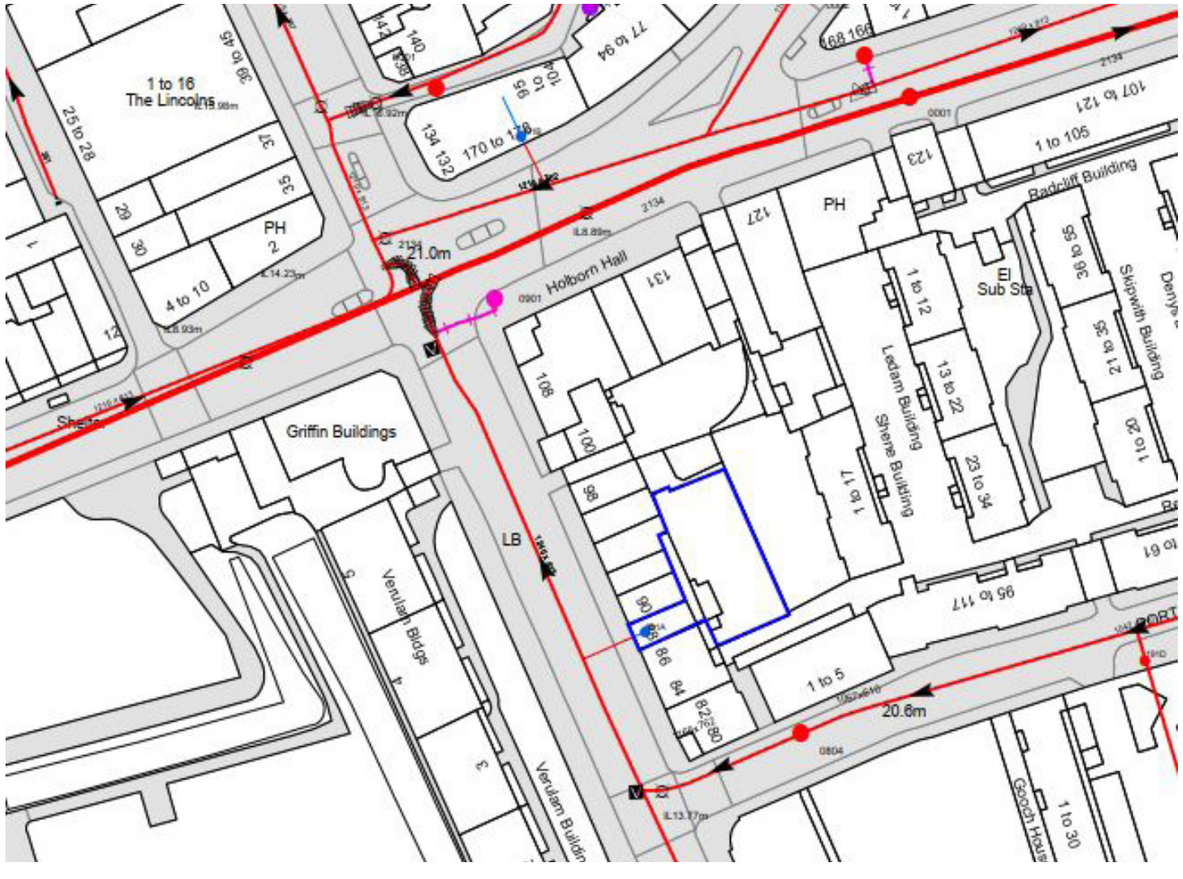


Image 7 - Thames Water Sewer Records

Image 8 - WW2 Bomb Damage Map

2.4 Soil Profile and Risks

Initial archive borehole searches suggest that the site is underlain by Lynch Hill Gravel and London Clay. The gravel was found to depths of 3.66m to 6.40m bgl (17.63mAOD and 14.57mAOD) with the clay beneath extending down to a maximum depth investigated at 18.29m bgl (3.01mAOD). The archive boreholes also encountered made ground to up to 3.96m bgl above the gravels. The extent of the made ground varies across the site but appears to have been removed to make way for the basement under 100 GIR.

The made ground will provide poor load-bearing capacity and may include contaminants or deleterious materials. The extent of the made ground should be investigated to the rear of 127 Clerkenwell Road where proposed piling works are to be carried out.

Based on the information from the borehole records the current basement sits within the gravels.

The gravels and clay appear to be suitable for the introduction of a raft slab for the proposed lowering of the existing basement. The excavation of the basement will result in heave of the underlying clay. The clays will also be suitable for the proposed piling to the rear of 127 CR.

The Lynch Hill Gravel is classified as a Secondary 'A' Aquifer, which refers to permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers, while the London Clay Formation is classified as an Unproductive Stratum, rather than its former classification as a non-aquifer, referring to rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

A resting groundwater level of 3.08m below basement level (15.18mAOD) was found within the Lynch Hill Gravel during preliminary drilling. Groundwater is likely to be present near the boundary between the high permeability Lynch Hill Gravel Member and the low permeability London Clay and is likely to flow in a generally south-easterly direction towards the River Thames.

Further investigation and monitoring throughout the year is required to understand the water table and de-risk the design.

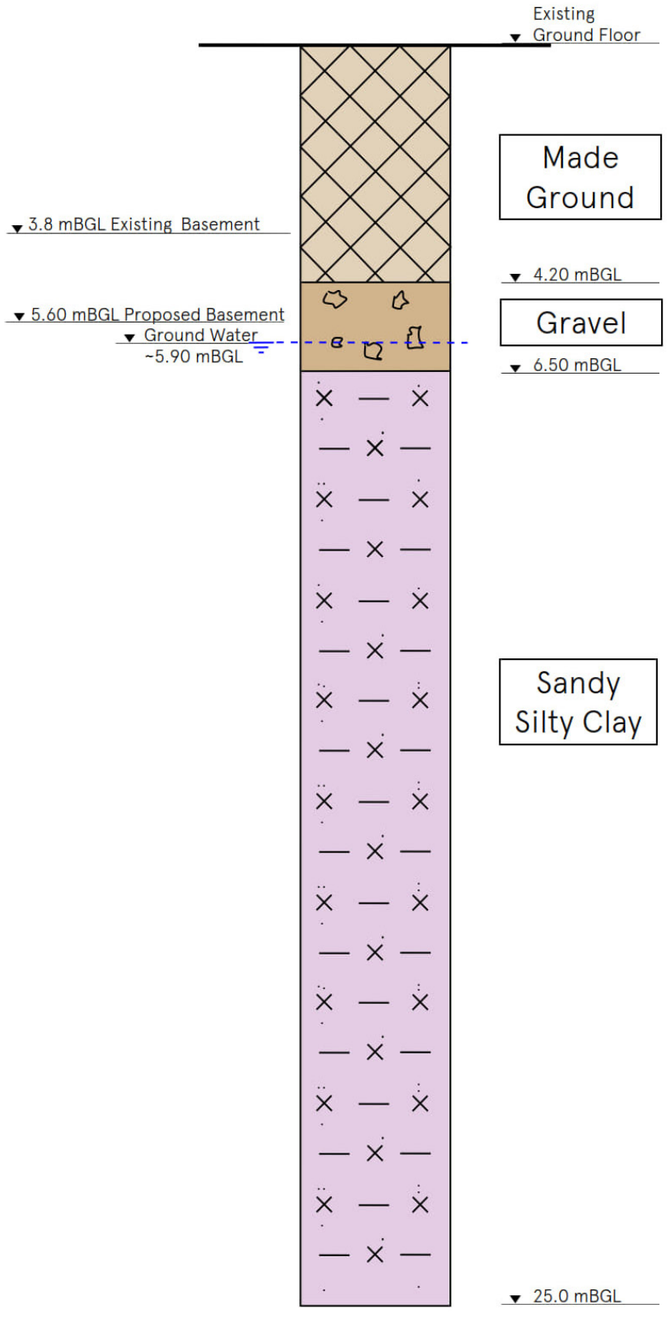


Image 9 - Borehole

2.5 Flood Risk

The site lies in Flood Zone 1 and benefits from flood defences. The proposed development is classed as both 'Less Vulnerable' for the office development of 100 GIR and 'More Vulnerable' for the residential change of use at 88 GIR. As the proposed use is in Flood Zone 1 and is classified as 'More Vulnerable', the proposed use is acceptable and no exception test is required to justify the proposed development.

With consideration to the scope of works for the development, flood mitigation measures will be proposed through the use of SuDS and basement waterproofing measures. With the proposed measures in place, the risk of flooding from all sources is reduced to low.

Image 10 - Flood Map

3. Proposed Works

3.1 100 Gray's Inn Road

The scheme includes the creation of an eight-storey office building above the existing basement that will be retained and lowered. The proposed will be approximately 26m x 50m on plan with stepped terraces progressing up the height of the building along the south face with another step at Level 08 on the north face.

Cores are required for vertical transportation and will be used for lateral stability, while columns are to be strategically placed along the building perimeter and internally within the structure. An engineered timber structure is currently proposed for the building and will consist of a glulam frame with cross-laminated timber (CLT) floors. The use of engineered timber has the following benefits:

+ A highly sustainable structural solution
+ Aesthetics
+ Lightweight, adaptable, and fast construction
+ Dry-construction
+ Reduced foundation requirements compared to traditional construction methods due to lightweight construction
+ Reduced crane size and time required for crane on site
+ Construction precision, safety and prefabrication

The developed scheme is presented in Appendix A

Due to the height of the building, the lateral stability of the structure against wind will be a key structural design consideration. The two cores are currently proposed to fulfil this function, and so careful coordination of the layout will be required as the design develops.

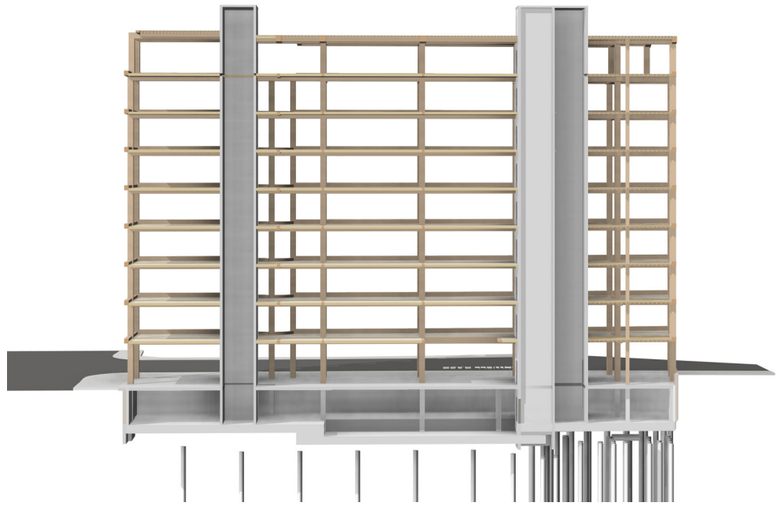


Image 11 - Long Section Through 100 GIR

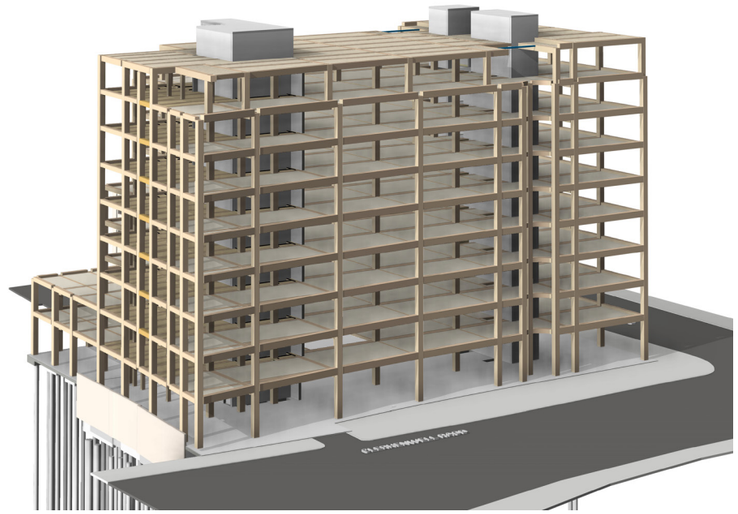


Image 12 - North Elevation

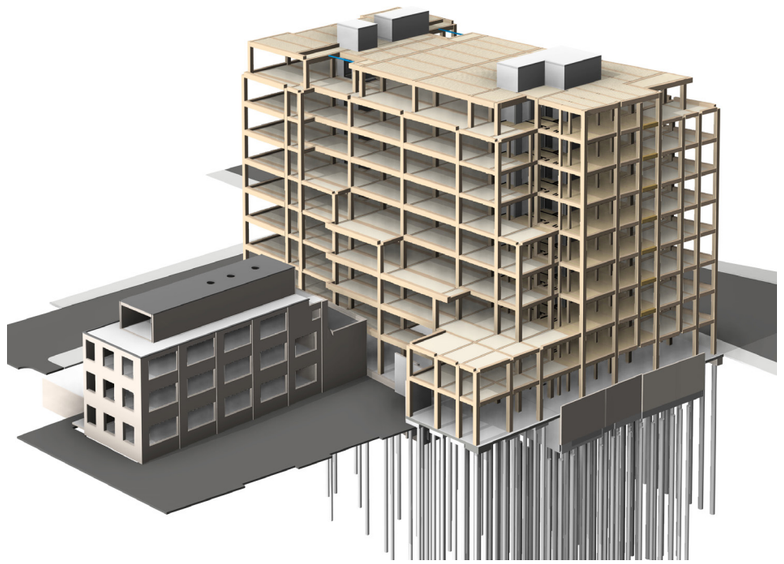


Image 13 - Rear View Showing 88 GIR

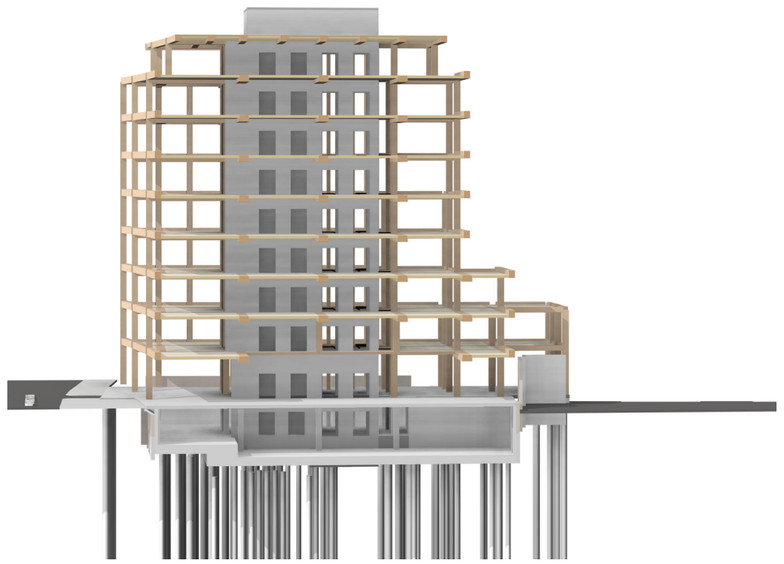


Image 14 - Short Section Through 100 GIR

3.1.1 Superstructure

The current proposal is for the office building to be constructed from a glulam frame with CLT floor structures. The superstructure consists of 240mm thick cross laminated timber (CLT) floor panels spanning between primary glulam beams supported on glulam column on a typical 9m x 6.5m grid.

The primary glulam beams are typically 560mm deep by 760/840mm wide 'T' beams, rebated to seat the floor panels within the beam depth. 240mm deep by 240mm wide tie beams span perpendicular to the primary beams, between columns and within the slab depth, providing the necessary tying function in line with disproportionate collapse requirements.

Perimeter glulam beams are set as upstand beams with a flush soffit between the beam and the CLT. The details of the support for this solution will be resolved at the next stage.

Typical glulam columns are 520mm square at ground floor level, and can be reduced further up the building, subject to loading, potential settlement and detailing issues. These will be rationalised during the next design stage. All column lengths/heights are to be limited to a maximum height of 13m to avoid transportation issues.

The toilets for each floor will be location around the east core. A timber joisted floor solution has been provided here to provide an early warning system for any leaks in these 'wet' areas. The joisted solution is preferable to a CLT solution here as any signs of water are visible almost immediately in the ply, whereas it can take months for any water to appear through the CLT, meaning by the time the water is visible extensive water damage may have already occurred.

The roof structure consists of glulam beams supporting timber joists and ply. Similar to the toilet areas, the joisted roof solution provides an early warning system for any leaks from the roof. The glulam beams will be 'T' sections with notches to sit the timber joists into. The final water mitigation strategy for the roof, terraces and toilet areas will be developed with the rest of the design team at Stage 3.

A series of transfer beams are required where the building steps in for external terraces. These transfers will be constructed from glulam timber except at 1F where a series of three steel beams are required to transfer eight floors of load above the ground floor loading bay.

All beams and columns have been designed with pinned connections to allow for simple connection detailing throughout. These will typically comprise embedded steel fin plates with dowelled connectors that are plugged to provide fire resistance.

The ground floor slab consists of a 300 thick RC slab that is supported by 450mm sq RC columns. The glulam columns of the superstructure stack with these RC columns under.

3.1.2 Cores

Two internal RC cores housing stairs and lifts provide horizontal stability to the structure. Lateral loads are transferred back from the elevations to the core via diaphragm action of the CLT floor structure.

The raft slabs beneath each core will be designed for the compressive loads from vertical loading of the structure and the loads arising from the moments in the core.

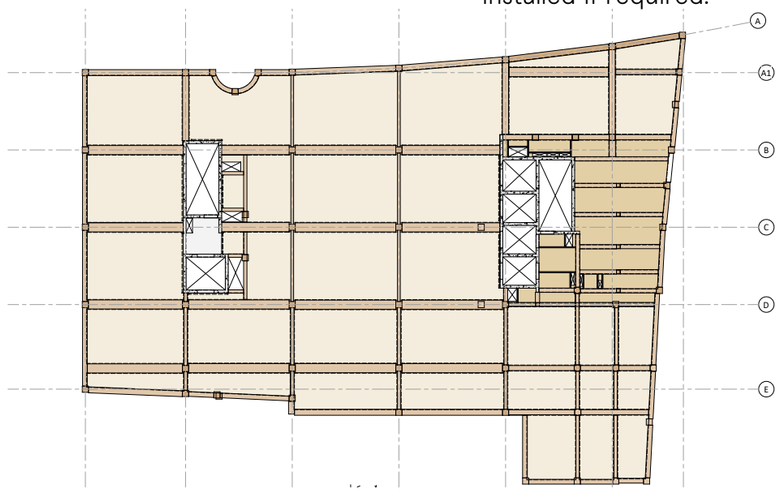


Image 15 - Typical Floor Plan

3.2 88 Gray's Inn Road

The existing 88 GIR office structure consists of assumed loadbearing masonry walls with steel beams supporting unknown floor structures. A series of investigations are required to confirm these assumptions.

The existing top floor structure is to be removed and replaced with a new lightweight structure consisting of a steel frame with a traditional joisted roof structure. Column lines will be centred over lines of existing structure below. Stability will be provided by a series of braced bays.

A series of inset balconies will be provided as part of the proposed alterations. The proposed external RC slab of these balconies will be lower than the existing level to allow a consistent floor level between internal and external areas. A steel beam will be required to trim out opening made in the existing structure and to support the proposed balcony.

The lift core will extend through the existing and proposed structure for 88GIR and will consist of a steel frame.

A single storey extension will be provided to the north of the ground floor to house the proposed plant room. This structure could consist of a steel and timber frame or a SFS product. The existing foundations in this area require investigation to confirm their suitability for the proposed structure. MC pad foundations will be installed if required.

3.3 Foundations

As described in section 2 of this report, the site geology appears to be suitable for a raft slab for the proposed lowering of the existing basement. The clays will also be suitable for the proposed piling to the rear of 127 CR.

3.3.1 100 Gray's Inn Road Foundations

The proposed 750mm thick raft slab will provide a foundation solution for the majority of 100 GIR, including beneath the cores, that can be designed to provide the required stiffness for the superstructure loading. A raft slab foundation solution was chosen over bored piles as it can provide a significant cost saving. This shallow foundation solution effectively floats on the strata below the basement. The investigations carried out to date confirm that a raft solution is feasible. The excavation of the basement will result in heave of the underlying clay which the raft slab can be designed to resist.

The existing structure is supported on piles that will be cut to ensure no load is transferred through to them that may cause failure of a pile.

For the area to the rear of 127 CR at ground level where no existing foundations are in place a series of piles and pile caps will be installed to support the structure over and transfer loads back to the ground.

A ground movement assessment has been carried out and concluded that for a worst case scenario a vertical settlement of up to 26mm could occur immediately behind the proposed retaining walls (within our site boundary), reducing down to less than 2mm at a distance of 10m from the proposed walls. Horizontal movement is expected to be less than 3mm.

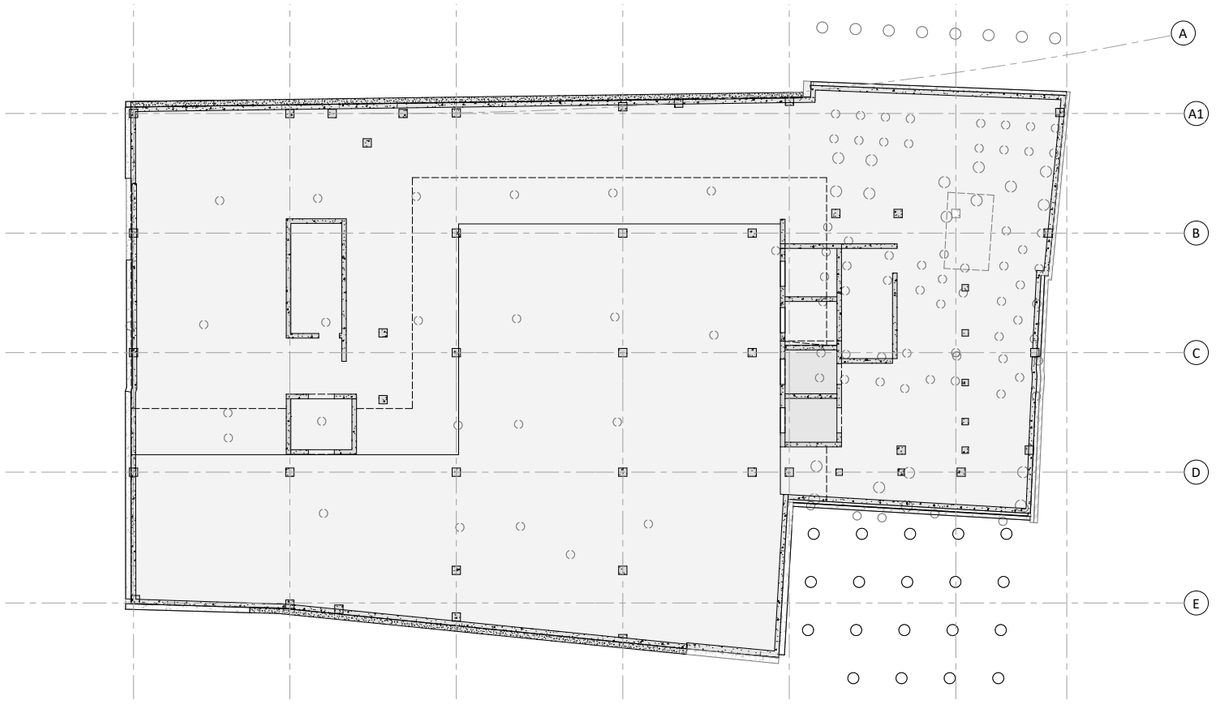


Image 16 - Basement Plan

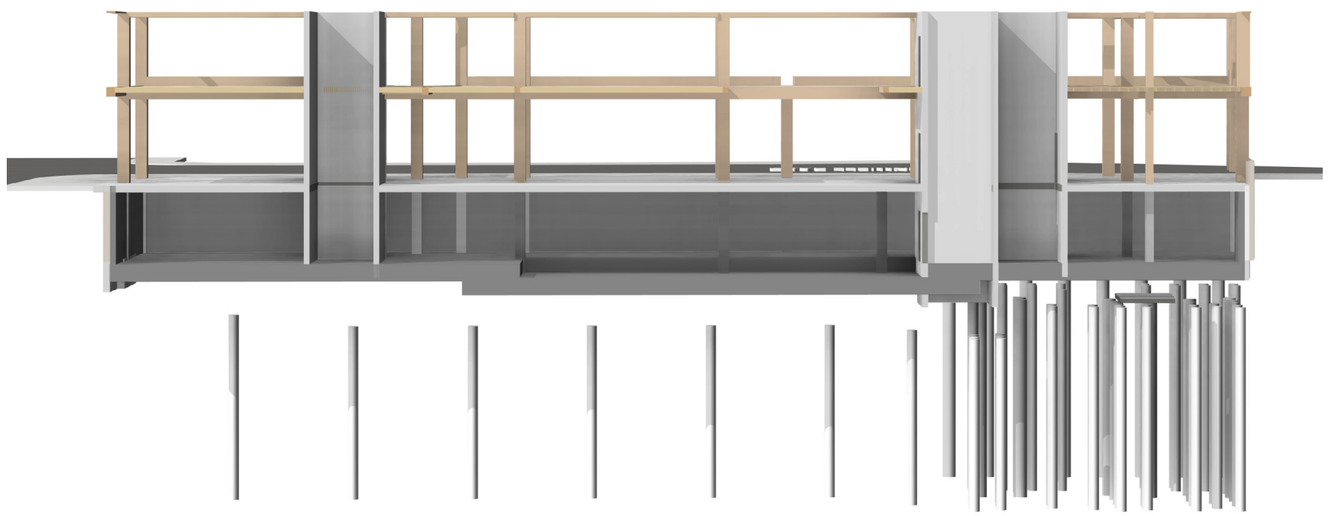


Image 17 - Long Section Through Basement of 100 GIR

A series of neighbouring structures have been set as sensitive structures and have therefore required a Building Damage Assessment to assess the impacts of the proposed works to 100 GIR. The buildings include:

+ 125 Clerkenwell Road to the east
+ The northern parts of the Ledam and Shene Buildings that form part of the neighbouring estate to the southeast of the site
+ The northern part of 88 Gray's Inn Road to the south of 100 Gray's Inn Road
+ Nos 90 to 98 Gray's Inn Road to the southwest of 100 GIR
+ Clerkenwell Road and Gray's Inn Road to the north and west respectively

Most of the proposed works cause Category 0 – Negligible levels of damage to the neighbouring buildings. There is the possibility of Category 1 – Very Slight damage to part of 125 Clerkenwell Road and to 98 Gray's Inn Road. These structures will be monitored throughout the proposed works to limit any potential damage.

3.3.2 88 Gray's Inn Road Foundations

The existing foundations to 88 GIR are currently unknown. The replacement of the existing top floor with a lightweight replacement, and the reduced loading from the change of use from office to residential, mean that by inspection the existing foundations within the main building for 88GIR are suitable and require no further investigation or strengthening.

Further investigations are required for the extension to the north of 88 GIR, currently pad foundations are proposed.

3.3.3 Basement

A basement impact assessment has been carried out following the information and guidance published by the London Borough of Camden. The assessment was carried out by GEA and it is concluded that the proposed development is unlikely to result in any significant groundwater, surface water or slope stability issues.

3.4 Proposed Sewer Connections

It is proposed to tie into the existing combined sewers in the vicinity of the site for proposed foul and surface water drainage. Separated foul and surface water networks will be provided to serve the buildings as far as possible, and will be designed in accordance with Building Regulations Part H.

3.5 Surface Water Drainage

As the development is a major planning application a detailed SuDS Strategy Report is required to support the planning application. The proposed SuDS will be designed in accordance with the NPPF, London Plan and London Borough of Camden's planning policy. SuDS are prioritised in line with the SuDS hierarchy which favours SuDS that provide multi-functional benefits, manages rainwater close to source and favours "green over grey" proposals. Along with this, the strategy will aim to reduce the discharge rate down to Greenfield rates.

The strategy for sustainable drainage includes the following:

+ blue and blue-green roofs located on terraces at levels 2 to 5, 8 and at roof level for 100 GIR
+ blue and blue-green roofs to 88 GIR
+ attenuation tank within the basement of 88GIR

The SuDS proposals are subject to agreement via planning submission with London Borough of Camden and Thames Water.

3.6 Foul Drainage

Foul water drainage from ground floor level and above is proposed to be discharged by gravity to the existing outfall to the Thames Water sewer. Drainage at basement level will employ appropriate surcharge protection measures.

3.7 Facades

A series of reviews have been carried out during Stage 2 to investigate the interface with the timber structure and the potential panel spans. Further development will be required during Stage 3 as the detailed solution is agreed.

3.8 Fire

All structural elements and connections have been designed for a 90-minute fire-rating. Engineered timber chars in fire, providing inherent protection that can be used to avoid the use of non-structural fire linings. Currently no spread of flame treatment is required for the exposed faces of the engineered timber.

CLT slabs will have a minimum 40mm thick outer-layer to reduce the risk of delamination in a fire. We are co-ordinating with the project fire consultants and understand that a detailed assessment of the impact of combustible timber surfaces on the overall performance of the building is under way.

Reinforced concrete structures have inherent fire protection, achieved through the size of their cross-section and by providing sufficient cover to reinforcement.

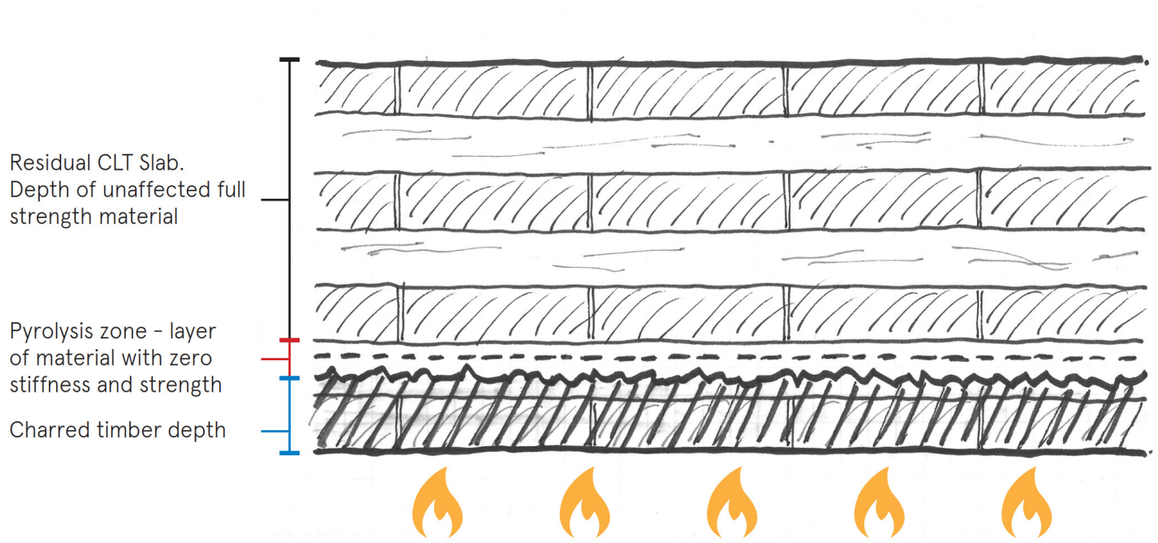


Image 18 - Performance of CLT In Fire

3.9 Construction Sequence

3.9.1 Site Set-up

Access to the site is primarily via Gray's Inn Road. A Construction Management Traffic Plan will be prepared to explain access for operatives, deliveries, and removals.

+ Erect site hoarding along the pavement boundaries to provide protection to the public
+ Set up site office, welfare, and toilets
+ Install monitoring survey targets on party walls/neighbouring properties to monitor any potential movement that may occur during the works, and begin monitoring to an agreed frequency and accuracy in line with a traffic light warning system.
+ Terminate/protect existing services as required. Install temporary drainage as required for site facilities and any required drainage diversions.
+ Check current groundwater levels via existing standpipes

3.9.2 Demolition of Existing Structure – 100 GIR & 127 CR

+ Commence demolition of the existing superstructures; sequentially demolished from the top down
+ Grub out existing basement slab and break out top of existing piles
+ Removal of rubble and waste materials in accordance with the Site Waste Management Plan

3.9.3 Demolition of Existing Structure – 88 GIR

+ Commence demolition of the existing top floor of 88 GIR

3.9.4 Basement Works

+ Upon completion of demolition of the existing superstructures commence underpinning works to existing RC retaining walls to proposed raft slab formation level
+ Complete excavations to basement formation level installing additional temporary works as required. Temporary works to contractor design during construction phase.
+ The principles of spoil removal are to be agreed

3.9.5 RC Liner Wall and Basement Slab

+ Install all below ground drainage
+ Lay hardcore and concrete blinding
+ Fix reinforcement and cast new raft slab
+ Fix reinforcement and cast new RC retaining/liner walls to perimeter of basement
+ Cast foundations to side extension to 88 GIR

3.9.6 Piling

+ Provide a piling mat at ground floor and pile new foundations to rear of 127 CR
+ Cast pile caps and new ground floor slab

3.9.7 Complete Superstructure Works

+ Erect new basement RC columns
+ Cast new GF suspended RC slab
+ Remove temporary propping to basement and GF as construction progresses, once permanent props are in place and sufficiently cured (to Contractor's design)
+ Jump-form or slip-form the RC core structures ahead of the remainder of the frame
+ Superstructure works to follow on, progressing floor by floor. The transfer beam over the entrance bay is to be jacked following each floor construction to control deflections and load distribution
+ Install proposed single-storey extension to 88 GIR

3.9.8 Cladding and Services

+ Once the superstructure is complete, work can focus on making the building weather-tight
+ The cladding is expected to be a pre-cast system spanning between column locations and lifted in to place, potentially in sequence with the works to save on programme time if possible.
+ Once the structure is completed and cladding installed work can begin on second fix

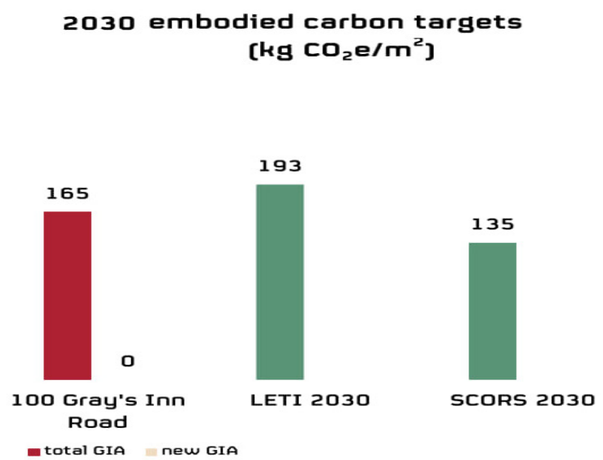
3.10 Sustainability

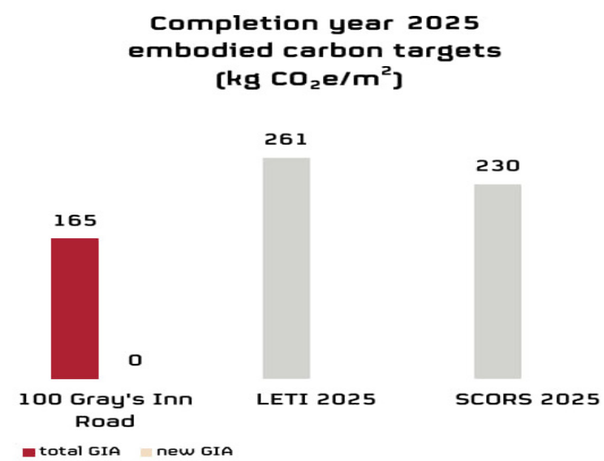
In order to benchmark the environmental performance of our structure we count the carbon using an in-house tool we have developed in conjunction with our Revit model. This is compared against the RIBA & LETI 2030 sustainability targets for a residential building structure up until practical completion (stages A1-A5) which is 193 $kgCO_2e/m^2$.

The overall embodied carbon for the structure is 165 $kgCO_2e/m^2$ which is below the RIBA & LETI 2030 sustainability target. Further information is shown in Appendix C. This value is below average for `business as usual'.

GGBS contents of 50% and 70% will be specified for the super- and sub-structure RC respectively. The use of engineered timber is highly sustainable.

Additionally, the use of timber for the barn structure allows carbon to be `sequested' within the timber. This is the carbon that is captured by the timber during growth. A total of 119$kgCO_2e/m^2$ is stored within the timber used for the structure. Once the structure reaches the end of its design life the structural timber can be re-used or recycled in to other wood products.





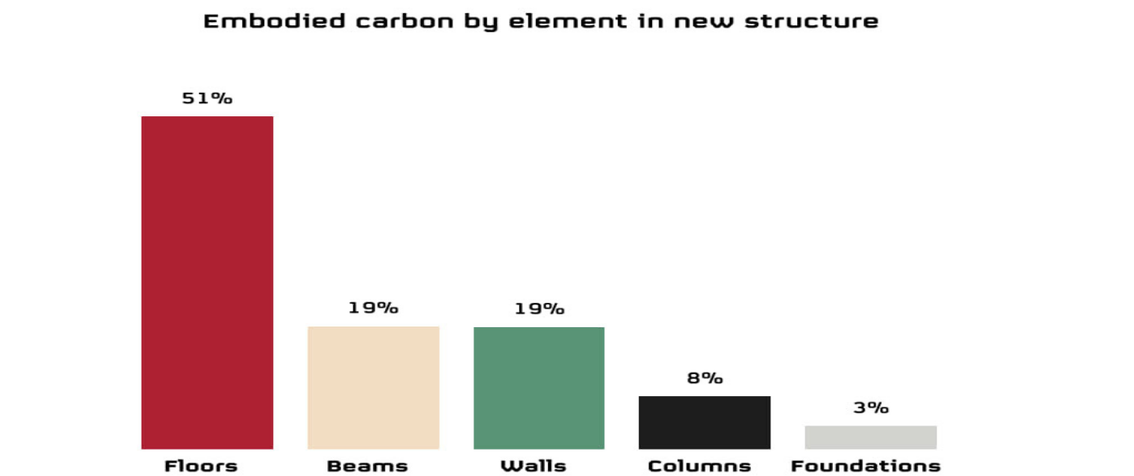


Image 19 - Embodied Carbon Summaries

4. Designer's Hazard & Risk Assessment

The lists only residual risks – those which despite careful consideration could not be designed out. A competent Contractor is assumed to be aware of the guidance in the HSE publication "Health and Safety in Construction"

Item	Activity	Risk	Action for Plan	Information for File
1.	Water management during construction	Water damage to engineered timber structure	Contractor to provide water management plan	Contractor's method statement
2.	Fire management during construction	Damage or destruction of engineered timber structure	Contractor to provide fire management plan	Contractor's method statement
3.	Formation of openings in structure without engineer input	Damage to structure or reduction in structure's capacity	All builder's works openings to be provided to engineer for review	Engineer's drawings and specifications
4.	Constrained site	Risk of damage to adjoining building	Contractor to provide method statement	Contractor's method statement
	Demarcation of site compound and access routes, with particular reference to the neighbouring buildings and streets.	Construction activities causing harm to nearby workers and members of the public during works	Contractor to formulate method statement: i) highlighting boundary of site compound ii) and various routes for deliveries and personnel to and from site. NOTE: Contractor to retain safe passageway of public along pavement immediately outside site	Contractor's method statement and sequence of construction.
5.	Proposed demolition and excavation work	Construction activities causing damage to neighbouring structures and existing retaining walls	Contractor to provide monitoring plan Contractor to provide method statements	Contractor's method statement and sequence of construction
6.	Working near the water table	Risk of flooding to proposed excavation	Contractor to provide method statement	Contractor's method statement and sequence of construction

Appendix A

HTS Drawings

HEYNE TILLETT STEEL

Appendix B

Design Parameters

HEYNE TILLETT STEEL

Appendix C

Embodied Carbon Assessment

HEYNE TILLETT STEEL

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