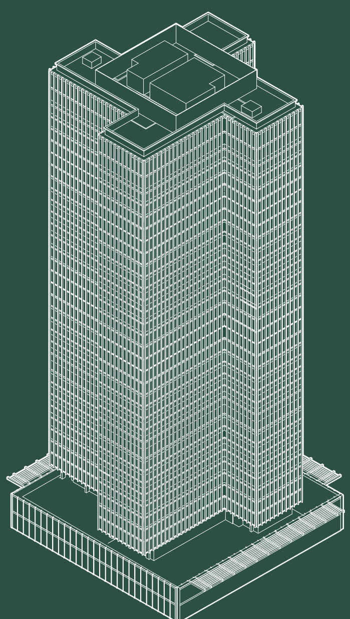

EUSTON TOWER

Feasibility Study Volume Two
Pathways for Alternative Uses

November 2023

British Land

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Rev: B

Contents

Executive Summary - Volume Two

This study forms part of the design evolution and pre-application process to explore options for re-imagining Euston Tower. This document is Volume Two of a detailed, three-part feasibility study to assess, in detail and transparently, the opportunities for reuse, degrees of retention and refurbishment of the existing tower.

In Volume One the focus was on the condition of the existing tower. The study showed that significant intervention to key building elements is required to bring it up to the standard that is required by current Building Regulations and guidance, let alone the standards expected for a contemporary, high quality, flexible, and sustainable building. The resulting floorplates would be compromised and unsuitable within the Central London office market and to support the Knowledge Quarter.

A review of planning policy has been undertaken, and it is clear in its overwhelming support for the continued use of the tower as a commercial building. From a policy perspective, the site is inappropriate for residential use due to the quantum of commercial floorspace that would be lost within the Knowledge Quarter, together with the noise and poor air quality on Euston Road which can have adverse impacts on amenity, quality of life and well-being.

Notwithstanding the strong policy support for the continuation of commercial use in the tower, this Volume builds on Volume One to explore the feasibility of alternative uses: Office-only (continued use), Office and Laboratory, Residential and Office, Residential and Laboratory, Hotel-only, and Hotel and Student Accommodation.

Regardless of use, the same primary issues identified in Volume One will need to be addressed before the building can be brought back into viable use:

- Wide-reaching upgrades of the fire safety provisions are required, including upgrades of the structural fire performance and new fire fighting lifts to meet current Building Regulations
- Existing servicing provisions (e.g. fresh air risers) are insufficiently sized to accommodate current Building Regulations, and new MEP services equipment is required, with almost all of the MEP equipment beyond its service life (and mostly already stripped out)
- The façade does not comply with current Building Regulations and guidance for fire or thermal performance, and many of its components are beyond their service life.

Substantial structural alterations are necessary to deliver these upgrades, including new lift shafts and new risers. Large portions of the floor slab are impacted by these interventions, where entire slab zones need to be removed if any portion of the existing ribbed system is overlapped by new vertical penetrations. This is exacerbated in the mixed-use options, where each use requires two, independent escape cores, further reducing net area and precluding the possibility of mixing more than two distinct use cases.

To accommodate modern MEP services, an increased floor and ceiling zone is required. The resulting floor to ceiling heights for the office uses are as per Volume One, where regardless of whether exposed services or a dropped ceiling are pursued, there are extensive areas of the floorplate that are not compliant with the BCO recommendations for floor to ceiling heights, and this would challenge lettability. For the residential schemes (incl. student accommodation), the resulting clear floor to ceiling height is between 2,265-2,445mm across the apartments, which does not meet the requirements of the London Plan for clear heights in residential apartments.

A viability analysis for the use cases was undertaken. For the offices, the costs of undertaking the required upgrades within the existing envelope make the viability challenging. For the residential schemes, the poor quality nature of the resulting apartments — with low floor to ceiling heights, lack of outdoor amenity, several single-aspect units, and noise and pollution issues — makes the cost of such a conversion relative to value achieved prohibitive. This is exacerbated when 35% affordable housing is included on site. A full-hotel scheme on the site would be one of the largest hotels in London, and lack of operator or investor interest would be prohibitive to viability.

An Air Quality Assessment was undertaken and found the environment to be sufficiently polluted to recommend against openable windows in the lower potion of the tower along Hampstead Road. Similarly the noisy environment, driven by 24-hour road noise and the nearby A&E department at UCLH, are not compatible with noise-sensitive uses.

With quality being subjective, there is no single reason not to pursue any of the alternative use cases. Rather the reasons are layered, and ultimately it is clear that when balancing technical suitability, quality, economic viability, and planning policy, the best use for the tower is continued use as commercial space.

TESCO express
SCO express
Victoria 390
Anti-freeze
LTZ 1113

8

Euston Tower

Introduction

8.1 Background

Standing as a forgotten landmark on the northern edge of central London, Euston Tower is the tallest and oldest building in the Regent's Place campus. Comprising 645,000ft², it was completed in 1970 as an office building to provide cellular office accommodation typical of the period, and formed part of a wider master plan known as Euston Centre.

The site falls within the London Borough of Camden, and is bounded by Euston Road to the south, Hampstead Road to the east, and the pedestrianised Regent's Place Plaza to the west. It now sits within the Knowledge Quarter Innovation District.

Since its completion in 1970, it has undergone a small refurbishment to add a secondary glazing system and perimeter fan coil system (ca. 1990), but beyond this its external form and façade remain largely as originally constructed. These elements of the building are in a generally poor condition, due to a combination of wear in use and the quality of the original detailing.

Gradually it has been vacated, and since 2021, with the exception of the retail at ground level, the building is entirely vacant.

Accordingly, British Land is seeking to transform Euston Tower into a beautifully designed, sustainable, new building, delivering pioneering workspace, accessible and inclusive spaces for neighbouring communities, and support the development of the local economy. Their vision is to create a world leading science, technology and innovation building and public realm for Camden and the Knowledge Quarter that inspires, connects and creates opportunities for local people and businesses.

As a first step in the re-imagining of Euston Tower, British Land is assessing the opportunities for retention and refurbishment of the existing tower and its basement. At a high level this assessment considers the condition of the existing building and its fitness for purpose, the technical feasibility of upgrades where appropriate, alternative use cases, the economic viability of these scenarios, and options for retention and extension of the existing tower.

Figure 8.1 Euston Tower in 1970 as seen from the BT Tower

8.2 Structure of this Study

This feasibility study is split into three volumes, which together form a detailed and transparent assessment of the opportunities for retention and refurbishment of the existing tower.

This document forms Volume Two of the study.

Volume One
Volume One explores, in detail, the condition of the existing tower. It considers the planning policy relating to the future use of Euston Tower, as well as market requirements for continued commercial use of the tower.

It presents an appraisal of the operation of the existing building, including an assessment of the building services.

Finally it sets out the upgrades required to comply with current legislation, based on a technical review looking at the condition of the architecture, structures, and facade.

Volume One concludes that the cost of upgrades required for continued office use and the quality delivered where the existing building is refurbished, would make viability challenging, and the resulting product would be compromised in the leasing market. Therefore alternative use cases in connection with a refurbishment of the existing building should be explored.

Volume Two (this document)
Volume Two explores pathways for alternative uses within the existing tower. It studies a broad spectrum of realistic use cases, with both single- and mixed-use options, specifically:

- Office-only
- Office and lab
- Residential and office
- Residential and lab
- Residential and hotel
- Hotel-only
- Hotel and student accommodation.

It considers the policy position for each use case in turn, and how the specifics of the site and proposals are suited or unsuited thereto.

It presents stacking diagrams and test layouts, which are developed working through the implications on structures, MEP, fire, and vertical transportation.

As in Volume One, it sets out the upgrades required to comply with current legislation for each respective alternative use case.

Finally it considers the economic viability of the alternative use cases.

Volume Two concludes that only continued commercial use is appropriate, but that additional value is required to improve the viability. Therefore options that generate additional lettable area should be explored.

Volume Three
In response to the preceding two volumes, Volume Three explores options for retention and extension of the existing tower.

It considers commercial use only, and details several options for retaining portions of the existing tower while at the same time extending the floorplates. The options range from maximum retention and extension, through partial retention and extension retaining some floor slabs and/or the core, to new build.

The study shows how, due to the interventions required to comply with Building Regulations, there is no scenario that retains 100% of the existing structure within the existing envelope, and that accordingly the schemes should be judged against an upgraded tower.

Each option entails a different level of complexity. For each option the amount of structural salvage, the buildability and impact of temporary works is assessed. The resulting quality of space is considered looking at grid constraints and floor to ceiling heights. Finally, the impact on flexibility, adaptability, and potential to design for disassembly is studied. This is followed by a feasibility stage whole life-cycle carbon assessment of the options.

Figure 8.2 Three volumes of this feasibility study

8.3 Purpose of this Report

This study forms part of the design evolution and pre-application process to explore options for re-imagining Euston Tower. This document is Volume Two of a detailed, three-part feasibility study to assess, in detail and transparently, the opportunities for reuse, degrees of retention and refurbishment of the existing tower.

This document is prepared in response to the requirements of the London Plan 2021, specifically policy SI 7 and its associated guidance on the circular economy, but also takes cognisance of policy D3 with regards to optimisation of site capacity. It is also aligned with the policies of the Camden Local Plan 2017 and its supplementary document: Camden Panning Guidance - Energy efficiency and adaptation which in clause 9.4 requires a condition and feasibility study, and an options appraisal for all major developments proposing substantial demolition.

This Volume builds on Volume One to explore alternative uses for the tower. For each use case in turn, the policy context is considered, as well as the technical feasibility based on the interventions required to the structure, facades, fire safety, building services, and lifts. Finally the economic viability for each use case is considered.

Section 9 explores commercial-led developments, looking at an office-only case, as well as an office and laboratory-enabled use case. It concludes that the resulting office spaces would be compromised and difficult to lease, and that with the costs of upgrading would be challenging to viability.

Section 10 presents residential / mixed-use options, specifically:
- Residential and office
- Residential and laboratory
- Residential and hotel.

It finds that the location and moreover the existing building is not well-suited to residential use. The resulting residential apartments would be of low quality, with low floor to ceiling heights failing to meet minimum standards, lack outdoor amenity provision, have several single-aspect units, and have noise and pollution issues. The cost relative to value achieved would make such a conversion unviable.

Section 11 presents hotel / student accommodation options, specifically:
- Hotel-only
- Hotel and student accommodation.

The resulting hotel suites would be of medium quality, but the scale of the hotel (it would be the fifth / sixth largest in London) means operator and investor demand is unlikely. The resulting student accommodation is of low quality, for similar reasons to the residential apartments, and similarly the cost relative to value achieved would make such a conversion unviable.

Finally Section 12 presents a brief conclusion to this part of the study, showing that only continued commercial use is appropriate, but that additional value is required to improve the viability.

The findings in this report are based on technical drawings and documentation, as well as the results of extensive non-intrusive and intrusive surveys. These are signposted where relevant throughout the report and included in their entirety in the appendices.

The aim of this study is to outline and explore the various factors — technical, economic, policy-driven, market demand, etc. — that inform a re-imagining of Euston Tower. Together with London Borough of Camden and its stakeholders, this will allow for an informed, fact-based decision to be made for Euston Tower's future. A future which realises British Land's vision to create a world leading science, technology, and innovation building and public realm for Camden and the Knowledge Quarter that inspires, connects, and creates opportunities for local people and businesses.

8.4 Project Team

Client	British Land
Project Manager	Gardiner & Theobald
Cost Manager	Gardiner & Theobald
Architect	3XN Architects
Executive Architect	Adamson Associates
Planning Consultant	Gerald Eve
Structural Engineer	Arup
Services Engineer	Arup
Fire Engineer	Arup
Wind	Arup
Transport & Servicing	Velocity
Lifting Consultant	SWECO (with input from Arup)
Facade Consultant	Thornton Tomasetti (with input from Arup)
Sustainability Strategy	GXN
Sustainability Consultant	SWECO
Daylight	Point2
Market Analysis	CBRE
Financial Viability	DS2

8.5 Overview of Alternative Uses

Volume One of this feasibility study assessed the condition of the existing building. The status and quality of the existing tower were assessed - both its existing servicing capacity and technical capacities - in terms of the requirements for delivering a modern high-end commercial office building.

It is clear in Volume One that the level of intervention required to do so is extensive and far reaching. Volume One concludes that the cost of upgrades required for continued office use and the quality delivered would make viability challenging, and the resulting product would be compromised in the leasing market, as well as lack the capacity to flex and adapt to future demands. Therefore alternative use cases for a refurbished building should be explored.

As a means of exploring the potential for the site, Volume Two (this volume) studies several alternative uses for the existing building. These studies are intended to better understand how the land can be utilised most effectively, in line with the intention of London Plan Policy D 3 for "optimisation of site capacity".

The following land use cases are presented in the following sections:

Commercial-led developments (Section 9)
- Commercial office-only
- Commercial office and laboratory-enabled spaces

Residential-led mixed use (Section 10)
- Residential and commercial office
- Residential and laboratory-enabled spaces
- Residential and hotel

Hotel / Student Accommodation developments (Section 11)
- Hotel-only
- Hotel and student accommodation.

The stacking diagrams for the studied use cases are shown in Figure 8.3. Explanation for how these are developed is given in the relevant sections.

8.5.1 Approach

The approach with all of these studies is to be as unintrusive as possible. That is, to deliver a Building Regulations-compliant building for each of the relevant use cases with the least intervention possible.

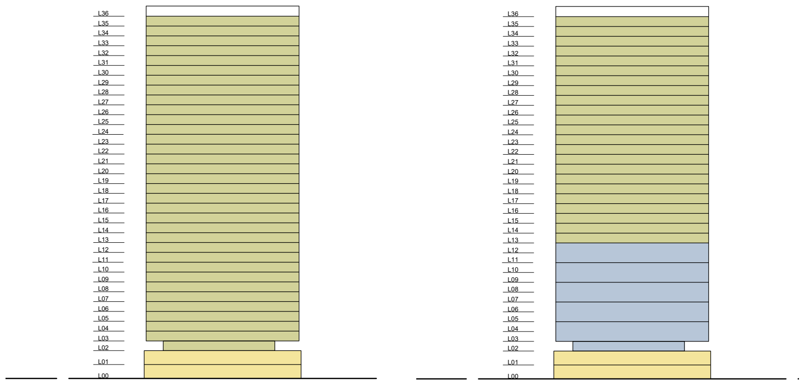
In studying the use cases across a broad base, each case is considered in terms of its relation to current policy, its design and technical considerations, and its economic viability.

Each case is developed architecturally using plan layouts (test fits) and sections. With input from the engineering team, these are developed to a level of detail commensurate with a feasibility study, and are intended to be indicative of the primary spatial requirements for each of the use cases.

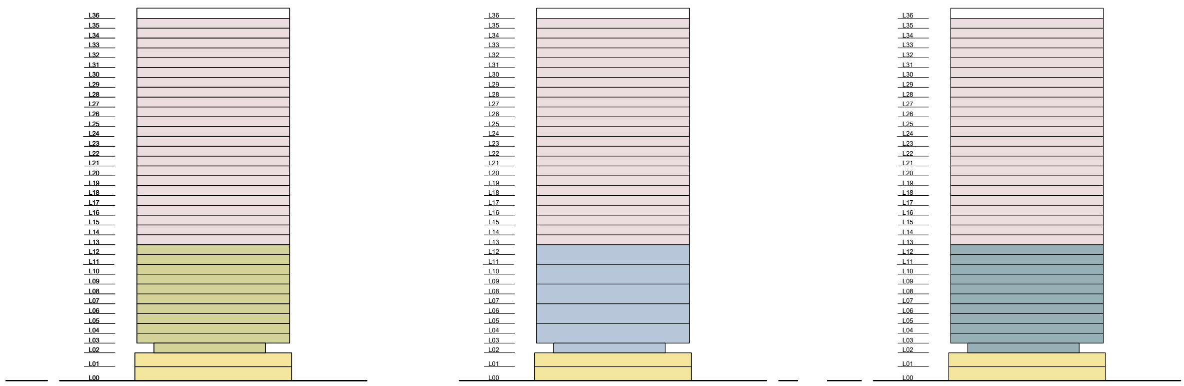
The options are chosen to represent plausible possible mixes of land uses. A maximum of two land uses within the tower are chosen, as introducing three separate options is not viable given the extent of separate escape cores, circulation space and services that would be required to accommodate the distinct individual uses.

Of course there are myriad possible combinations of mixed-use options. However the poor air quality in the lower portion of the tower along Hampstead Road precludes any uses here that require openings in the facade. And while there exist sub-options within the use cases presented, the developed options are chosen to be representative of the issues that would arise from various other options.

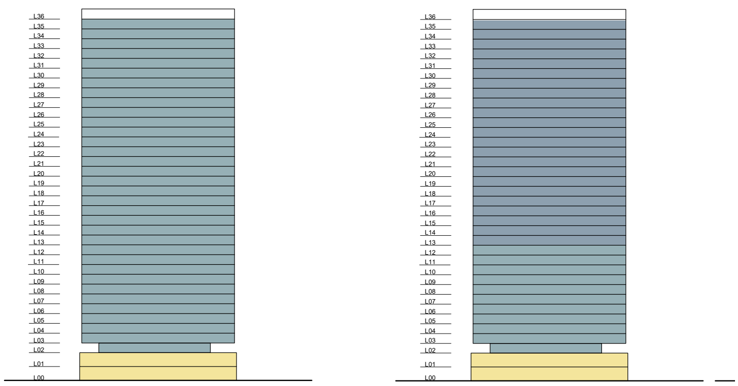
COMMERCIAL-LED DEVELOPMENTS



RESIDENTIAL-LED DEVELOPMENTS



HOTEL / STUDENT ACCOMMODATION DEVELOPMENTS



Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Figure 8.3 Stacking diagrams for use cases explored in this volume of the feasibility study

9

Euston Tower

Commercial-led Developments

9.1 Introduction

9.1.1 General Description

The commercial-led use cases studied in this Section are the following:

- Commercial office-only
- Commercial office and laboratory-enabled spaces.

The office-only case represents effectively the "base case" position explored in Volume One, in that it does not deviate from the current office use case.

In the office-only option, all floors above the podium are considered as speculative office (Levels 02-35 inclusive). In the option with laboratory-enabled spaces, the existing, intermediate floors are removed for the areas to be lab-enabled. This results in lab-enabled space from Levels 02-12 (but giving only 6 no. lab-enabled storeys), and speculative office above, from Levels 13-35 inclusive. The stacking diagrams are shown in Figure 9.1 and the floor plans in Figure 9.2 - Figure 9.4.

9.1.2 Architectural Commentary

As demonstrated in Section 9.3, the increased servicing and lifting provisions required to meet building regulations and bring the floorplate up to code, result in a series of small, disconnected spaces, separated by the enlarged satellite cores. This is evident in the floor plans in Figure 9.2 - Figure 9.4.

Pinch-points around the cores and risers, and the clear routes required to access the satellite cores, lead to a series of corridors which result in further divisions of workspace and a loss of usable floor area. This is further exacerbated if multi-tenant floorplates are considered as illustrated in Figure 9.28.

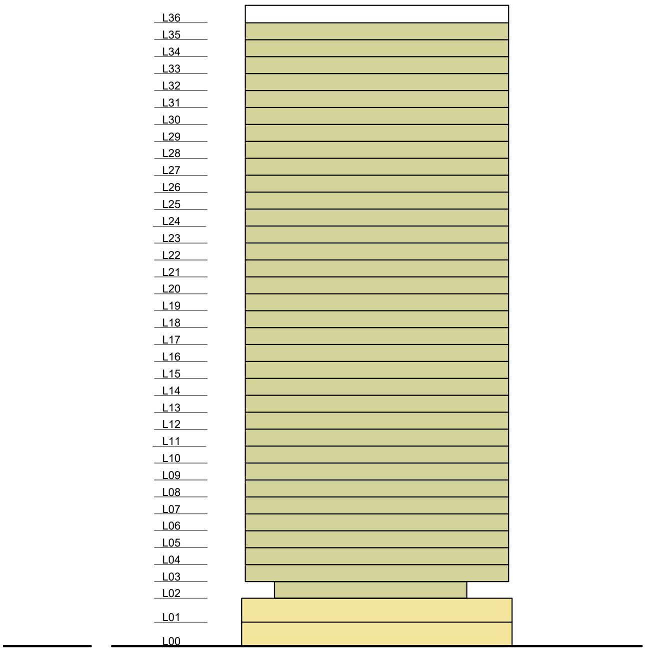
The pinwheel plan and relatively shallow floorplate allow adequate access to daylight. However, the increased riser provision and local AHUs around the satellite cores create solid elements behind the façade, resulting in obstruction to the daylight access in these locations. Daylight access is further impeded by negotiating services and the perimeter ring beam. To hide high level services, the perimeter ring beam requires either a dropped ceiling, or at least a bulkhead ceiling area. In both cases this would drop into the daylight zone (below the level of the clear vision glazing), reducing the daylight penetration onto the floorplate. See Figure 9.8.

The low floor to ceiling height that results from adequately servicing the floorplates with modern MEP services, may create dark areas and a sense of compression, even for the relatively shallow floorplate. Though there are methods to raise the perceived height of the space (through raft ceilings or exposing the services, for example), these strategies limit the fit-out options for tenants, restricting the number of potential occupiers and consequently lowering the value of the development. These strategies notwithstanding, the clear floor to ceiling height would be significantly lower than is expected for a Class A office space in the UK. Refer to the market commentary in Section 3 in Volume One.

From an architectural perspective, the qualities of the upgraded office floorplate are therefore not considered appropriate given the prominence of Euston Tower and the ambitions for high quality workplace in Camden.

OFFICE-ONLY

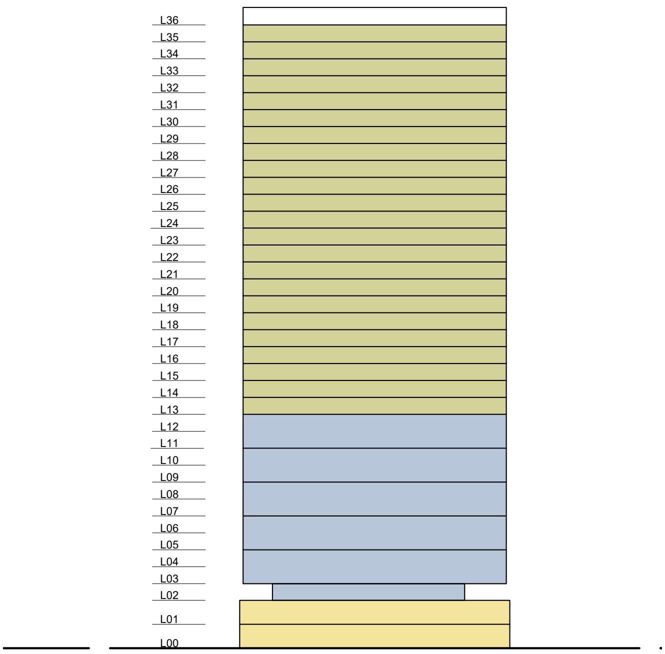
Key
Residential
Student Housing
Hotel
Offices
Labs
Retail



Office-only Stack

In this stack all levels above the podium are office levels (Levels 02-35 inclusive). This stack represents a continuation of the existing use case.

OFFICE AND LAB



Office and Lab-enabled Stack

In this stack the lower portion of the stack is laboratory-enabled levels, with offices above. The existing, intermediate floors are removed for the areas to be labs. This results in lab-enabled space from Levels 02-12 (but giving only 6 no. lab-enabled storeys), and speculative office above, from Levels 13-35 inclusive. The lab-enabled space is proposed below the offices because it requires a heavier structure for loading and vibration control which is better suited lower down. This case accepts that specialised laboratory services like central flues will need to be taken up internally, through the office levels to roof.

Figure 9.1 Commercial-led section stacks. Office-only (above) and office with lab-enabled (below)

Figure 9.2 Typical floorplates for offices in office-only scenario with 4 no. AHUs per level

Figure 9.3 Typical floorplates for labs in office and lab-enabled scenario with 4 no. AHUs per level.

Figure 9.4 Typical floorplates for offices in office and lab scenario with 4 no. AHUs per level.

9.2 Planning

9.2.1 General

As set out in Section 2 of Volume One, regional and local planning policy overwhelmingly supports the continued use of Euston Tower for commercial use.

9.2.2 Relevant Site Designations

Euston Tower is located centrally within one of Camden's and London's most strategically important, and thriving, economic areas. Maintaining, protecting and promoting the world class status of this business hub is crucial to the economic success of Camden, to encourage market leaders to the area and provide a range of jobs for local people and across London. This objective is promoted under National Planning Policy Framework (NPPF) Paragraph 8, which seeks to "build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity." Paragraph 83 supports this by stating "Planning policies and decisions should recognise and address the specific locational requirements of different sectors. **This includes making provision for clusters or networks of knowledge and data-driven, creative or high technology industries."**

Euston Tower is centrally located within the Central Activities Zone (CAZ), Euston Area Plan and Knowledge Quarter Innovation District, and is one of the few existing buildings of this scale and location within the London Borough of Camden. Policy E1 of the London Plan recognises the CAZ as a location for unique agglomerations and dynamic clusters of work city business and other specialist functions. London Plan Paragraph 6.1.2 states that it is important that the planning process does not compromise potential growth in the office market, and the CAZ is expected to grow by 59% over the period of 2016-2041.

There is therefore an exciting opportunity to ensure that the area is maintained as a leading centre enabling Camden to compete on the world stage in business and innovation.

Furthermore, Camden seeks to protect existing employment floorspace under policy E2 of the Local Plan on sites that are suitable for continued business use, in particular premises for small businesses, businesses and services that provide employment for Camden residents, and those that support the functioning of the Central Activities Zone (CAZ) or the local economy. Ultimately, commercial floorspace in this location is protected under regional and local planning policy. The loss of the commercial floorspace would not only be contrary to policy but would be a lost opportunity to provide world class commercial floorspace in this sustainable location which would complement and enhance the economic prosperity of the area. A commercial building of this size, which brought back to life, could provide significant opportunities for local people through a range of jobs, through the construction and operational phase of the development and provide a focal point for the community.

9.2.3 The Knowledge Quarter

Given the Site's location within the Knowledge Quarter, relevant, emerging policies within the Site Allocations document apply. Policy KQ1 states that any floorspace proposed should support future reconfiguration for different activities and where possible include flexible floorplates, plant room and mechanical and electrical systems that allow a change from offices to laboratories. Suitable floorspace for priority growth sectors within the district such as life sciences, digital collections and machine learning will also be required.

The opportunity to provide flexible floorspace to accommodate both offices and laboratory space is therefore supported at a local level, with positive, strategic implications for wider London to cement the area as a centre of innovation.

In order to do so, the layout, floorplates, access and services need to be designed flexibly, to allow for adaptability in the future to meet changing market demands to ensure the requirements of the CAZ and Knowledge Quarter are appropriately met.

Figure 9.5 View from the roof of Euston Tower 2022

9.3 Technical

9.3.1 Structures

The original tower was designed as an office space. The original live load for the floor is understood to be 2.9kN/m^2 + 0.96kN/m^2 for partitions. The superimposed dead load was taken as 1.15kN/m^2 + 0.29kN/m^2, giving a total ultimate load capacity of 7.7kN/m^2. This is larger than the minimum recommended live load allowance of 2.5kN/m^2 + 0.5-1.2kN/m^2 for partitions provided in the BCO, and as such, is suitable for use as an office.

The existing floor performs well in terms of vibration comfort. Measurements taken by Arup in 2019 (see Appendix C) show an average response factor (R) of between 1 and 5. This is compliant with the BCO recommended value of <6 or <8 for a high specification office.

While the loading capacity and the vibration response of the existing slabs is suitable for reuse as a commercial office, it is its adaptability that plays a large part in determining the feasibility of retaining the slabs.

The ribbed slab areas provide a reasonable location to penetrate the floor for additional risers or vertical circulation. However, given that the ribs span in one-direction, the entire rib must be demolished if it is disrupted. The effect is that areas of small demolition result in larger portions of the ribbed slab needing to be removed.

If cutting through flat-slab areas, additional framing structure will be required to support the floor slab around the void.

Lab-enabled Levels
The laboratory levels in the option with lab-enabled spaces require taller floor to ceiling heights than the typical commercial office levels. To accommodate this with minimal structural intervention, it is envisaged that the intermediate floor slabs between Levels 02 - 12 will be removed, resulting in double-height spaces for the remaining floors. See Figure 9.1.

Unlike offices which are well understood, the structural requirements for laboratory spaces are contingent on the nature of work undertaken there. The proposed loading and vibration criteria are shown in Figure 9.6.

The loading allowances are significantly more than for a typical office space, and accordingly the loading allowance exceeds the existing allowance. Laboratories would be designed to live loads of 3.5 + 1.0kN/m^2 for partitions. It is anticipated that the laboratory spaces will be designed to meet a vibration criteria of R < 1, 8x stricter than a Grade A office space.

To accommodate this and remove the intermediate floors, extensive and major structural works are required:

- Column strengthening to span two storeys
- Core wall strengthening to span two storeys
- Strengthening of the perimeter edge beam to support a double-height facade
- Possible strengthening of the floor structure to support heavier lab loading and achieve vibration criteria.

Office Structural Criteria				
Topic	**Parameter**	**BCO**	**British Land**	**Arup Suggestion**
Grid	**Structural**	9m, 10.5m, 12m, 15m	12m x 9m	9 x 9m (typ)
Planning		15m module	1.5m module	1.5m module
Permanent Loading	**SDL**	0.85kN/m2	0.85kN/m2	0.85kN/m2 as target maximum
Partitions		0.5-1.2kN/m2	1.0kN/m2	0.5kN/m2 as target maximum
Imposed Loading	**Typical**	2.5kN/m2	3.0kN/m2	2.5kN/m2
High load areas		7.5kN/m2 over 5% of floor area	Not mentioned	7.5kN/m2 over 5% of floor area
Floor vibration		R < 6 to 8	Ref. BCO	R < 8 (as local peak)

Laboratory Structural Criteria				
Topic	**Parameter**	**BCO**	**British Land**	**Arup Suggestion**
Grid	**Structural**	6.2, 7.2m	9m x 9m	9 x 6m (typ)
	Planning	Not mentioned	2.3m module	To suit architecture
Floor finish		Heavy duty RAF or screed	Heavy duty RAF or screed	Avoid screed if possible
Permanent Loading	**SDL**	Not mentioned		1.0kN/m2 as target maximum
	Partitions	Not mentioned		1.0kN/m2 as target maximum
Imposed Loading	**Typical**	4.0kN/m2 *	4.0kN/m2	3.5kN/m2 as target maximum
	High load areas	Not mentioned		Facilitated in write-up areas
Floor vibration		Various	100% R < 1 **, 50% R < 0.5	100% R < 1 **, 50% R < 0.5

* The BCO allows for a reduction to $3.0kN/m^2$ for some laboratory uses.

** Response factor in laboratories due to walking at 1.8Hz within tenants' own demise and 2.5Hz in landlord corridors.

*** Target maximum values for permanent and imposed loading will be reviewed and optimised further.

Figure 9.6 Structural criteria for offices floors (above) and laboratory floors (below)

9.3.2 Fire

The building will need to comply with current fire regulations, including Approved Document B 2021 edition and BS9999 for non-residential uses. Due to the commercial use case, Building Regulation 7 does not apply.

Critically, a building the height of Euston Tower (more than 30m) requires 120 minutes structural fire rating, see Figure 9.7. Based on a previous Arup assessment, the existing structural fire rating is understood to be between 60 and 90 minutes when tested to current standards. This means that, even in this case where the aim is minimal intervention, areas of the existing structure will need to be upgraded to achieve the required structural fire rating.

An office or lab-enabled use would need 2 fire fighting stairs, and 1 additional escape stair from basement to ground. The existing stair provision is suitable, noting that the structural fire rating may need upgrading to 120 minutes as per above. However, each escape stair would need an associated dedicated fire fighting lift and an evacuation lift, meaning new lifts will be required above those already provided. Additionally mechanical smoke ventilation will be required (e.g. pressurisation system), resulting in increased plant space requirements.

A commercial fire sprinkler system would be required per BS EN 12845 and likely LPC insurance requirements, as well as an automatic L1 detection/alarm system. Because the existing building is only sprinklered from basement to Level 02, allowing for a full system will have implications on plant and riser provision that must be accommodated.

Notwithstanding that the building is not considered a Relevant Building, the external wall construction must still limit the risk of fire spread. The existing facade does not have adequate fire stopping provisions at slab edge, meaning it does not achieve acceptable fire compartmentation between floors. This would need to be corrected as part of a new facade, that is proposed as part of the MEP/energy overhaul.

The following lists other key fire design implications for the office and/or laboratory use:

- Evacuation strategy is phased throughout
- Travel distances vary depending on uses with the office usage of 50m for two way travel or 20m for single travel
- Occupancies are limited by the size and locations of exits/stairs as well as usage of spaces. 1:6 occupancy target for typical office floors, with a higher density on public floors (tbc depending on use).
- Fire fighting provisions include vehicle access to all stair cores (2 cores), wet risers and a fire control centre.

Risk profile	Minimum periods of fire resistance, in minutes					
	Depth below access level of lowest basement		Height * of top occupied storey above access level			
	More than 10m	Not more than 10m	Not more than 5m	Not more than 18m	Not more than 30m	Not more than 30m
A1	60	60	30	60 **	90 ***	120
A2	90 ***	60	30	60	90	120
A3	Not allowed	120 ****	60	90	90	120
B1	60	60 **	30	60	90 ***	120
B2	90 ***	60	30	60	90	120
B3	Not allowed	120 ****	60	90	90	120
C1, C2 and C3 (not individual residential)	90 ***	60	30	60	90 ***	120

NOTE: 15 min. fire resistance may be used for open car parks above ground level and with a top occupied storey not more than 18m above access level (increased to 30 min. protecting vertical means of escape)

* Buildings above 30m are not permitted unless they have sprinklers in accordance with BS 5306-2 or BS EN 12845

** 30 min. if sprinklers conforming to BS EN 12845 (new systems) or BS 5306-2 (existing systems) are fitted.

*** 60 min. if sprinklers conforming to BS EN 12845 (new systems) or BS 5306-2 (existing systems) are fitted.

*** 90 min. if sprinklers conforming to BS EN 12845 (new systems) or BS 5306-2 (existing systems) are fitted.

Figure 9.7 Fire resistance periods for elements of structure (independent of ventilation conditions)

9.3.3 MEP

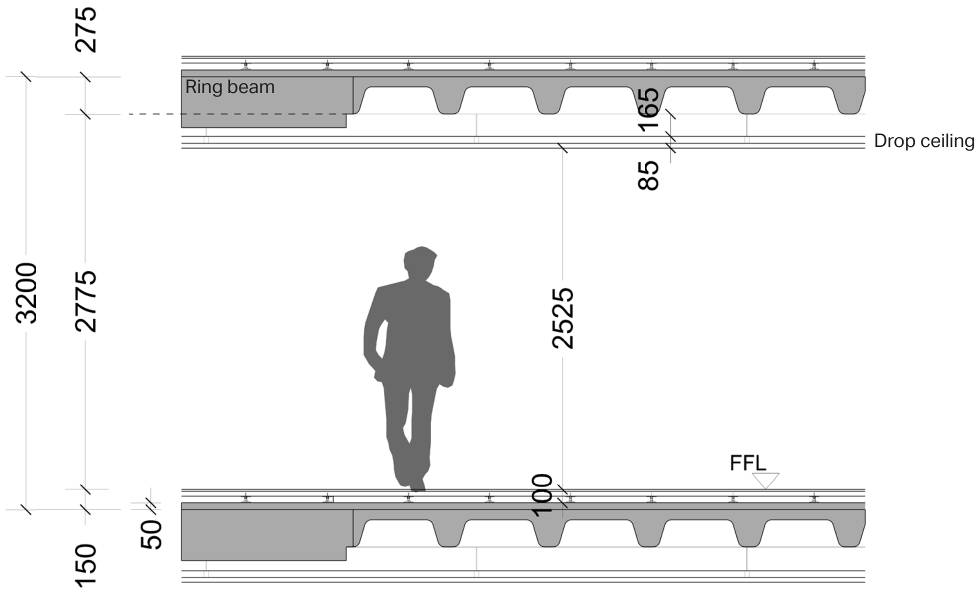
A new office will need to comply with current Building Regulations, particularly Approved Documents L and F for MEP services.

The existing ventilation systems are likely to have been based on fresh air rates commensurate with ADF 1995, or possibly below given the age of the original design (less than 6.4l/s/p). The existing risers form the centralised ventilation plant rooms (Levels 01, 12, 35) would have been sized for this rate.

A new offering would need to provide minimum 12l/s/p in accordance with ADF 2021, but more likely provide 16l/s/p in accordance with the WELL Building Standard, a 2.5x increase over the original design. Together with much more stringent requirements for energy efficiency (necessitating larger risers to move air at lower speeds), the new provision would require both new air handling plant and its associated plant space, and significantly larger riser provision. It is anticipated that new air handling plant would be provided decentrally (local to the floors) to minimise disruption to the existing cores.

Beyond ventilation, the scheme would also need to comply with ADL 2021. The scheme would therefore seek to be all-electric in order to avoid burning fossil fuels on site, to help improve local air quality, and to tie the scheme's operational performance to the ever improving carbon intensity of the national electrical grid. This would result in a totally revised plant space and riser configuration.

On the room side, the existing floor to floor height of 3.2m is low by modern standards. It is enabled in the existing building because the original services are located at the perimeter, notwithstanding changes to requirements and expectations (e.g. ventilation provision, data accessibility). With the 100mm raised floor zone and the current ca. 225mm ceiling provision, the resulting clear floor to ceiling height is 2,550mm. This is not sufficient space to support modern building services. See Figure 9.8 to Figure 9.12.

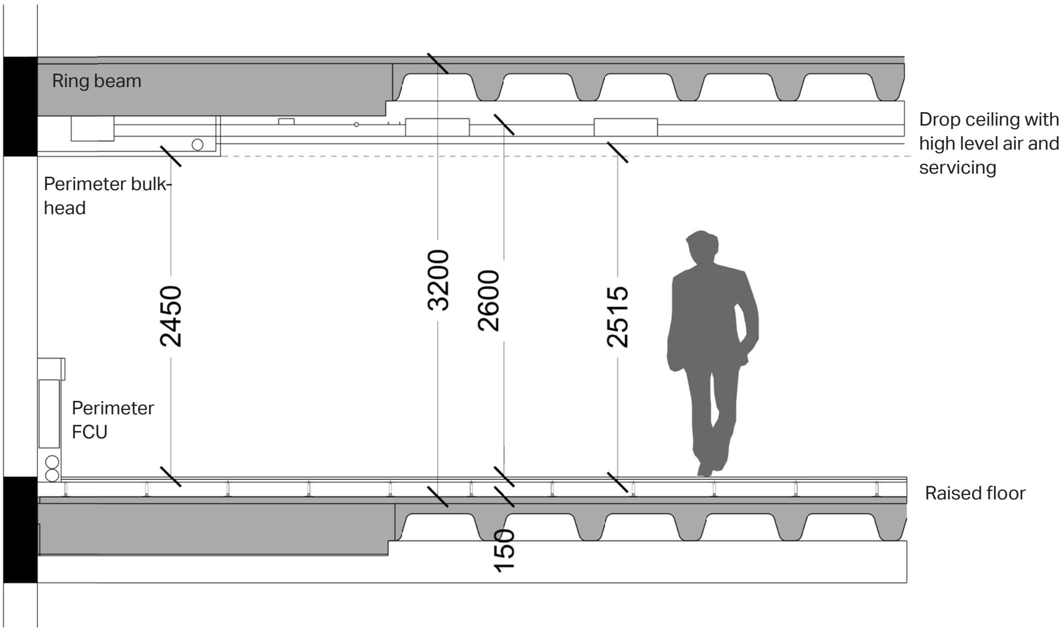


Existing Condition
The 100mm raised floor is not enough space for modern services. The 250mm ceiling depth is minimal since services are located at the perimeter. To make room for modern services, the depth of the floor and ceiling would need to increase. The minimal ceiling build-up and services zone under the ring beam will require compromises in the fitout.

Figure 9.8 Existing floor to ceiling height

Room Section Options

Several options are considered to provide floor and/or ceiling zones that do support such services (refer to Figure 9.9 to Figure 9.12).

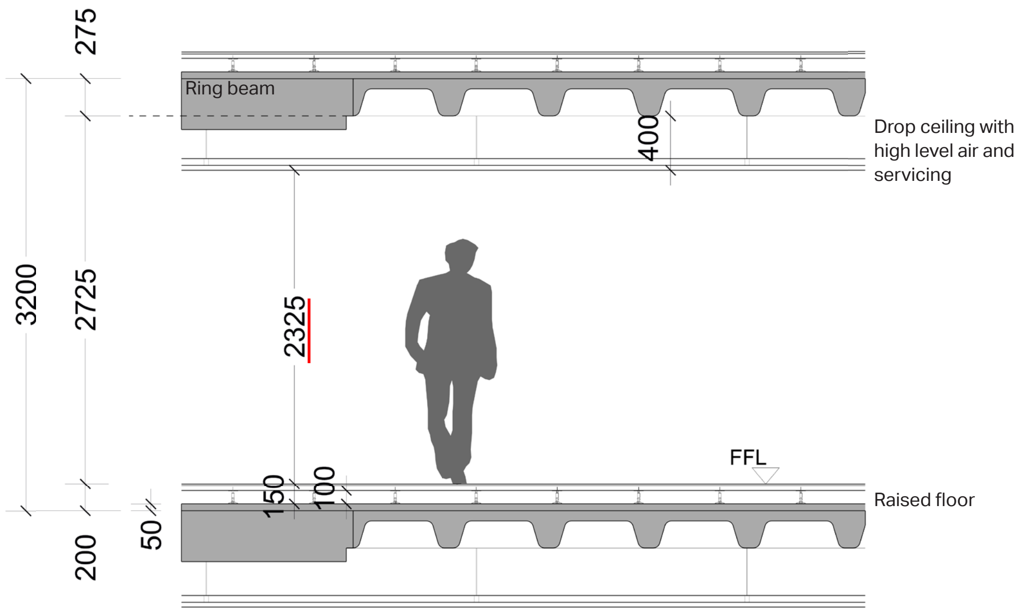


Modernising Option 1

One strategy is to have perimeter servicing with a drop ceiling with high level air and a servicing bulkhead. The floor is raised to allow 100mm clear (150mm total build up). Clear height is at the low end of the BCO recommendation for refurbishments.

In Option 1 a modernised, perimeter servicing strategy is proposed as this was the strategy for the existing building. All major services are provided at high level (ventilation, heating and cooling, fire sprinklers, lighting). Ventilation is provided from perimeter, on-floor AHUs and distributed in a bulkhead at the perimeter. In this case the ceiling void at the bulkhead needs to be ca. 4000mm, but it steps up ca. 2,000mm away from the facade to deliver increased floor to ceiling height. Subject to more detailed coordination, the bulkhead may have to be widened locally to avoid existing perimeter columns, further compromising the floorplate. Facade heating and cooling would be delivered by low-level fan coils at the perimeter. It is assumed that cooling will be delivered by slimline, in-ceiling fan coil units, so that the raised floor is used for power and data reticulation only requiring 100mm clear. Allowing for the thickness of ceiling construction throughout, the resulting clear floor to ceiling height is 2,515mm over an extensive portion of the floorplate. Clear height of 2,450mm would be achievable below the bulkhead, which would just comply with the lower end of the BCO guidance, but would still not meet occupier requirements.

Figure 9.9 Servicing modernisation option with perimeter servicing strategy

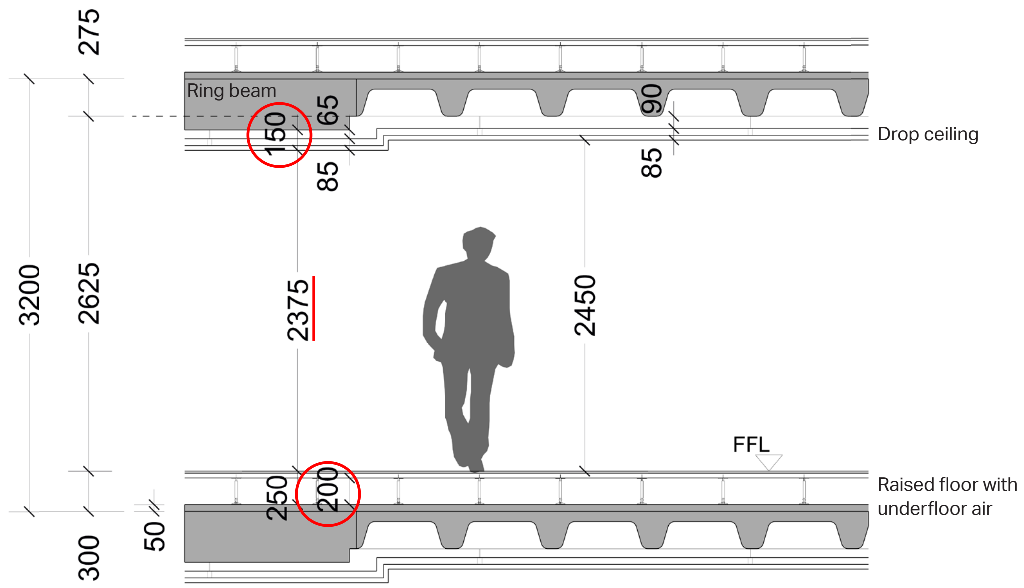


Modernising Option 2

One strategy is to have a drop ceiling with high level air and servicing. The floor is raised to allow 100mm clear (150mm total build up). Clear height is below BCO recommendation.

In Option 2 all major services are provided at high level (ventilation, heating and cooling, fire sprinklers, lighting). In this case the ceiling void needs to be ca. 400mm deep, and the floor is raised slightly to provide 100mm clear to support power and data reticulation. Allowing for a ceiling construction, the resulting clear floor to ceiling height is 2,325mm which is below the BCO minimum for refurbishments of 2,450mm, and would not meet occupier requirements. This option accepts that the ceiling void is reduced to 150mm at the perimeter under the ring beam.

Figure 9.10 Servicing modernisation option with dropped ceiling and all high level servicing

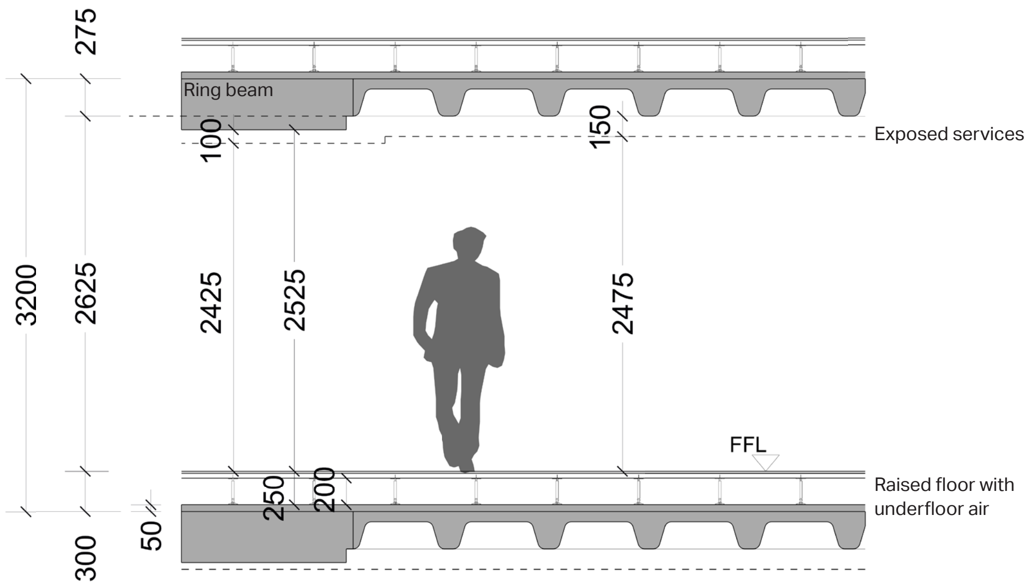


Modernising Option 3a

Another option is to have minimal services in the ceiling (lighting, sprinklers) and to provide a taller raised floor with underfloor air. Floor trunking is not desired as it limits flexibility. Clear height is 2,375mm, below BCO recommendation, over an extensive area of the floor plate. The minimal ceiling build-up and services zone shown would be subject to detailed co-ordination and integration of the services as well as require compromises in the fitout. This option assumes 4 no. AHUs per floor. Fewer AHUs results in a taller raised floor.

Option 3a is the opposite of the previous Option 2, where there are minimal services provided at high level (fire sprinklers, lighting). Instead, the major services are pushed into the floor and ventilation as well as heating and cooling is delivered via underfloor air. This requires a taller raised floor of 200mm clear (assuming 4 no. local AHUs per floor, see Figure 9.15), but can accommodate a shallower ceiling void of 150mm below the ring beam and 175mm below the ribbed slabs, including ceiling structure. The resulting clear floor to ceiling height is 2,375mm below the ring beam, below the BCO minimum for refurbishments of 2,450mm over an extensive portion of the floorplate. Clear height of 2,450mm would be achievable below the ribbed slabs, which would just comply with the lower end of the BCO guidance, but would still not meet occupier requirements. The minimal ceiling build-up and services zone would be subject to detailed co-ordination and integration of the services as well as require compromises in the fitout.

Figure 9.11 Servicing modernisation option with dropped ceiling



Modernising Option 3b

Another strategy is to expose the ceiling with sprinklers, lighting, etc. This may not be to every tenants liking. The raised floor provides underfloor air. A minimum 100mm services zone results in a compromised servicing strategy, though less so than in modernising option 3a. There is an option to step the services up to achieve a clear height of 2,475mm to underside of services, though this would only be possible under the ribbed areas of slab.

Option 3b is the Option that offers the tallest clear floor to ceiling height. It is the same as Option 2 except the high level services are left exposed, though it would require slightly deeper service zones. In this case, the resulting clear floor to underside of services height is 2,425mm below the ring beam, below the BCO minimum for refurbishments of 2,450mm over an extensive portion of the floorplate. Clear height of 2,475mm would be achievable below services in the ribbed slab areas, which would just comply with the lower end of the BCO guidance, but would still not meet occupier requirements. Areas between services would achieve taller floor to soffit heights. This Option does not offer tenants the flexibility to install a dropped ceiling if desired.

Figure 9.12 Servicing modernisation option with exposed soffit

Decentralised Ventilation Options
To minimise disruption to the existing cores, it is proposed that new air handling plant would be provided locally to the floorplates.

Two options are considered with the initial aim of providing maximum net floor area. These are shown in Figure 9.14 and Figure 9.15.

In AHU Option 1, 2 no. local AHUs per level are provided located at the east and west satellite cores. This frees up area around the north and south satellite cores, and reduces the impact on the overall floor layout. However, the AHUs must overcome a relatively large pressure drop in providing air across half the floorplate, and are therefore ducted within the floor plenum. The ducted floor plenum necessitates a larger floor void (350 mm clear). The result is a saving on net floor area, but a reduction in the clear floor to ceiling height. See Figure 9.14. Net to gross achieved is 70%.

In AHU Option 2, 4 no. local AHUs per level are provided located at each of the satellite cores. Conversely to AHU Option 1, this requires more on floor plant area for the additional AHUs, but because the individual units are working less hard, this results in a reduction of the floor void required (200 mm clear in this case). Due to the marginal size decrease of the local AHUs, the local plant rooms in this option are no smaller than those in AHU Option 1. Net to gross achieved is 67%.

While AHU Option 1 results in a higher floor efficiency (net to gross 70%), it is clear from the room section that the clear floor to ceiling height of 2,225mm is unacceptably low, and well below the BCO minimum for refurbishments of 2,450mm, and would not meet occupier requirements. Even with the additional 150mm of clear height enabled in AHU Option 2, the clear floor to ceiling height of 2,375mm (below the ring beam) is still below the BCO minimum for refurbishments.

Accordingly, it is not possible to support the combination of modern room-side services, desired clear floor to ceiling heights, and offer tenants a degree of fitout flexibility within the current structural floor to floor height.

While the wholesale overhaul and upgrade of the MEP systems will improve energy performance, the new systems will be compromised by the poor condition and outdated design of the existing facade.

Figure 9.13 Existing floor to ceiling height is partially enabled by perimeter servicing

AHU Option 1

2 no. local AHUs per level are provided located at the north and south satellite cores (marked up). The plan shown works for single use case only (office or office and lab-enabled), as only the east and west satellite cores are acting as escape cores. Overall net to gross is 70%. The AHUs are ducted in the floor void, resulting in a larger floor void (350 mm clear).

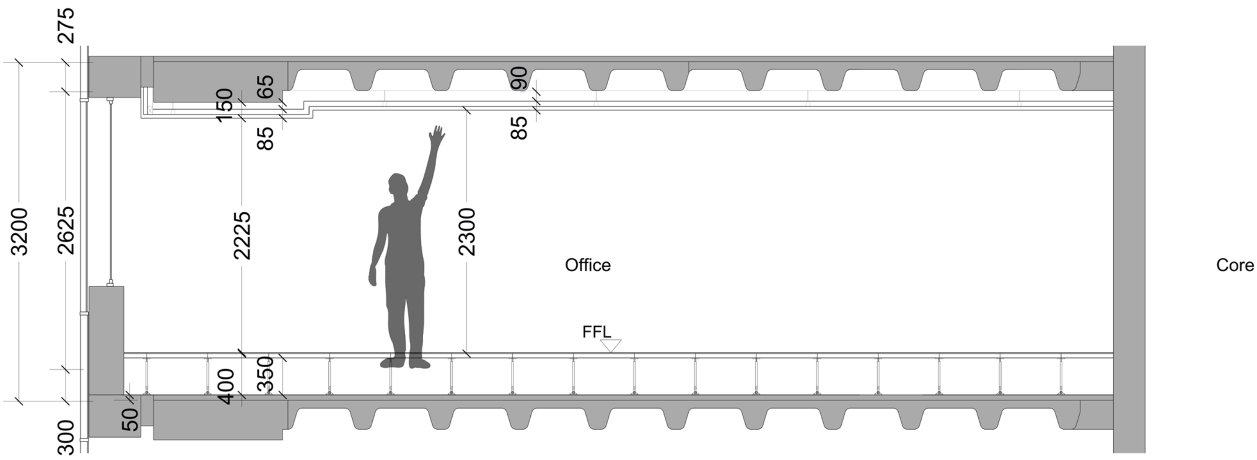


Figure 9.14 Typical office plan layout (above) and room section (below) for option with 2 no. local AHUs per floor.

AHU Option 2

4 no. local AHUs per level are provided located at all the satellite cores (marked up). The plan shown for single use case only (office or office and lab-enabled), as only the east and west satellite cores are acting as escape cores. Overall net to gross is 67%. The AHUs are not ducted in the floor void, resulting in a smaller floor void (200 mm clear) and larger clear floor to ceiling height.

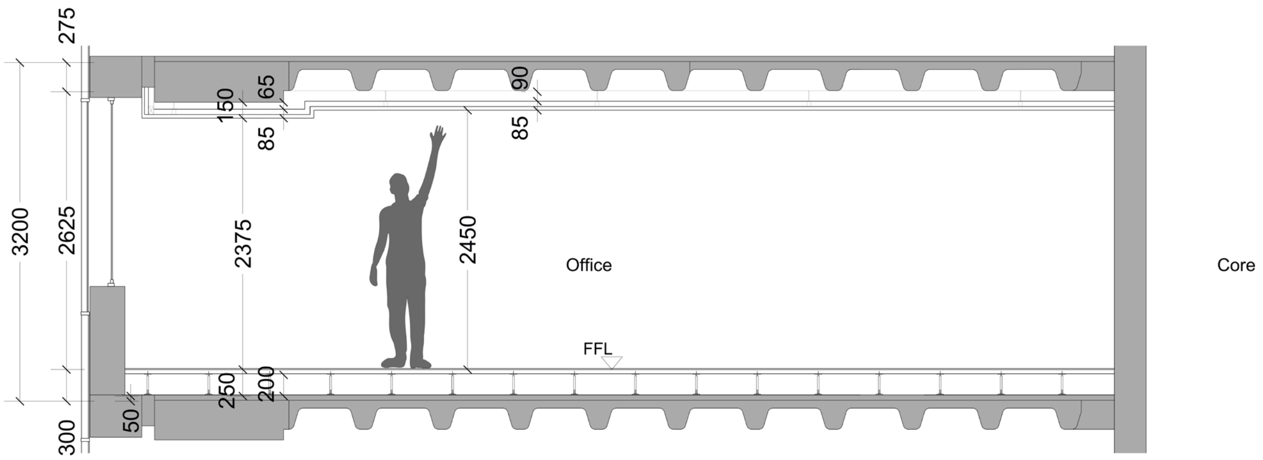


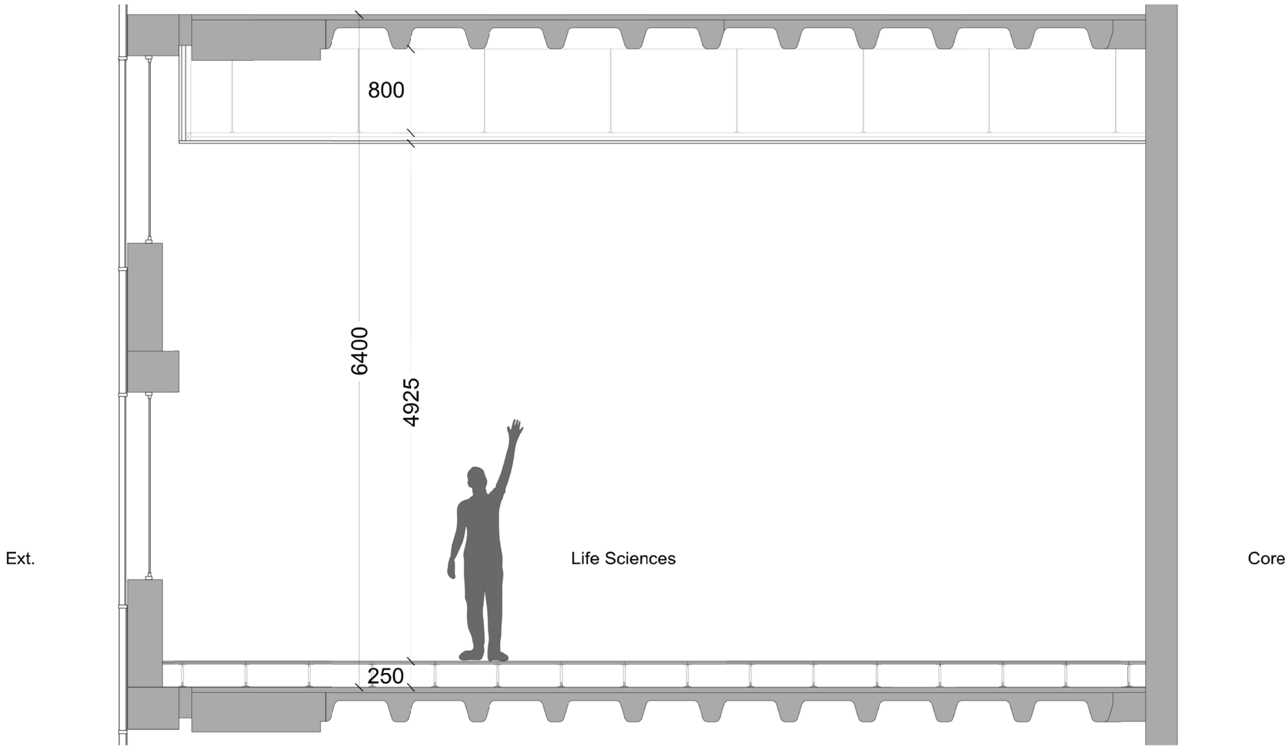
Figure 9.15 Typical office plan layout (above) and room section (below) for option with 4 no. local AHUs per floor.

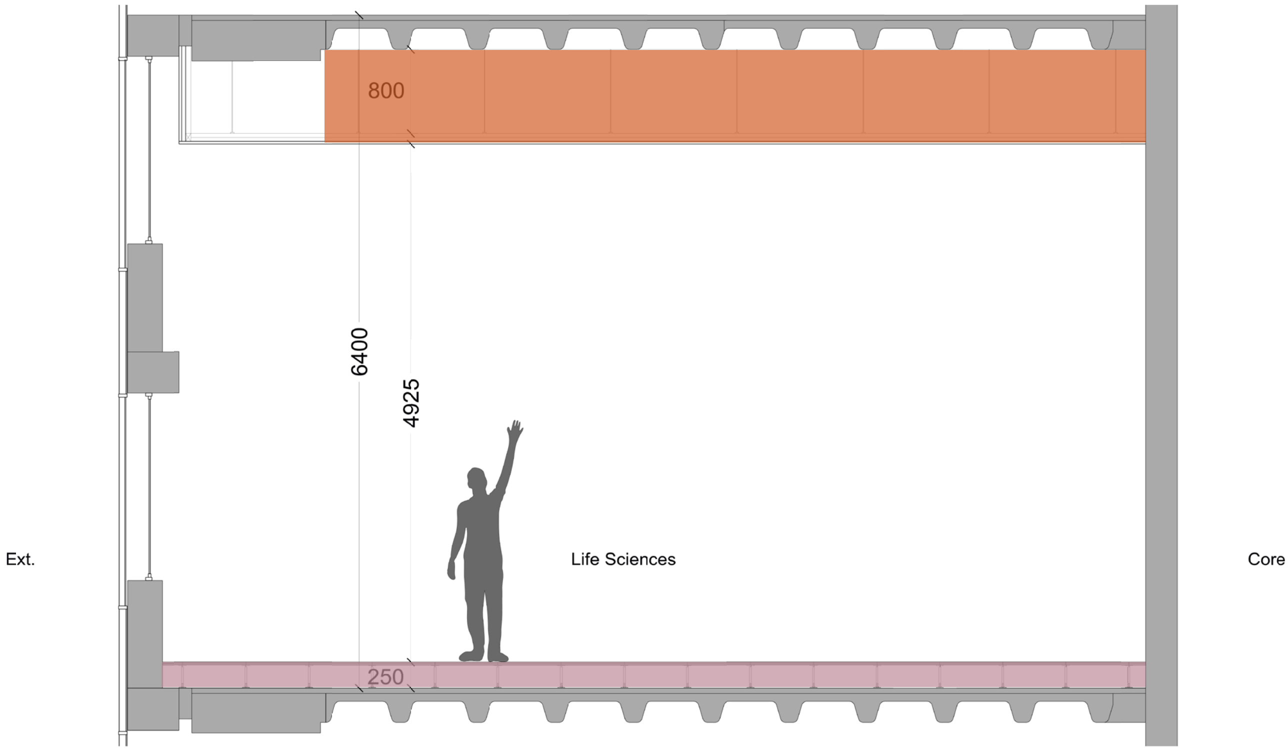
Lab-enabled Levels
The laboratory levels in the option with lab-enabled space have more intensive servicing requirements than a typical speculative office. To accommodate these levels, the intermediate floor levels are removed, resulting in a double-height space with floor to floor height 6,400mm. However, this is not optimised as the increased volume is significantly more than is necessary for lab spaces.

Like the commercial office levels, ventilation (as well as heating and cooling) for the laboratory levels would be delivered by decentralised air handling plant. However it would not be delivered from underfloor, and instead would be supplied through overhead ductwork and diffusers requiring 800mm ceiling void depth. This strategy is proposed to take advantage of the double-height space accommodating lab areas, allowing more height for services distribution. The room section is shown in Figure 9.16.

Lab-enabled spaces are likely to require the installation of tenant fume cupboards. This would require exhaust duct risers to roof level, as well as plant space allocation at roof level for the installation of vertical discharge fume exhaust fans.

Tenants in the lab spaces will have different requirements depending on the type of activity undertaken in their demise. To enable this it is envisaged that foul water drainage stacks and vent pipes will be installed through dedicated penetrations in the floor slab, adjacent to columns. These will then transfer to the central core at the level below and drop to the basement level.





Lab-enabled space - 800mm void depth + 100mm ceiling zone

250mm raised access flooring

Figure 9.16 Floor sections for lab levels which gives the clearest floor to ceiling height while delivering modern building services and tenant flexibility.

Lab - AHU Option 1

2 no. local AHUs per level are provided located at the north and south satellite cores (marked up). The plan shown for single use case only (office or office and lab), as only the east and west satellite cores are acting as escape cores. Ventilation is provided via ducts at high level, taking advantage of the double-height space, and so there is no impact on the floor zone.

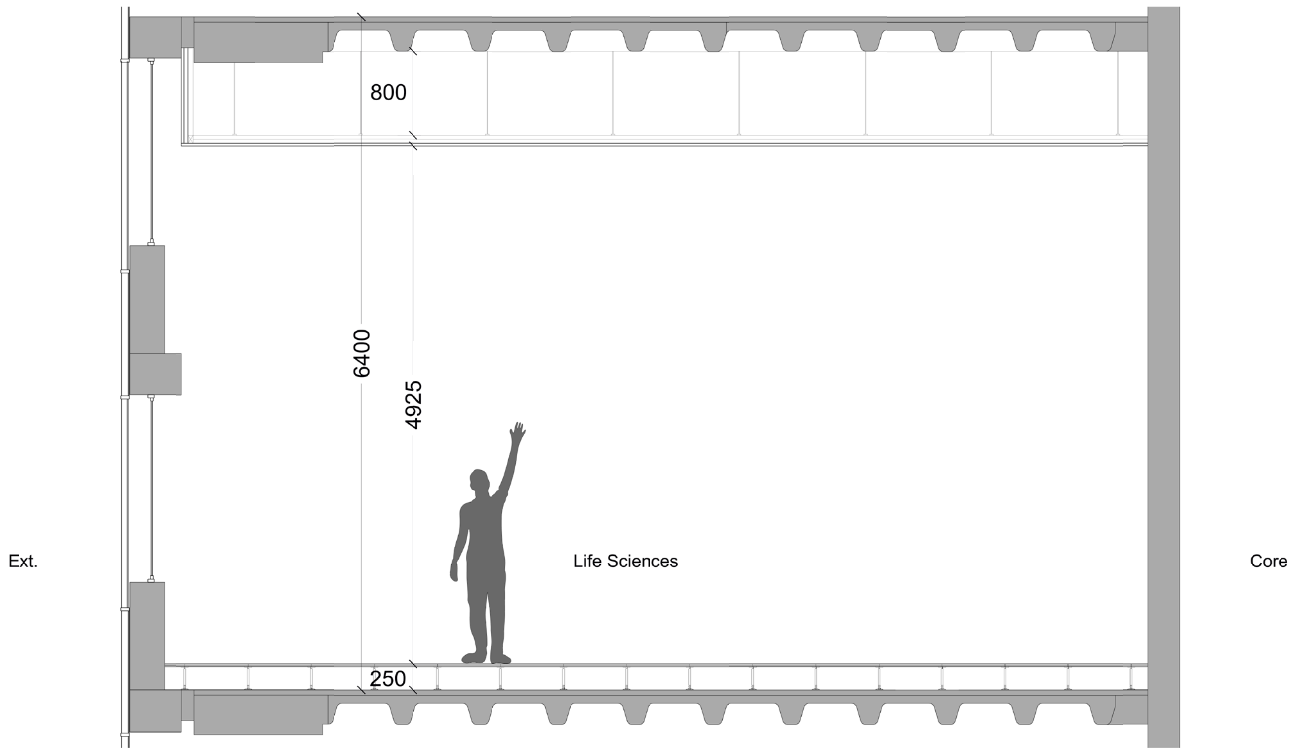


Figure 9.17 Typical laboratory plan layout (above) and room section (below) for option with 2 no. local AHUs per floor.

Lab - AHU Option 2

4 no. local AHUs per level are provided located at all the satellite cores (marked up). The plan shown works for single use case only (office or office and lab), as only the east and west satellite cores are acting as escape cores. Ventilation is provided via ducts at high level, taking advantage of the double-height space, and so there is no impact on the floor zone.

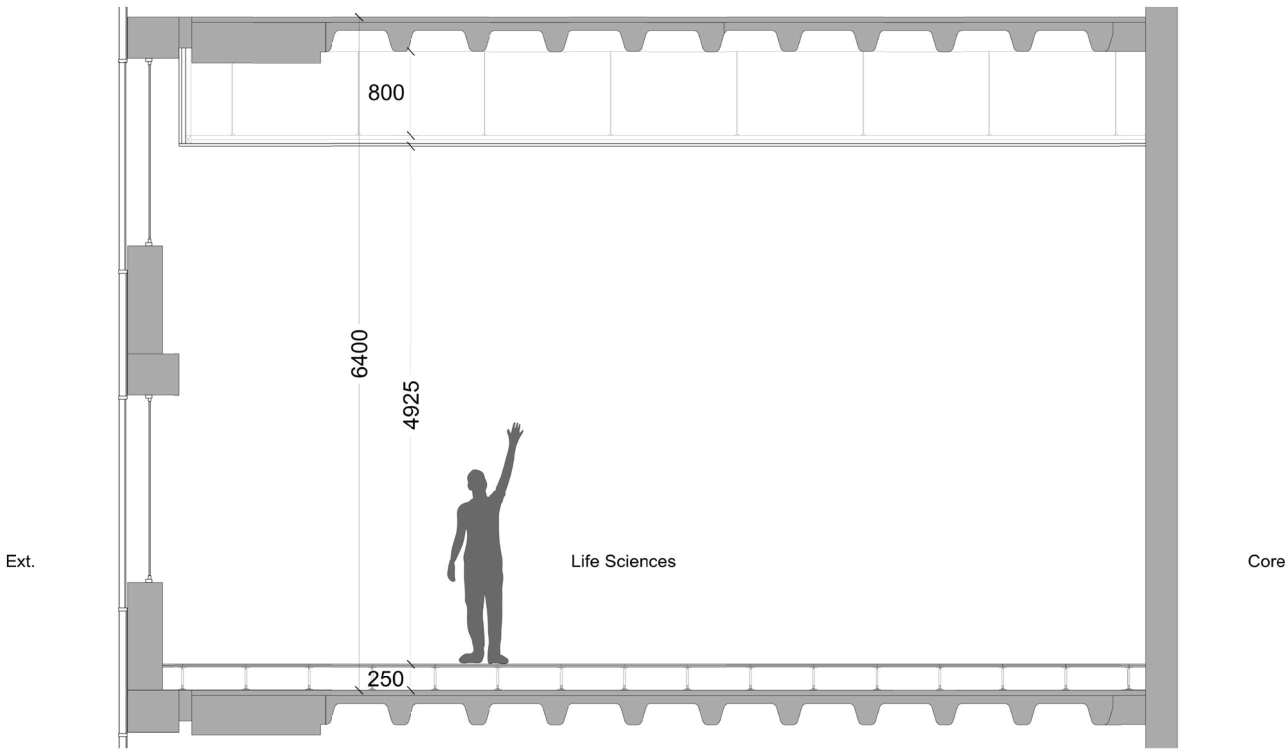


Figure 9.18 Typical laboratory plan layout (above) and room section (below) for option with 4 no. local AHUs per floor.

Overall Servicing Schematics

The diagrams in Figure 9.19 and Figure 9.20 show the overall proposed MEP servicing strategy for both stacks.

In both use cases, the proposed servicing combines tried-and-tested tower design principles with a future-looking all-electric concept.

Heating and cooling is provided via reversible heat pumps with heat recovery on the roof. High efficiency air-cooled chillers provide peak cooling capacity.

Office-only

All major plant is located in the basement or on the roof, with the exception of the decentralised ventilation plant located at every level.

The existing Level 12 plant storey is not required, except for the inclusion of pressure breaks and the like, but these require a slight increase in on-floor plant allowance rather than a full storey.

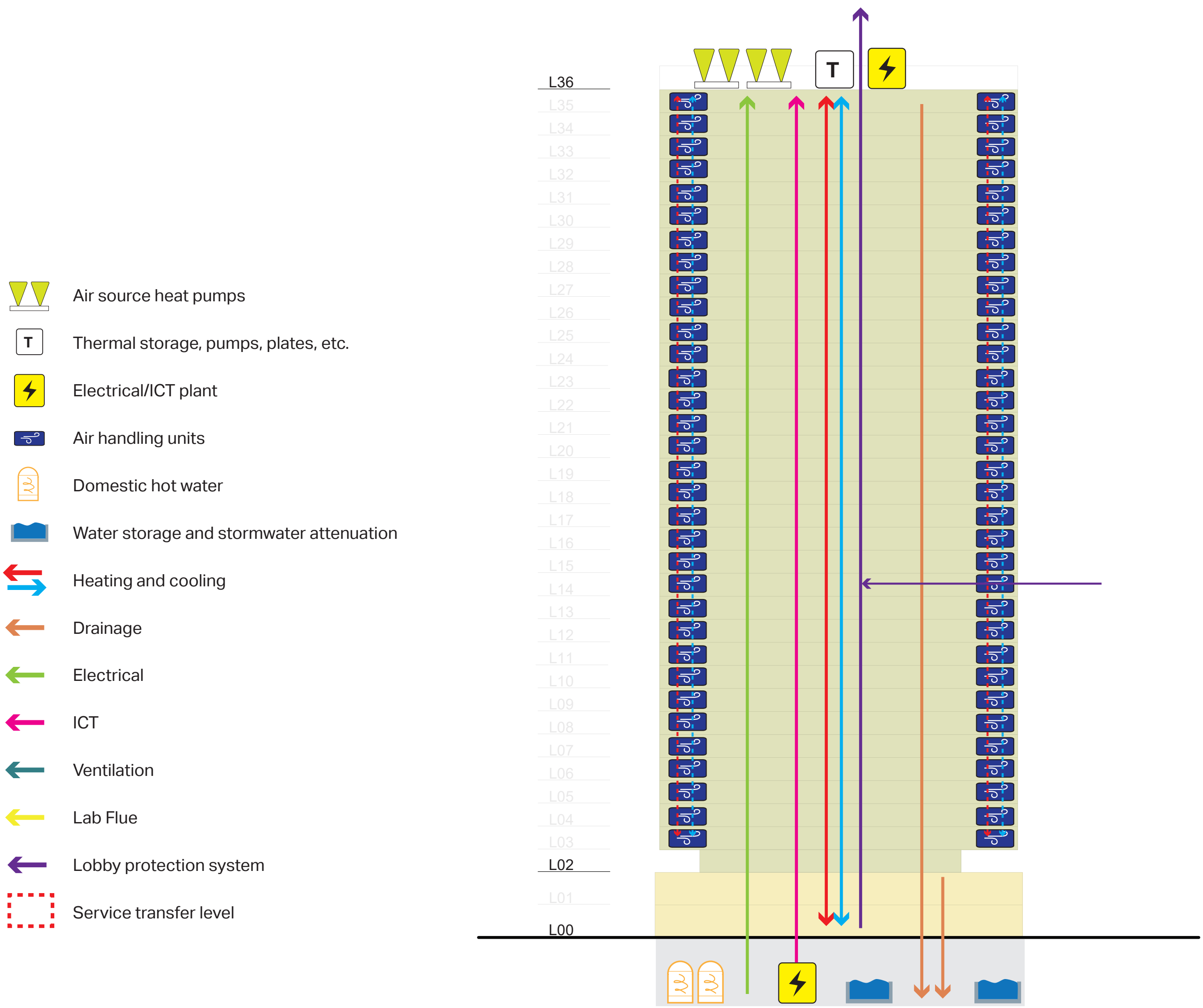


Figure 9.19 Overall servicing schematic for office-only use case

Office and Lab-enabled
All major plant is located in the basement or on the roof, with the exception of the decentralised ventilation plant located at every level.

The laboratory use in the lower portion of the stack necessities risers for flues running all the way up the building to roof.

On the lab floors, drainage points are more dispersed, and therefore a key area is the service transfer zone required above the podium where the drainage is collected and transferred to below. This will result in a compromised floor to ceiling height at Level 02.

The existing Level 12 plant storey is not required, except for the inclusion of pressure breaks and the like, but these require a slight increase in on-floor plant allowance rather than a full storey.

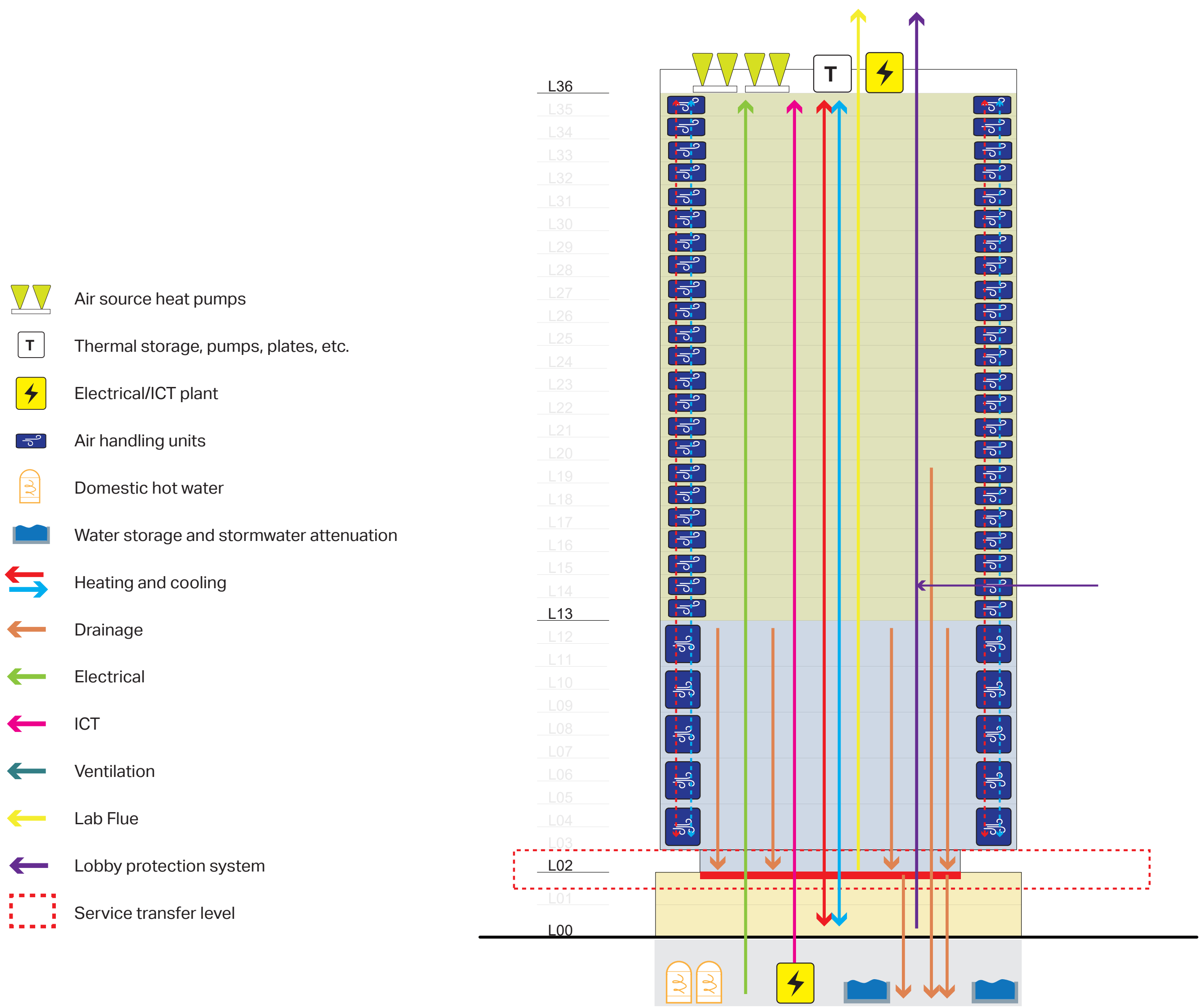


Figure 9.20 Overall servicing schematic for office and lab-enabled use case

9.3.4 Vertical transportation

As described in Section 6.6 of Volume One, there are significant implications on the lifting strategy to serve a modern commercial office and/or lab-enabled scheme.

Considering a full office use, there is a high demand on passenger lifts. The existing lifts were designed to meet a very different (and less onerous) demand. The existing lift capacity does not meet such demand, and would therefore require new lifts to support modern office densities and waiting times. With the aim of being as unintrusive as possible, this demand can be met using the existing 10 no. passenger lift shafts, but with new machinery.

Critically, as noted in Section 9.3.2, dedicated fire fighting lifts are required by BS 9999. The current provision of shared fire fighting/goods lifts is therefore unacceptable and a dedicated provision will need to be provided. In this case, this means new lift shafts and machinery.

While evacuation lifts are not strictly required (they are recommended and expected in the London Plan), these should be provided too. It is possible that the fire-fighting lifts can be used initially but once the fire brigade arrives they have to be handed over, and then the only option is to be carried down the stairs.

The existing goods lifts with a duty of 1,360kg are too small, BCO 2019 recommends a duty of 1,600kg to 3,000kg. Therefore new goods lifts will need to be provided.

The new goods lifts cannot be taken to basement level without interfering with the existing pile cap. Accordingly it is proposed that a separate goods lift is used from basement to ground, and then transferred to the new goods lift above ground.

Lab-enabled Levels

With the laboratory levels, there is a potential reduction in the demand on passenger lifts due to decreased occupancy density on the laboratory levels. However, to enable flexibility that all storeys are let as typical commercial office space, the passenger lifting provision should be determined by the full-office scheme, acknowledging that on multiple floors there is double height space, so even where all floors are used as office there is a reduced occupancy relative to an office-only scheme.

With laboratories, there are likely to be special requirements for a goods lift service enhancement (duty, materialism, etc.). This can be partially enabled by allowing suitably sized goods lifts in the full-office scheme, but any extraordinary measures will need to be coordinated with specific tenants.

Figure 9.21 Existing high rise lift motor at Euston Tower

9.3.5 Facades

As outlined in Section 7.3 of Volume One, the existing façade cannot achieve the level of performance required by current building regulations and standards.

Due to the condition and design, it cannot be realistically upgraded, and therefore a new facade is required. Replacing the façade with a new construction is feasible, however this will have several implications on the design.

Constructibility
The new facade would likely comprise an aluminium unitised façade system which would be fabricated in modules off-site. These units would then be transported to site, with minimum fabrication on-site. Installation would typically be carried out using a mini crane where the units are stored on the slabs and then installed one by one. Installation could also be carried out using a tower crane, particularly if it is necessary to reach challenging areas of the site or to lift large modules due to their dimension or weight. See Figure 9.22.

A challenge with this system is that additional space would be needed to fit the façade mullions and fire stopping beyond the line of the existing slab. This would shift the outer perimeter of cladding outwards from the existing glass line. An alternative would be to use a window-wall system that starts and stops at each slab level. This would increase installation time and the amount of work required on site, and would therefore be at disadvantage on a tall building. Bespoke detailing would also be necessary to ensure the fire compartmentation at each slab level. But an advantage of such a system is that installation can be readily carried out from the inside of the building using a glass manipulator. See Figure 9.23.

Loading
The existing facade loads have not accurately been calculated, but the primary system is understood to be mostly single glazed with monolithic glass, with a secondary window installed in most locations. The loading from this façade would be expected to range between 0.25 - 0.5kN/m^2. This is below the preliminary allowance for a new system (either unitised, or window-wall system), which would be at least 1kN/m^2 for the facade self-weight.

This increased loading has a minor impact on the primary structure. It would increase foundation loads by <10% for the columns around the perimeter, which should be justifiable on a global basis. This small load increase would not significantly affect the edge beam, other than a slight increase in deflections, which it is anticipated could be accommodated within the façade build up itself.

Thermal performance
In a commercial office, emphasis is likely to be on solar protection (g-values), with higher performance glazing selection and potentially darker glass and/or external shading. The U-values will be significantly better than those achieved by the existing façade, and these are likely to be achieved with double glazed systems.

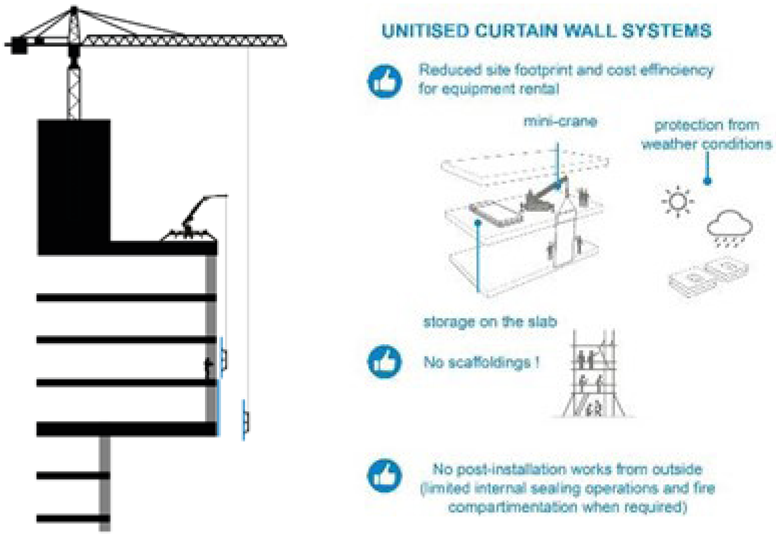


Figure 9.22 Installation of unitised facade

Figure 9.23 Installation of window-wall facade

9.4 Impact on Existing Floorplate

The diagrams in Figure 9.26 and Figure 9.27 test the impact of the preceding interventions on the existing structure. The aim is to be as unintrusive on the existing structure as possible.

This is the same as shown in Section 7.4.6 in Volume One, and is repeated here for completeness.

In general the spatial actions required are:

- Additional risers
- On floor AHUs
- Upgraded passenger lifts
- Distinct goods and fire fighting lifts.

The requirement for dedicated fire fighting lifts means new goods lifts are required. These goods lifts are pushed out and appended to the existing cores, with the existing shafts being used for dedicated fire fighting lifts. However, limited by the length of the floorplate in these locations, these goods lifts would be undersized for a modern goods lifts. The appended shaft is approximately 2,400 (w) x 3,200mm (d), while a modern goods lift would typically would have a 2,500kg rating and a well of 2,900 (w) x 3,600mm (d), in line with BCO recommendations.

For the laboratories, the goods lift requirement is dependent on laboratory users, but it is likely that a further goods lift is required to service laboratories.

The existing passenger lifts are too slow and don't support the desired occupancy. Fully-new low-rise and high-rise passenger lifts are required. These are added within the existing passenger lift banks in the central core.

Finally additional risers and on-floor air handling units would be needed to make the floor plate functional for energy and ventilation. The AHUs are housed in dedicated on-floor plant rooms adjacent to the cores, and a new riser is appended to each of the cores, to supplement existing riser provision.

Large portions of the floor slab would be impacted by these interventions cutting through existing slab. This is exacerbated by the existing ribbed slab system, where entire slab zones need to be removed if any portion of it is overlapped by the new vertical penetrations.

It is clear in the diagrams that large areas of the existing floor slab would need to be removed to bring the existing building up to code and current standards. The resulting floorplate is spatially inefficient with a net to gross efficiency of 67%. This decreases further if a lift lobby is added, and decreases again in a multi-tenanted scenario due to circulation space.

The resulting office accommodation is compromised and of low quality:

- The clear floor to ceiling heights are 2,325mm, everywhere below the BCO recommendation of 2,450-2,800mm (refurbishments), and would not meet occupier requirements
- The pinwheel plan and location of the satellite cores results in a disconnected floor plate
- The plan form is not suitable for multi-tenant splits due to increased circulation space
- The size of the new goods lifts is limited by the geometry of the floorplate, resulting in goods lifts that are undersized compared to BCO recommendations
- The additional plant space and risers result in an inefficient floorplate with net to gross of 67%, below a typical market target.

The diagrams in Figure 9.26 and Figure 9.27 show the floorplate development for the office or laboratory layout. Floorplate development diagrams for all mixed-use case combinations are included in Appendix A.

Satellite cores result in a disconnected floorplate

Inefficient floorplate with net to gross of 67%

Increased circulation space precludes multi-tenant layouts

Goods lifts are undersized compared to BCO recommendations

Clear floor to ceiling heights of 2,325mm below BCO recommendations

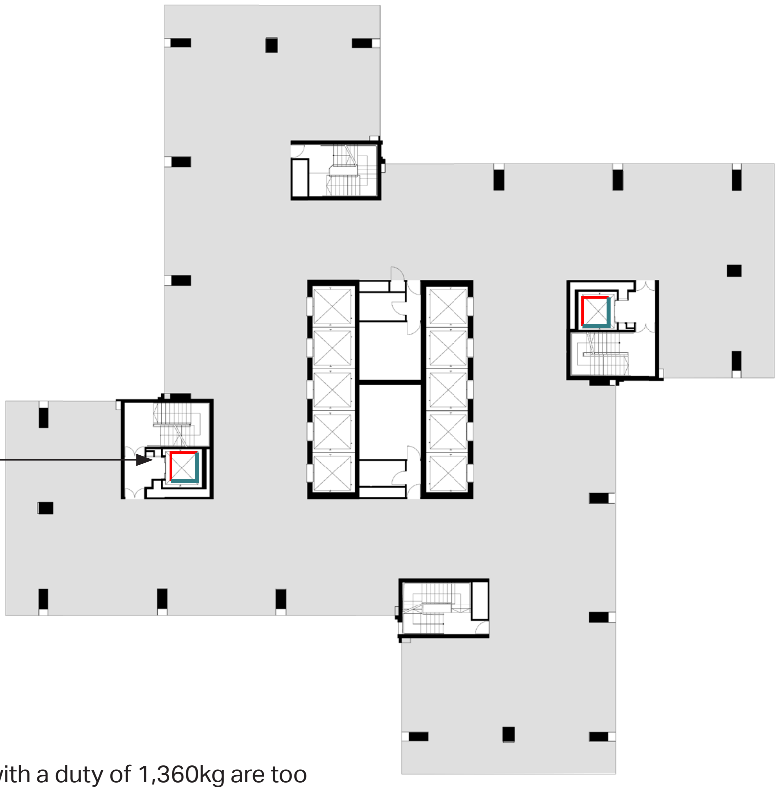
Figure 9.24 The resulting office layouts are compromised and of low quality

The resulting laboratory-enabled accommodation is compromised and of medium quality in layout, but the double-height spaces mean it is relatively unconstrained in section though over-dimensioned:

- The pinwheel plan and location of the satellite cores results in a disconnected floor plate which is especially important for a laboratory where unhindered connectivity between laboratory and write-up space is a necessity
- The size of the new goods lifts is limited by the geometry of the floorplate, resulting in goods lifts that are undersized compared to BCO recommendations
- Goods lift requirement dependent on laboratory users, but likely that a further goods lift is required to service laboratories
- The additional plant space and risers result in an inefficient floorplate with net to gross of 67%.

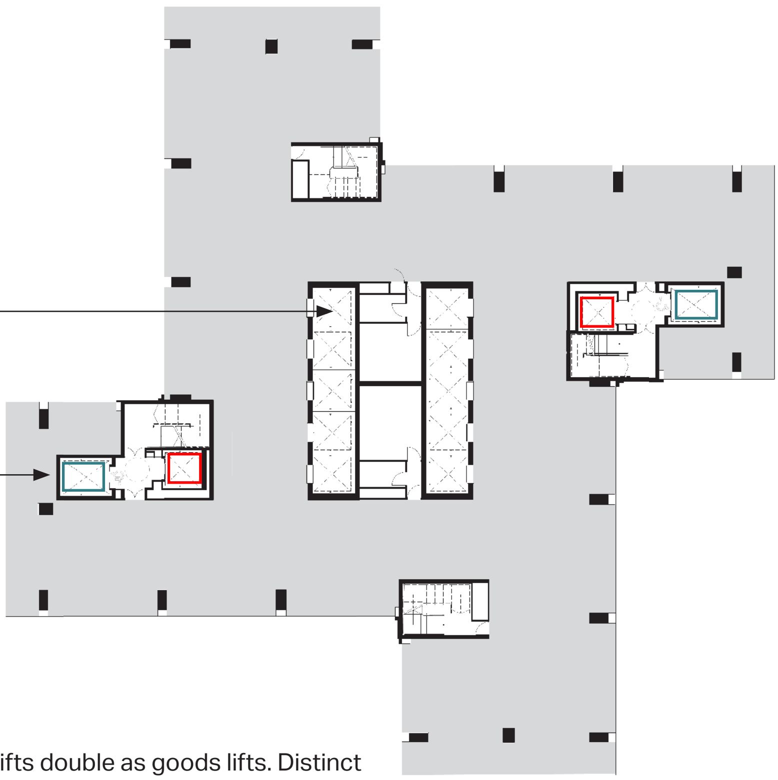
**Possibly further goods lift required depending on specific laboratory requirements*

Figure 9.25 The resulting laboratory layouts are compromised and of medium quality



Goods Lifts

The existing goods lifts with a duty of 1,360kg are too small, BCO 2019 recommends a duty of 1,600kg to 3,000kg. New goods lifts will need to be provided.



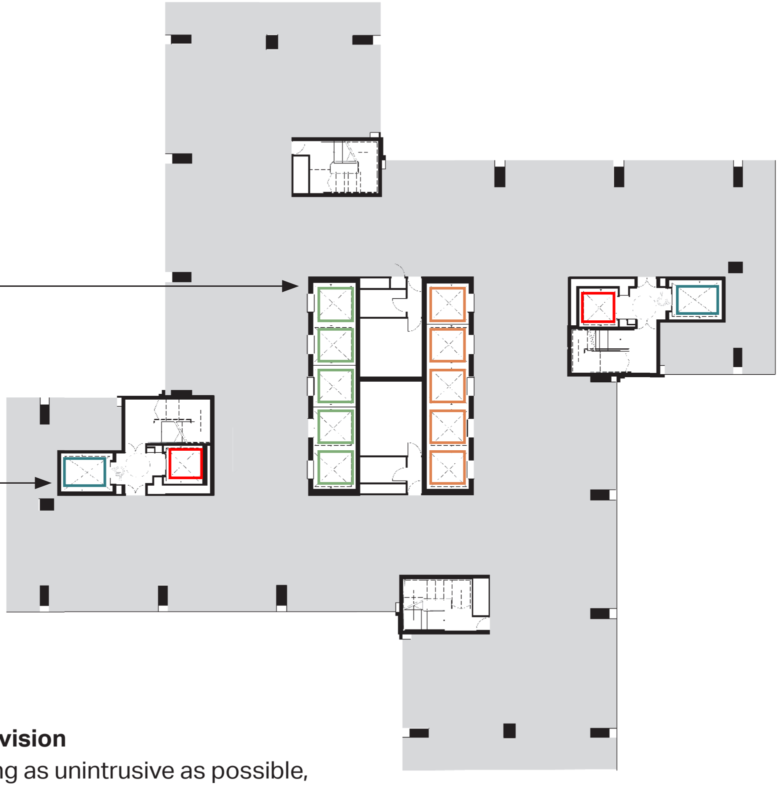
Fire Safety

The existing fire fighting lifts double as goods lifts. Distinct goods lifts would need to be added to allow for dedicated fire fighting lifts.

Figure 9.26 Impact of changes on existing floorplates for office use

New lifts provided in the existing 10 lift shafts

Insufficient risers and missing AHUs for fresh air provision



Required Actions:
- Additional risers
- On floor AHUs

Fire-fighting lift
Good lifts / Evacuation lifts
Passenger high-rise
Passenger low-rise

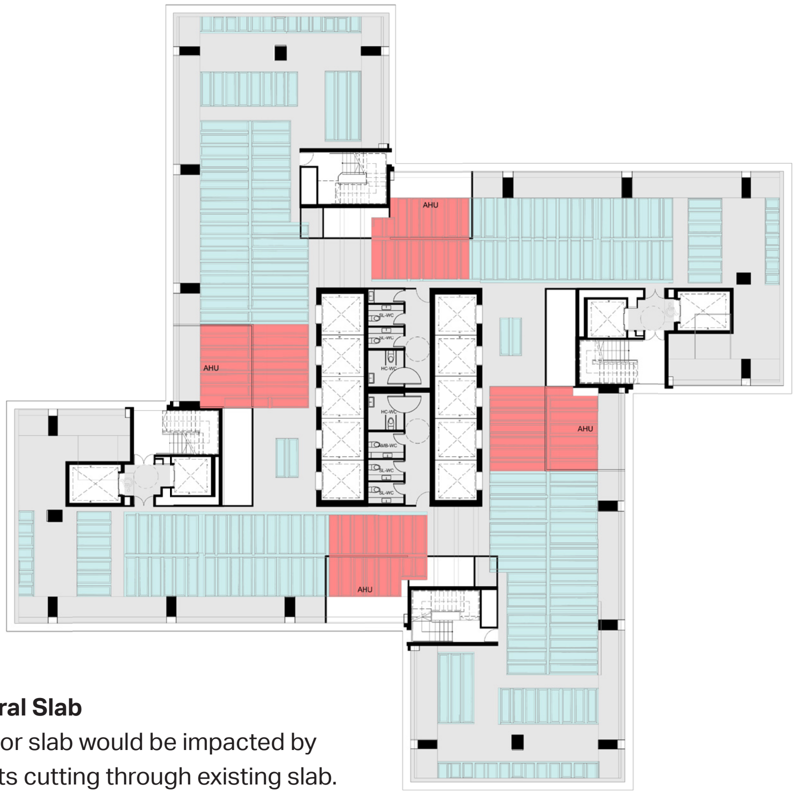
Passenger Lift Provision
With the aim of being as unintrusive as possible, demand can be met using the existing 10 no. passenger lift shafts, but with new machinery.

Sufficient riser space provided

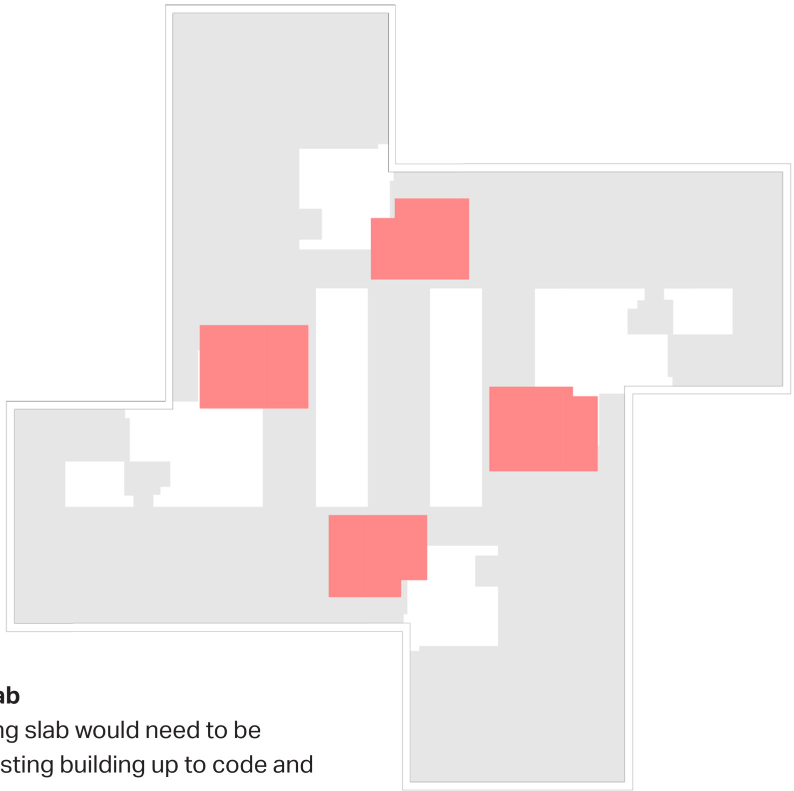
AHUs added to provide sufficient fresh air

Fire-fighting lift
Good lifts / Evacuation lifts
Passenger high-rise
Passenger low-rise
Risers
AHUs

Mechanical Services
Additional risers and on-floor air handling units would be needed to provide sufficient fresh air. They are provided decentralised to minimise disruption to the existing core.

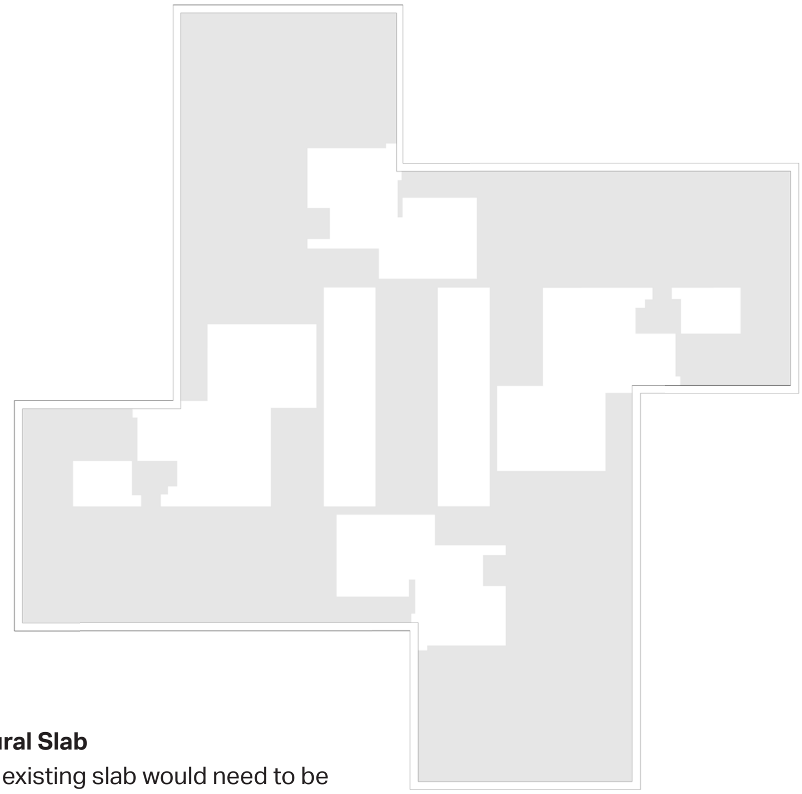


Implications to Structural Slab
Large portions of the floor slab would be impacted by these additional elements cutting through existing slab. Entire ribbed slab zones would need to be removed if overlapped with new vertical shafts.

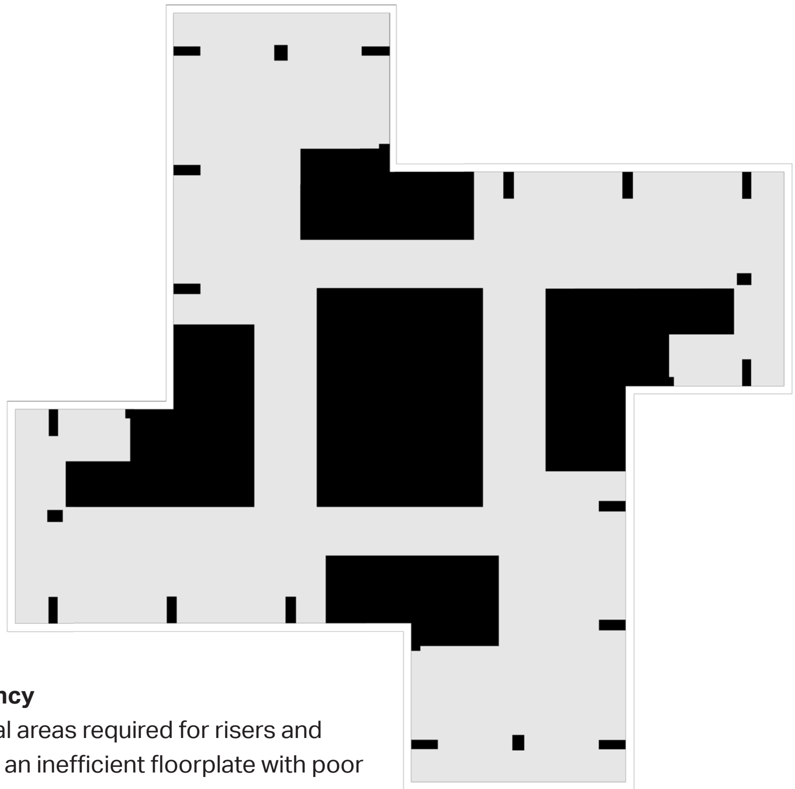


Resulting Structural Slab
Large amounts of existing slab would need to be removed to bring the existing building up to code and current standards.

Figure 9.27 Impact of changes on existing structural floor slab for office use



Resulting Structural Slab
Large amounts of existing slab would need to be removed to bring the existing building up to code and current standards.



Floorplate Efficiency
The large additional areas required for risers and lifts would result in an inefficient floorplate with poor efficiency net to gross 67%.

This disconnected floorplate can work in a single-tenant scenario, especially if the lifts open directly onto the floorplate. However the disconnection is exacerbated in a multi-tenanted scenario where, because the core is spilt into one central lift core and four satellite cores, main circulation takes up a significant portion of the floor plate.

This limited flexibility is shown on the test-fits in Figure 9.28.

Single Tenant
In a single-tenant scenario, the existing floor plate could work, but efficiencies are already low.

Two Tenants
In a multi-tenant scenario, main circulation takes up a significant portion of the floor plate.

Four Tenants
In a multi-tenant scenario, main circulation takes up a significant portion of the floor plate.

Figure 9.28 Test-fits showing how the existing floorplate limits multi-tenanted scenarios

9.5 Viability

The preceding sections have shown the extent of upgrades that are required to bring the existing tower up to the requirements of current Building Regulations and standards.

The following summarises the minimum requirements for compliance with current Building Regulations:

- Structural fire performance upgraded to 120 minutes
- Sprinkler provision added throughout
- Fire compartmentation added to facade as part of facade replacement
- Mechanical smoke ventilation added
- Dedicated fire fighting lifts required (not shared with goods lifts)
- Fire fighting lifts upgraded to current standards
- New air handling plant with higher fresh air rates to meet ADF, and heat recovery to meet ADL
- New central plant provisions with energy efficiency to meet ADL
- Facade thermal performance upgraded to meet energy efficiency requirements in ADL via facade replacement.

The cost of undertaking these upgrades relative to the quality of office space created and therefore the consequential economic payback is very challenging. A developer would be forced to outlay a minimum amount of expenditure with the out-turn building remaining highly compromised – effectively a safe version of its original 1967 structure. That is not to say the building would be completely unlettable, but **it would have a limited rental value and likely to suffer a particularly long leasing void, there is a good chance it would never become fully occupied.**

While the space could be acceptable for small or start-up businesses it would not attract the fast growing, intellectually-rich businesses that Camden is targeting for the Knowledge Quarter. The most significant challenge would be the quantum of space – due to the overall quality and physical compromises the building would not appeal to larger occupiers therefore limiting leasing activity to a high volume of small businesses on shorter, more flexible terms. In some circumstances this could be a successful letting strategy, but here there is simply too much floor space to reasonably consider that strategy beyond the short-term.

10

Euston Tower

Residential / Mixed-use Developments

10.1 Introduction

10.1.1 Description

The residential-led use cases studied in this Section are the following:

- Residential and commercial office
- Residential and laboratory-enabled space
- Residential and hotel.

With the office-only case from Section 9 being the nominal "base case", these options represent true alternative use scenarios.

In the residential and commercial office option, all floors from Level 13 are taken as residential. Levels 02-12 are taken as speculative office. In the option with laboratory-enabled space, the existing, intermediate floors are removed for the areas to be lab-enabled. This results in laboratories from Levels 02-12 (but giving only 6 no. lab-enabled storeys), and residential accommodation above, from Levels 13-35 inclusive. In the option with hotel, Levels 02-12 are assumed to be hotel use, with all levels above (Levels 13-35) providing residential accommodation.

In all of these scenarios, the office and laboratory levels use the same test fits as in Section 9.

The stacking diagrams are shown in Figure 10.3 and Figure 10.8 and the floor plans in Figure 10.4 - Figure 10.10.

In all of these residential-led options, four distinct test fits are considered for the residential accommodation, with the aim always being to be as unintrusive as possible. A market-rate mix is studied without and with private amenity, as well as a social housing mix without and with private amenity. The market-rate mix provides a mixture of one, two, and three bed apartments, while the social housing mix offers up to four-bed apartments. Refer to Figure 10.4 - Figure 10.10. The private amenity is studied because it is required by policy.

A fully-residential scheme is not considered viable due to poor air quality at the lower levels of the tower. See Section 10.3.7.

10.1.2 Architectural Commentary

Two residential splits have been considered as part of this feasibility study: a market-rate mix comprising mainly smaller units, and a social-housing mix made up of larger units.

The areas and classifications for these units are based on the London Housing Design Guide. For completeness, an option with and without private amenity has been considered for each split to understand how the extra provision of private amenity impacts the indicative layouts.

Strong wind conditions, air pollution and the desire not to impact the external massing of the existing tower, mean the private amenity space considered is internal. If an external private amenity space would have to be provided for each unit, further considerations around waterproofing and the thermal line would need to be developed, likely resulting in a more compressed floor to ceiling zone.

Care has been taken in the layout to limit the number of single-aspect units, especially those that are north-facing. However, the pinwheel plan and location of the satellite cores do ultimately result in some narrow, inefficient units with significant proportions of the GIA taken up as internal corridor space. This is particularly the case for the units along the longer north and south facades of the pinwheel floorplate.

The extra servicing required for the building to accommodate residential manifests itself in the extra risers required in plan, but also in the significant servicing zones in section. This necessary servicing generates particularly low floor to ceiling heights across the entire floorplate, with a floor to ceiling of less than 2.2m and a maximum of ca. 2.45m in some of the living spaces (although there would be additional bulkheads here for the MVHR, dropping the ceiling to ca. 2.335m in certain areas). This is significant given that the London Plan 2021 Policy D6 f(8) states: "The minimum floor to ceiling height must be 2.5m for at least 75 per cent of the Gross Internal Area of each dwelling.".

For these reasons, any residential alternative use for the existing Euston Tower would be considered to be of low quality.

10.1.3 Benchmarking Centre Point

Centre Point is another famous tall building in the London Borough of Camden, of a similar period to Euston Tower. Previously an office building, it was Grade II listen in 1995, and underwent conversion to residential use in 2015.

Sections for the Centre Point residential conversion and a possible conversion at Euston Tower are shown in Figure 10.2.

Centre Point has a floor to floor height of 3.05m and Euston Tower 3.2m.

Both Centre Point and Euston Tower have comparable slab depths which are driven by the spans they are supporting, which were designed as office spans. Office spans typically exceed residential spans such that a purpose designed residential scheme could have a thinner slab depth.

Apart from the structural depth, the key difference between Centre Point and Euston is the deeper servicing zone required in Euston Tower. This is driven by having mechanical ventilation with heat recovery (MVHR) that has to reach the facade on each unit. From the section and absence of intakes/exhausts in elevation, this is not the case at Centre Point where air intake and exhaust is generally via louvres in the lift lobby facades.

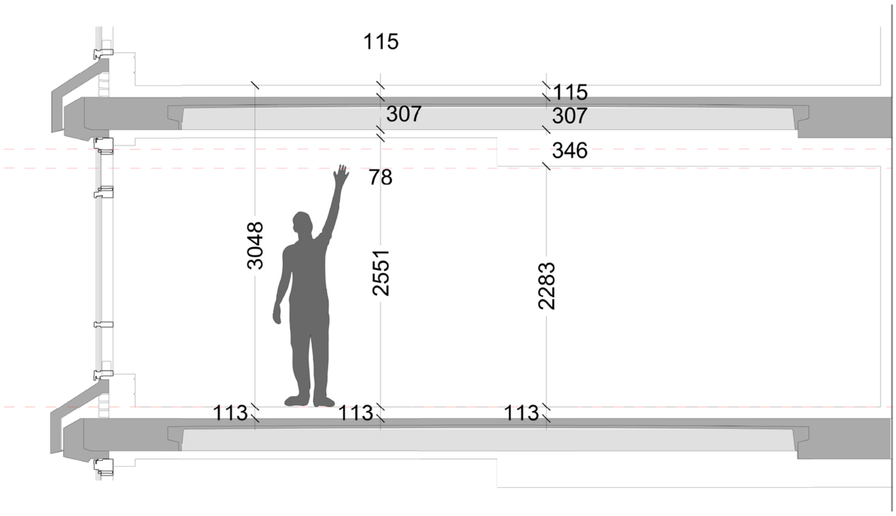
This results in a clear floor to ceiling heights of the following:

- Centre Point 2.28m at bulkhead and 2.55m elsewhere
- Euston Tower 2.27m at bulkhead and 2.44m elsewhere.

The result is that a residential conversion at Euston Tower would not meet, within any part of the unit, the minimum clear floor to ceiling requirement of London Plan 2021 (2.5m for 75% of floor area). Even with a reduction in the build up of the sub-framing and finishes to the ceiling construction, this would be marginal, and certainly would not account for 75% of floor area.

The letting record of Centre Point also speaks to the sensitivities of developing apartments of questionable quality. It is widely reported that, with owners not able to achieve their asking prices for the apartments, they are kept off the market and empty, resulting in so-called "Ghost Towers".

Figure 10.1 Formally an office building, Centre Point was converted to residential in 2015 and has had issues with widespread vacancy



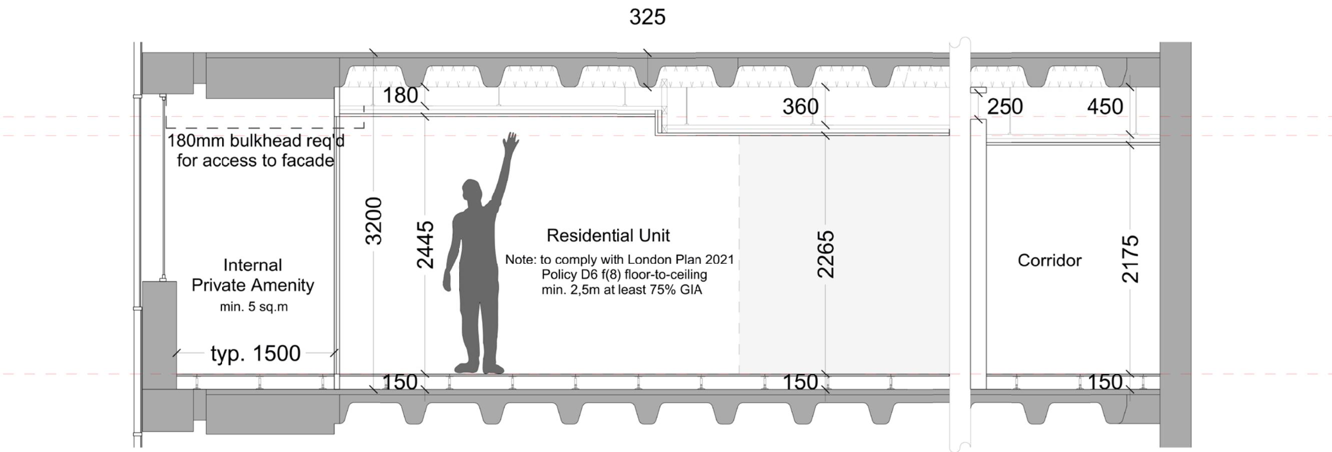
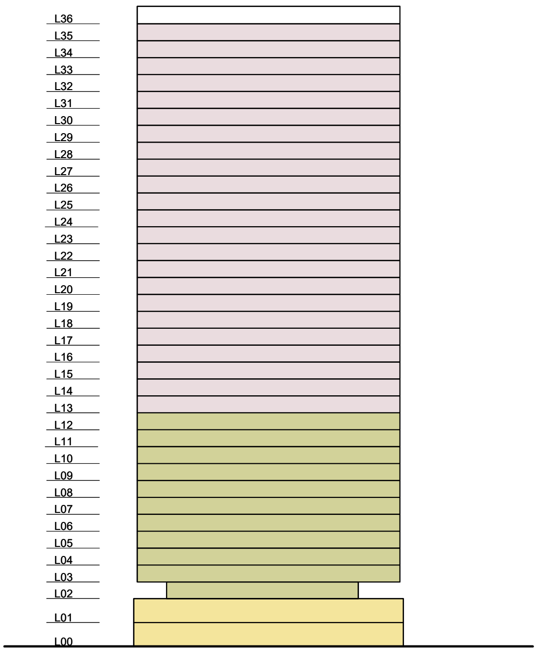


Figure 10.2 Residential room section showing clear heights for Centre Point (above) and Euston Tower (below)

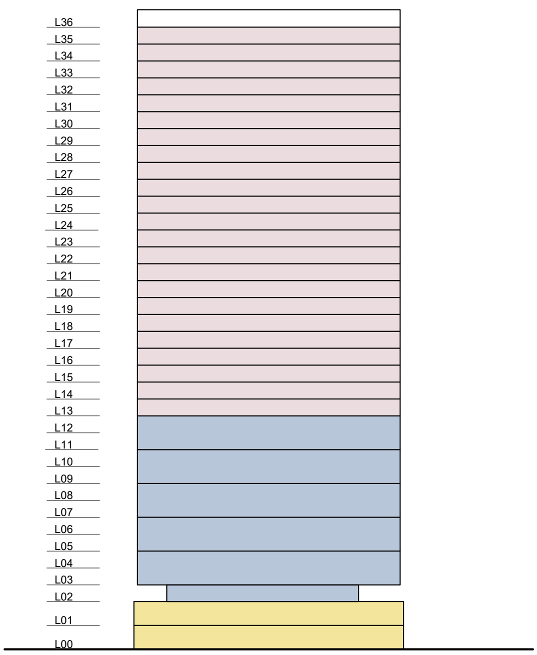
RESIDENTIAL AND OFFICE



Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Residential and Office Stack
In this stack the lower portion of the stack is commercial office, with residential units above. All existing floor slabs are retained, giving office floors from Level 02-12, and residential from Level 13-35. Residential apartments are not proposed in the lower portion of the floor plate due to pollution considerations. An air quality assessment (see Section 10.3.7) recommended no openable windows in the lower potion of the tower along Hampstead Road. Mechanical ventilation intakes at these levels would therefore also need to be strategically located. This precludes putting residential apartments at these storeys (even if only mechanically ventilated) as the intakes would need to be local to each apartment meaning they cannot be easily located in areas of better air quality.

RESIDENTIAL AND LAB



Residential and Laboratory-enabled Stack
In this stack the lower portion of the stack is laboratory-enabled, with residential units above. The existing, intermediate floors are removed for the areas to be labs. This results in lab-enabled space from Levels 02-12 (but giving only 6 no. lab-enabled storeys), and residential apartments above, from Levels 13-35 inclusive. Again, residential apartments are not proposed in the lower portion of the floor plate due to pollution considerations, as set out above.

Figure 10.3 Residential-led section stacks. Resi and office (above), resi and lab (below)

Figure 10.4 Typical tower level office test-fit for lower portion of stack. One lift bank doesn't open on to the office floors.

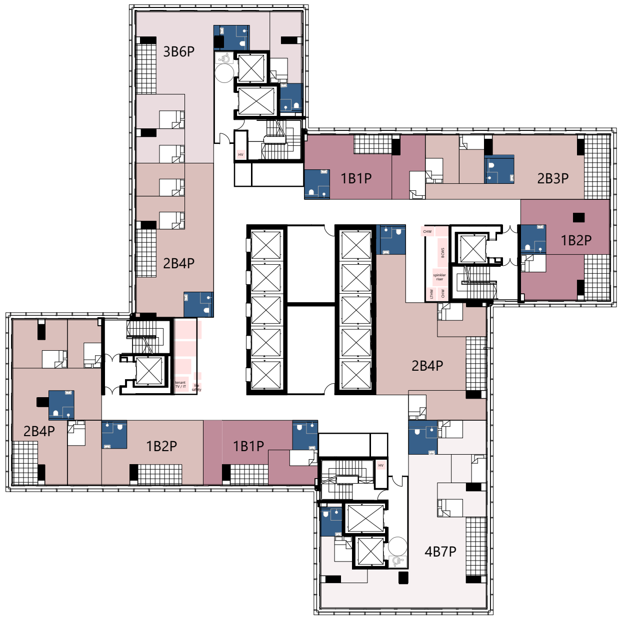


Figure 10.5 Typical tower level residential use test-fit for upper portion of stack. Market-rate mix with private amenity.

Figure 10.6 Typical tower level lab-enabled test-fit for lower portion of stack. One lift bank doesn't open on to the lab floors.

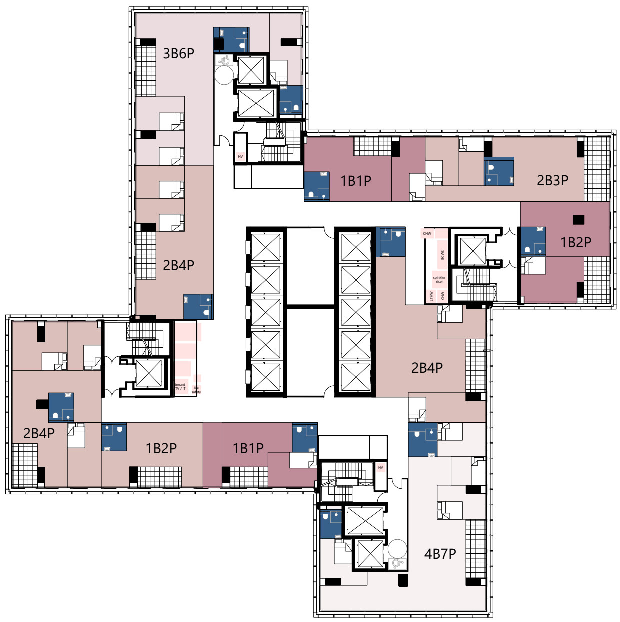


Figure 10.7 Typical tower level residential use test-fit for upper portion of stack. Market-rate mix with private amenity.

RESIDENTIAL AND HOTEL

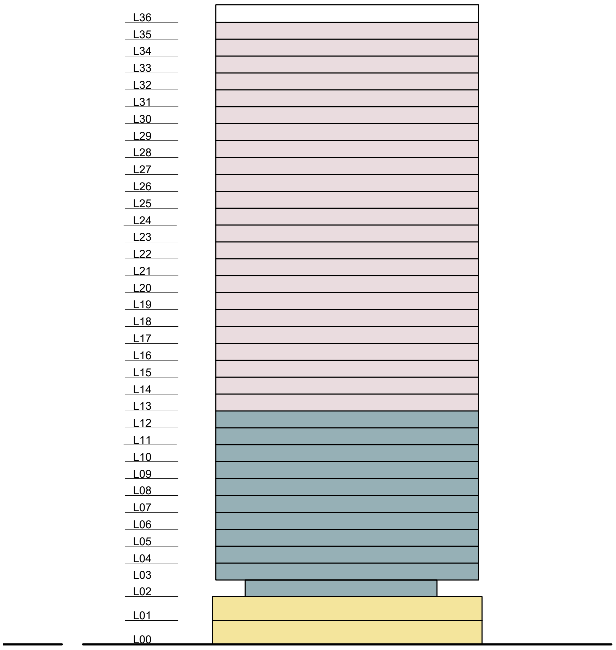


Figure 10.8 Residential-led section stack with resi and hotel.

Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Residential and Hotel Stack

In this stack the lower portion of the stack is hotel, with residential units above. All existing floor slabs are retained, giving hotel floors from Level 02-12, and residential from Level 13-35. Residential apartments are not proposed in the lower portion of the floor plate due to pollution considerations. An air quality assessment (see Section 10.3.7) recommended no openable windows in the lower potion of the tower along Hampstead Road. Mechanical ventilation intakes at these levels would therefore also need to be strategically located. This precludes putting residential apartments at these storeys (even if only mechanically ventilated) as the intakes would be local to each apartment. It works for hotel where the ventilation can be centralised, meaning the intakes can be easily located in areas of better air quality.

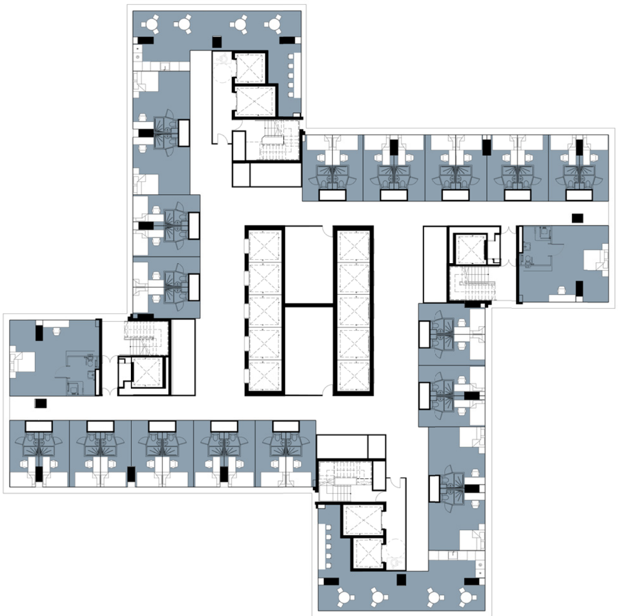


Figure 10.9 Typical tower level hotel test-fit for lower portion of stack. One lift bank doesn't open on to the hotel floors.

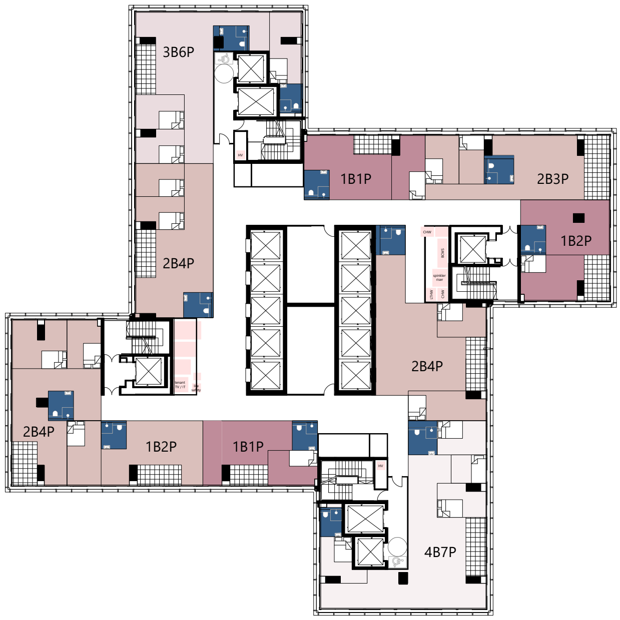


Figure 10.10 Typical tower level residential use test-fit for upper portion of stack. Market-rate mix with private amenity.

10.2 Planning

10.2.1 General

This section sets out national, regional and local planning policy position relating to converting the existing tower to a residential led scheme. While there is generally an acknowledgment within planning policy that there is a shortfall in the provision of housing within London, Regional and Local policy in particular, acknowledge that some locations are not necessarily suitable for new housing, due to alternative land uses being preferable or needed to maintain a strong economy and balance of communities, together with understanding the need to provide high quality, sustainable residential accommodation.

10.2.2 National Planning Policy Framework

Paragraph 11 of the National Planning Policy Framework (NPPF) seeks to ensure plans and decisions apply a presumption in favour of sustainable development. It states that all plans "should promote a sustainable pattern of development that seeks to: **meet the development needs of their area; align growth and infrastructure; improve the environment; mitigate climate change (including by making effective use of land in urban areas) and adapt to its effects."**

Chapter 5 of the NPPF sets out how national planning policy can sufficiently deliver a supply of homes. Paragraph 60 states "to support the Government's objective of significantly boosting the supply of homes, it is important that a sufficient amount and variety of land can come forward where it is needed, that the needs of groups with specific housing requirements are addressed and that land with permission is developed without unnecessary delay."

Paragraph 68 states "strategic policy-making authorities **should have a clear understanding of the land available in their area through the preparation of a strategic housing land availability assessment.** From this, planning policies should identify a sufficient supply and mix of sites, taking into account their availability, suitability and likely economic viability."

Paragraph 73 states "the supply of large numbers of new homes can often be best achieved through planning for larger scale development, such as new settlements or significant extensions to existing villages and towns, provided they are well located and designed, and supported by the necessary infrastructure and facilities (including a genuine choice of transport modes)."

10.2.3 The London Plan

The London Plan sets out the strategic vision for London. At its core, it seeks good growth through making the best use of Land. Policy GG2 seeks to create successful sustainable mixed-use places that make the best use of land, and it notes that those involved in planning and development must (inter alia):

A enable the development of brownfield land, particularly in Opportunity Areas, on surplus public sector land, and sites within and on the edge of town centres, as well as utilising small sites

B prioritise sites which are well-connected by existing or planned public transport

C pro-actively explore the potential to intensify the use of land to support additional homes and workspaces, promoting higher density development, particularly in locations that are well-connected to jobs, services, infrastructure and amenities by public transport, walking and cycling

D applying a design–led approach to determine the optimum development capacity of sites

E understand what is valued about existing places and use this as a catalyst for growth, renewal, and place-making, strengthening London's distinct and varied character.

Another strategic objective is to deliver homes for Londoners. It is well documented that there is a shortfall in the supply of good, quality homes and Policy GG4 recognises the need to create a housing market that works better for all Londoners. This policy states that those involved in planning and development must (inter alia):

A ensure that more homes are delivered

B support the delivery of the strategic target of 50 per cent of all new homes being genuinely affordable, and

C create mixed and inclusive communities, with good quality homes that meet high standards of design and provide for identified needs, including for specialist housing.

However, in exploring potential sites to deliver new market and affordable housing, the site's location and strategic context needs to be considered. Euston Tower is located within the Central Activities Zones (CAZ), the Knowledge Quarter and is adjacent to the Euston Opportunity Area. All are areas where commercial development are directed and supported, through providing new floorspace and retaining existing.

Policy SD5 of the London Plan states that offices and other CAZ strategic functions are to be given greater weight relative to new residential in all areas of the CAZ, save for in specific areas which are not applicable to Euston Tower. Furthermore, Paragraph 1.3.3 of the CAZ Supplementary Planning Guidance (SPG) sets out that offices and other CAZ strategic functions should be given greater weight relative to new residential development.

10.2.4 Camden Policies

Housing is Camden's key priority land use and Camden was required to submit a Housing Delivery Test Action Plan in August 2021 to deal with the shortage in predicted homes coming forward in the Borough.

Policy H1 of the Local Plan sets out that self-contained housing is the priority land use across the Borough.

Notwithstanding regional and local policy protection regarding existing employment floorspace, Policy H2 of the Local Plan seeks to achieve commensurate levels of self-contained housing whenever non-residential development is proposed to ensure a balance of uses across the Borough. The policy requires where more than 200m^2 GIA of non-residential development is proposed in the Central London Area, 50% of the additional floorspace will be required to be delivered as self-contained housing with an appropriate mix, including affordable housing where relevant (subject to a set of criteria). The requirement to deliver affordable housing on Site is subject to a set of criteria which is set out at Policy H4 of the Local Plan and the Housing CPG.

Supporting Paragraph 3.53 states: "Where development adds 1,000m^2 (GIA) or more floorspace, the Council considers that it will generally be possible to achieve a significant number of homes on-site sufficient to support the stairs, lifts and circulation space needed to serve them, and will therefore particularly expect on-site provision.

Policy H4 of the Local Plan sets out the Council's approach to affordable housing provision which is based on a site's capacity to provide housing, with affordable housing being required on a sliding scale between 2% and 50%. The policy also states that where development sites have capacity to provide fewer than 10 dwellings, that the Council will accept the provision of affordable housing as a payment in lieu of on-site provision.

Clearly, the principal policy test for the conversion of Euston Tower to residential is Policy E2 which protects office floorspace on sites that are suitable for continued business use, in particular premises for small businesses, businesses and services that provide employment for Camden residents and those that support the functioning of the Central Activities Zone (CAZ) or the local economy.

Notwithstanding that there would be no additional floorspace created with a conversion of the tower to residential, and therefore Policy H2 would not be applicable, we have considered the criteria set out in Policy H2 below as a way of assessing the appropriateness of residential use in the tower.

Policy H2 states that in considering whether a mix of uses should be sought, whether it can practically be achieved on the site, the most appropriate mix of uses, and the scale and nature of any contribution to the supply of housing and other secondary uses, the Council will take into account:

a the character of the development, the site and the area

b site size, and any constraints on developing the site for a mix of uses

c the priority the Local Plan gives to the jewellery sector in the Hatton Garden area

d whether self-contained housing would be compatible with the character and operational requirements of the proposed non-residential use and other nearby uses

e whether the development is publicly funded or serves a public purpose

f the need to add to community safety by providing an active street frontage and natural surveillance

g the extent of any additional floorspace needed for an existing user

h the impact of a mix of uses on the efficiency and overall quantum of development
i the economics and financial viability of the development including any particular costs associated with it, having regard to any distinctive viability characteristics of particular sectors such as build-to-let housing
j whether an alternative approach could better meet the objectives of this policy and the Local Plan.

Taking each point in turn:

a the character of the development, the site and the area

The existing building is wholly commercial and policy protects this use. The site is located in a predominately commercial area on the busy Euston Road. Opposite the site lies a large hospital with an A+E department. The road and the hospital generate noise 24 hours a day. Furthermore, the air quality along the road is extremely poor and the busy thoroughfare has one of the highest particulate (pollution) counts in the capital.

The site suffers from a windy microclimate which would make the provision of usable balconies challenging.

Policy A4 advises that the Council will seek to ensure that noise and vibration is controlled and managed. Part (b) of the policy states that: **"We will not grant planning permission for: … development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses."**

Amenity CPG advises that noise and vibration can have a significant impact on amenity, quality of life and well-being. While things may change in the future, Euston Road will still remain as a main road and UCLH is likely to remain in situ. Therefore, there will always be noise and air quality implications at this location.

b site size, and any constraints on developing the site for a mix of uses

Converting the existing tower to residential fails to accord with policy E2 which seeks to protect commercial floorspace. The clear floor to ceiling heights in the tower fail to meet London Plan standards.

Furthermore, the resulting unit mix would not accord with Camden’s housing requirements and would provide ca. 20% north-facing units.

c the priority the Local Plan gives to the jewellery sector in the Hatton Garden area

Not applicable.

d whether self-contained housing would be compatible with the character and operational requirements of the proposed non-residential use and other nearby uses

As set out under criterion (a), the site is located on the busy Euston Road with UCLH hospital opposite. Both the road and the hospital generate noise 24 hours a day, which together with poor air quality makes it a very challenging environment for residential uses.

e whether the development is publicly funded or serves a public purpose

The site is privately owned and any redevelopment would be privately funded.

f the need to add to community safety by providing an active street frontage and natural surveillance

The site is located in a prominent location where active street frontages are provided.

g the extent of any additional floorspace needed for an existing user

The site is currently vacant, save for the retail units at the ground floor. Additional floorspace is not being provided for an existing user.

h the impact of a mix of uses on the efficiency and overall quantum of development

The introduction of residential, both market and affordable, would require the introduction of further, separate cores and entrances resulting in an inefficient floorplate, and therefore less usable floorspace delivered overall. Two different cores would not be an effective use of land, and would not efficiently optimise the potential of the site. Each use and tenure would also require its own ground floor entrance and circulation space, further reducing the quality of the ground and upper floor lettable area and overall quality of the space.

i the economics and financial viability of the development including any particular costs associated with it, having regard to any distinctive viability characteristics of particular sectors such as build-to-let housing

Whether designed as market accommodation, or a blend of market and affordable housing, the resulting units would be compromised and of generally low quality. The cost of such a conversion relative to value achieved is highly prohibitive to financial viability. When considering the development of the tower as a whole, the provision of residential floorspace would be a drag on economic viability with other uses.

j whether an alternative approach could better meet the objectives of this policy and the Local Plan

A commercial scheme would better meet the policy objectives for the Knowledge Quarter .

The proposal provides flexible commercial floorspace for Knowledge Quarter users, of which there is an under-supply and few sites capable of delivering significant area. This includes laboratory and office space, with a particular focus on innovation occupiers. These are businesses that cover a range of scales from start up to global corporations, but particularly those who have high growth potential and whose business models leverage modern technology. Often these businesses will be developing high-value intellectual property across a range of sectors and will often build collaborations with educational institutes located in the Knowledge Quarter such as universities, teaching hospitals and libraries. These businesses wish to cluster close to other similar organisations as they consider knowledge exchange to be essential.

It is clear that converting the entirety of the tower to residential is not appropriate. Notwithstanding that the loss of the commercial use of this building is contrary to national, regional and local policy, it is clear that the site is not appropriate or suitable to provide quality residential floorspace.

Residents living in this tower would experience significant impacts on their quality of life, due to the poor floor to ceiling heights, the lack of amenity space, poor noise and air quality and poor quality of residential units due to north-facing units, internal daylight and sunlight implications and the prevailing wind microclimate.

10.3 Technical

10.3.1 Structure

The original tower was designed as an office space, and it is understood that the original live load for the floor was taken as 2.9kN/m^2 + 0.96kN/m^2 for partitions. The superimposed dead load was taken as 1.15kN/m^2 + 0.29kN/m^2, giving a total ultimate load capacity of 7.7kN/m^2.

For the office and laboratory use cases in the lower stack, loading and vibration requirements would be as per those detailed in Section 9.3.1. The existing loading is thought to be acceptable for continued office use, while the laboratory areas would need a heavier structure.

For the other residential/hotel use cases, the governing use case is the hotel which typically demands a loading allowance of 2kN/m^2 + 1 kN/m^2 for partitions (lightweight). Residential is typically less onerous due to decreased density. Accordingly, the existing floorplate loading capacity will be sufficient for these use cases, noting that superimposed dead load allowance of 1.15kN/m^2 + 1.2kN/m^2 assumes no additional screed is required over and above the existing 50mm screed.

For vibration, measurements taken by Arup in 2019 show an average response factor (R) of between 1 and 5 varying across the floorplates (higher (R) values generally occur at mid-spans). This will be challenging for hotel, residential, or student accommodation layouts particularly for bedrooms, where (R) of approximately 1-2 is desired, constraining bedrooms to be near to columns which is not always achievable.

A number of previous adaptations have been made throughout the life of the building. It should be expected that some of these modifications will require remedial work to fully utilise the potential of the building, though these won't be known until a full study has been undertaken.

The slab adaptability diagrams in Section 7.2 of Volume One (repeated here in Figure 10.11 for ease of reference), illustrate the required work for introducing large riser spaces into the floorplate. The residential-led use cases require a greater number of smaller openings (than an office, for example) for the purpose of plumbing, drainage runs, etc. The floorplate would generally be quite accommodating to these changes where such openings can be made between ribs, though it should be noted that ribs may not necessarily be aligned well between floors, likely requiring wider breakout and remedial works in some areas. Given that the ribs span in one-direction, the entire rib must be demolished if it is disrupted. This effect is that any small demolition that interrupts ribs results in larger portions of the ribbed slab needing to be removed.

If cutting through flat-slab areas, additional structure will be required to support the floor slab around the void.

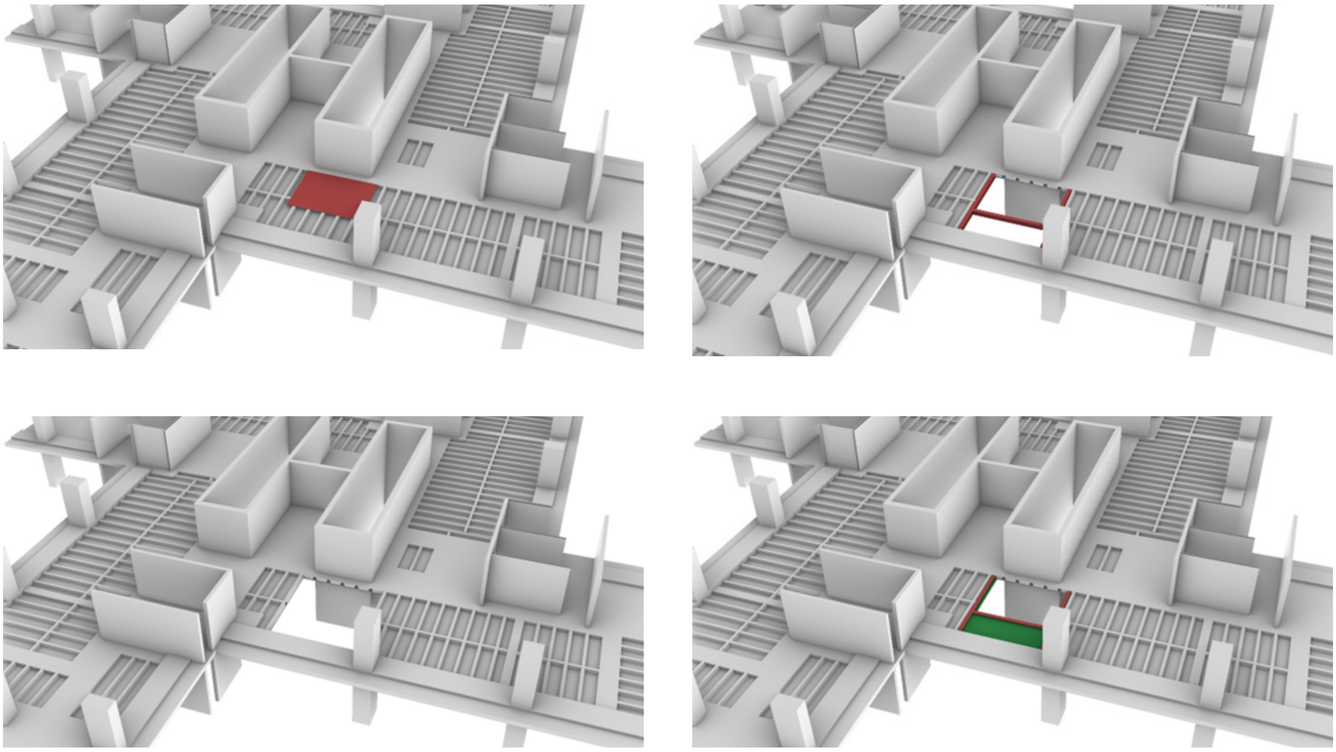


Figure 10.11 Slab adaptability diagrams from Volume One showing work to introduce risers into the existing floorplates

Top left: areas to be demolished to accommodate new MEP or VT openings in existing slab (shown indicatively)

Bottom left: whole section span of ribbed slab to be removed – i.e. section of slab removed is greater than extent of void required

Top right: new framing added to trim opening of new void. Likely solution involves steel beams sat within depth of existing structural ribs (250mm)

Bottom right: new slab areas infilled

10.3.2 Fire

The building will need to comply with current fire regulations, including Approved Document B 2021 edition and BS9999 for non-residential uses including hotel. For the residential use cases (applicable to both residential and student accommodation) BS9991 applies.

Due to the residential use cases in the upper portion of the stack, the building will be classed as a Relevant Building and Building Regulation 7 applies.

Critically, a building the height of Euston Tower (more than 30m) requires 120 minutes structural fire rating. Based on a previous Arup assessment, the existing structural fire rating is understood to be between 60 and 90 minutes when tested to current standards. This means that, even in this case where the aim is minimal intervention, areas of the existing structure will need to be upgraded to achieve the required structural fire rating.

In all three of these use cases, where residential is mixed with commercial office, laboratory, and hotel respectively, it is not permissible to share fire escape stairs. Both use cases require minimum 2 no. stairs each and both would need to be fire fighting stairs. This means that in total 4 no. fire fighting stairs are required. This requirement for independent escape cores precludes mixing more than two use cases, as each additional use would necessitate its own independent escape cores.

Additionally, each escape stair would need an associated dedicated fire fighting lift and an evacuation lift, meaning many new lifts will be required above those already provided.

For life safety systems for the office and laboratory levels, refer to Section 9.3.2.

On the residential levels, a fire sprinkler system would be required per BS 9521, as well as LD1 + L1 (to 5839-1 and -6) fire detection and alarm system + BS 8629 (all out system). For the hotel levels, a commercial fire sprinkler system would be required per BS EN 12845 and likely LPC insurance requirements, as well as an automatic L1 detection/alarm system.

Regardless of use case scenario, because the existing building is not sprinklered, allowing for a full system will have implications on plant and riser provision that must be accommodated.

In the residential-led use cases, the building is considered a Relevant Building meaning Building Regulation 7 applies and the materials used in the facade construction are strictly controlled. Beyond external fire spread, the existing facade does not have adequate fire stopping provisions at slab edge, meaning it does not achieve acceptable fire compartmentation between floors. This would need to be corrected as part of a new facade, that is proposed as part of the MEP/energy overhaul.

The following lists other key fire design implications for the residential-led uses:

- Evacuation strategy for residential would be "defend in place", with "simultaneous" evacuation for the hotel levels.
- Evacuation for the office and laboratory levels would be a phased approach.
- Travel distances vary depending on uses. For residential a travel distance of 20m from any point in a flat due to AWFSS and LD1 alarm/detection system being provided and a maximum of 15m in common corridors. For hotels 9m within the room, and 13m or 35m in common corridor depending on whether these are single or multiple direction respectively.
- Travel distances for student accommodation are 15m in a single direction, and 35m in a double direction (with AWFSS). Maximum distance in residential common corridors is 15m.
- Travel distance for the office usage of 50m for two way travel or 20m for single direction travel.
- Occupancies in the residential (and student accommodation) are limited by the number of residential accommodations provided, noting that these present a sleeping risk. Similarly in the hotel, occupancy is limited by the number of keys, noting that hotel amenity may vary with design and operator. Sleeping risk still applies.
- Fire fighting provisions include vehicle access to all stair cores (4 cores), wet risers and a fire control centre.

Options	Evacuation Strategy	Stairs	Travel Distances	Occupancies	Life Safety Systems	Facade	Fire-Fighting provisions
Office/Lab mix	Phased throughout	2 fire-fighting stairs. 1 additional escape stair required at basement level. Mechanical smoke ventilation.	Varying depending on uses: Office usage 50m for two way or 20m for single.	Limited by the size and locations of exits/stairs as well as usage of spaces. 1:6 occupancy target for typical office floors, with a higher density on public floors (tbc depending on use)	Automatic L1 detection/ alarm system. BS EN 12845 / commercial sprinklers + LPC compliance assumed	Façade design must limit risk of fire spread but Building Regulation 7 does not apply.	Vehicle access to all stair cores (4 cores) Wet Risers Fire control centre
Residential with Hotel	Simultaneous for hotel alongside 'defend in place' for resi.	Hotel and Student Resi areas cannot share stairs. Both uses will require a minimum of 2 stairs each and both would need to be fire-fighting stairs (i.e. total of 4 FF shafts).	For hotel: 9m within the room Common corridor: 13m single direction 35m in two directions. For resi: 20m from any point in flat due to an AWFSS and LD1 alarm/detection system being provided. 15m maximum in common corridor.	Limited by number of hotel rooms and residential apartments. Hotel amenity may vary. Sleeping risk.	Hotel: Automatic L1 detection/ alarm system. BS EN 12845 / commercial sprinklers + LPC compliance assumed Residential: LD1 + L1 (to 5839-1 and -6) fire detection and alarm system + BS 8629 (all out system BS 9251 / residential sprinklers	Regulation 7 of the Building Regulations applies to all external walls. (Strict limitations on all façade materials)	Vehicle access to all stair cores (4 cores) Wet Risers Fire control centre
Office with Residential	Phased for commercial alongside 'defend in place' for resi	Office and Resi areas cannot share stairs. Both uses will require a minimum of 2 stairs each and both would need to be fire-fighting stairs (i.e. total of 4 FF shafts).	See above for office areas. For resi: 20m from any point in flat due to an AWFSS and LD1 alarm/detection system being provided. 15m maximum in common corridor.	Limited by the number of residential accommodations provided. Sleeping risk.	LD1 + L1 (to 5839-1 and -6) fire detection and alarm system + BS 8629 (all out system) BS 9251 / residential sprinklers, and BS 12845 / commercial sprinklers + LPC compliance assumed	Regulation 7 of the Building Regulations applies to all external walls. (Strict limitations on all façade materials)	Vehicle access to all stair cores (4 cores) Wet Risers Fire control centre
Office with Student Acc.	Phased for commercial alongside simultaneous or phased for student resi (subject to further design development)	Office and Student Resi areas cannot share stairs. Both uses will require a minimum of 2 stairs each and both would need to be fire-fighting stairs (i.e. total of 4 FF shafts).	See above for office areas. For student resi: 15m in single direction, 35m in double direction (with AWFSS). 15m in residential common corridor.	Limited by the number of residential accommodations provided. Sleeping risk	LD1 + L1 (to 5839-1 and -6) fire detection and alarm system + BS 8629 (all out system) BS 9251 / residential sprinklers with possible need for 12845 system depending on amenity provisions + LPC compliance assumed	Regulation 7 of the Building Regulations applies to all external walls. (Limitations on all façade materials)	Vehicle access to all stair cores (4 cores) Wet Risers Fire control centre

Figure 10.12 Matrix of key fire requirements of each use on overall design

10.3.3 MEP

The residential building will need to comply with current Building Regulations, particularly:

- Approved Document Part F - Ventilation (ADF)
- Approved Document Part L - Conservations of fuel and power (ADL)
- Approved Document Part O – Overheating (ADO).

Each of these documents have a variety of implications to the existing building form and MEP servicing strategy with significant interventions required in order to meet the latest policy, associated guidance and codes of practice.

In general, whether for residential or hotel use, the need to introduce a raised floor zone and also a services bulk head in the modest ceiling void depth is not enough space to support modern building services. To modernise this, the servicing zone required in the floor and or ceiling would need to increase. See Figure 10.13.

One of the key implications of these mixed use schemes is the coordination that happens at the interface between the different uses. For all three scenarios, a ca. 600mm deep ceiling zone is required in the level below the residential accommodation (Level 12) to enable drainage offsets from the accommodation above. The laboratories are proposed below the residential apartments because they require a heavier structure for loading and vibration control which is better suited lower down, as well as for air quality reasons. Therefore in the laboratory use case, flues would need to be coordinated to pass through the residential core areas meaning additional laboratory-dedicated riser space would be required through landlord core areas.

An indicative residential riser schedule is shown in Figure 10.14.

Residential

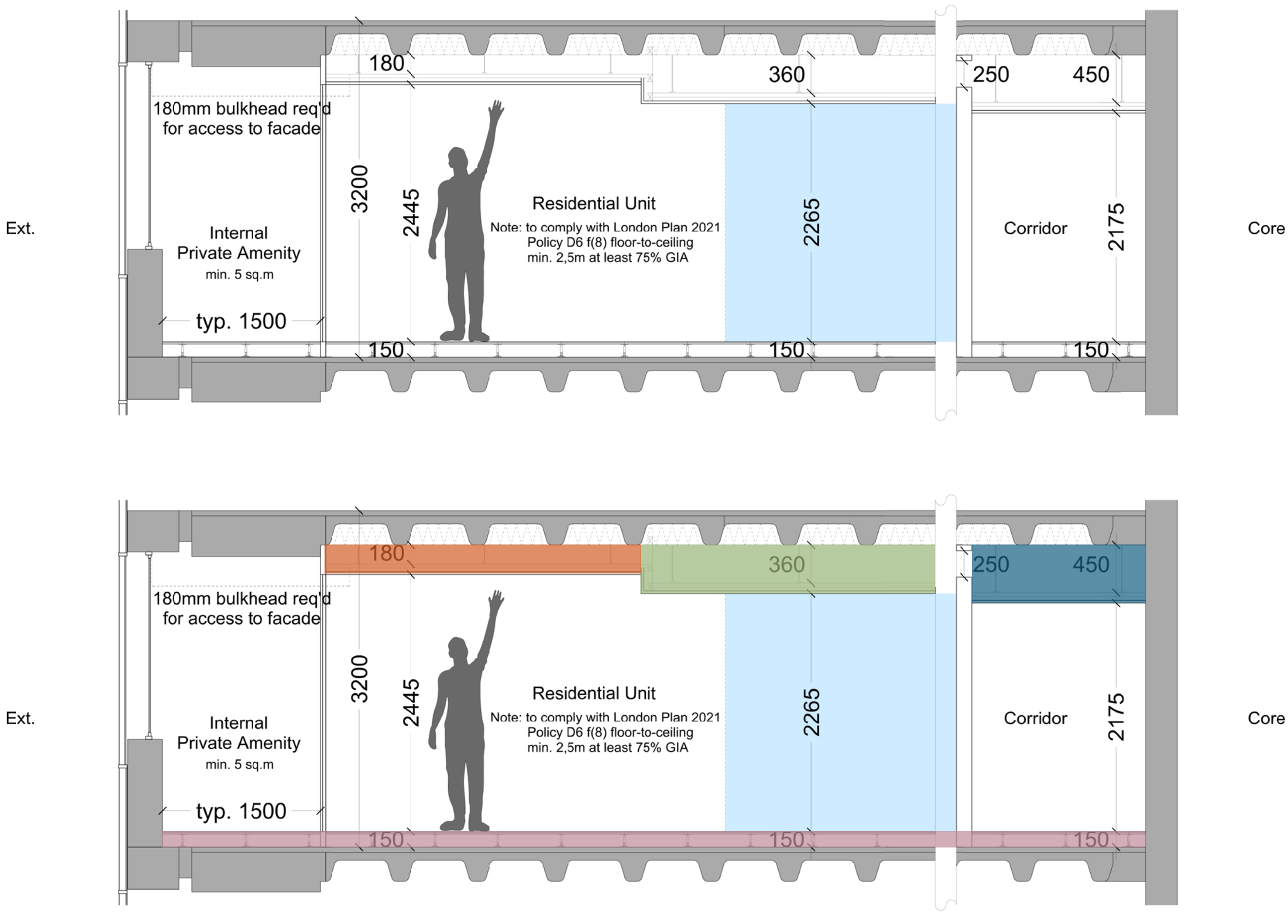
Statutory guidance for ventilation is given in ADF. ADF was first published in 1985, (15 years post construction of Euston Tower) as part of The Building Regulations 1985, and was most recently updated in 2021 with changes to post-Covid ventilation. In the residential apartments, a new offering would need to provide minimum fresh air rates in accordance with ADF 2021.

- The existing central plant of Euston Tower, complete with its riser provision does not support the ventilation requirements outlined for a residential tower.
- New dedicated systems integrated into each of the proposed apartments would be required. Due to the perimeter down stand beams the available head height within the apartment will be compromised in some areas due to the integration of these systems.

It is anticipated that ventilation would be provided decentrally (via mechanical ventilation with heat recovery (MVHR) units local to each apartment), following the principle of keeping as much of the residential equipment within the apartment's demise as possible. Air intake and extract would be ducted to the MVHR via openings in the facade in each apartment, necessitating a ceiling zone between the facade and the MVHR unit.

Building regulation statutory guidance for conservation of fuel and power (energy performance) is given in ADL. ADL was first published in 1985 and most recently updated in December 2021.

- The building would require extensive upgrades to meet the latest regulations with the existing carbon intensive oil fired boilers being replaced with new all-electric central plant to provide a low carbon heat source to the building (and in-line with London Plan requirements for air quality). This would result in revised riser and plant space requirements including upgrading electrical infrastructure.
- The minimum efficiency for fixed building services installations has also increased across all systems, ventilation heat recovery which is not a feature of the existing system, heating and cooling minimum efficiencies and domestic hot water generation.
- The target building, against which the proposed building will be compared, now incorporates wastewater heat recovery. These systems would be a challenge to integrate in apartments in Euston Tower due to the spatial requirements and the need to keep within an individual apartments demise. This shortfall in energy comparison would consequentially need to be compensated for in other areas of the design pushing each of the proposed systems even further from the existing building's current performance.



Bedrooms / living area - 180 mm void depth + 100 mm ceiling zone

WC and kitchen - 360 mm void depth + 100 mm ceiling zone

Corridor - 450 mm service zone + 100 mm ceiling zone

150 mm raised access flooring

	LENGTH (MM)	WIDTH (MM
Tenant power	2,000	1,200
Tenant broadband/TV	1,000	1,000
Landlord power	1,600	1,000
HV	500	500
Smoke extract	1,000	1,200
Smoke extract	1,000	1,200
Life safety	500	500
HV	500	500
PH vent	400	400
Sprinkler riser	600	1,200
BCWS	600	2,100
Landlord IT	1,000	1,200
LTHW high rise	850	600
CHW high rise	850	600
LTHW low rise	850	600
CHW low rise	850	600

Figure 10.13 Floor sections of residential use (above) with MEP zones marked up (below).

Figure 10.14 Residential riser schedule

- The existing building energy performance is heavily impacted by the poor condition and outdated design of the façade. It is not consistent with modern insulation requirements which would require a significant increase in thickness to meet the latest limiting U-value requirements, improved air tightness, and management of solar gain to meet the latest energy requirements.

The substantial revision in riser area requirement to support a residential offer will also have significant structural implications including additional penetrations through the existing structure. It is assumed that local plumbing and drainage risers can be coordinated to fit between ribs.

ADO was first released in December 2021 as a brand new regulation limiting the overheating in residential buildings. It is applicable to a variety of buildings and covers places where people might sleep. A significant emphasis is placed on the management of summer solar gains and adequate means of removing excess heat from the indoor environment.

- The building façade would require significant intervention to upgrade its performance to meet these requirements, balancing the aspects impacting overheating and natural ventilation strategies such as noise and air quality within a densely populated urban environment.
- There is a restriction on the lower storeys of the building, where the air quality is too poor for natural ventilation (see Section 10.3.7).

It is anticipated that cooling may need to be provided to satisfy ADO.

Room Section
The anticipated MEP requirements have been developed to produce the indicative room-side section in Figure 10.13. In the bedrooms and living areas a 180+100mm ceiling zone is anticipated for distribution, ventilation, lighting, and the like. In the WCs and kitchens, this would need to be 360+100mm to accommodate denser servicing like connections on to the MVHR/FCU, and servicing cross overs.

This ceiling zone cannot realistically be reduced any further due to the pinch point at the facade where the fresh air and exhaust ductwork would need to offset below the ring beam. This is circled in Figure 10.15 which shows indicative services distribution.

A raised access floor of 150mm is anticipated throughout. This is based on bathroom pods being utilised to help keep drainage connections within the demise. A reduced floor zone in the living spaces would necessitate a step between the WCs and living spaces, which is not appropriate for accessibility.

From the existing clear concrete to concrete height, this results in a maximum floor to ceiling height of 2,445mm in bedrooms and living areas, and 2,265mm below the bulkhead. This means that no part of the residential apartments would be compliant with the London Plan 2021 ceiling height requirement of minimum 2,500mm for at least 75% of the GIA.

In the corridors, allowing for a transfer zone and a double stacked distribution zone (LV, fire alarm, BCWS, comms, ELV, LTHW, fire sprinklers), results in a clear floor to ceiling height of 2,175mm.

Hotel
For MEP considerations for the hotel levels refer to Section 11.3.3.

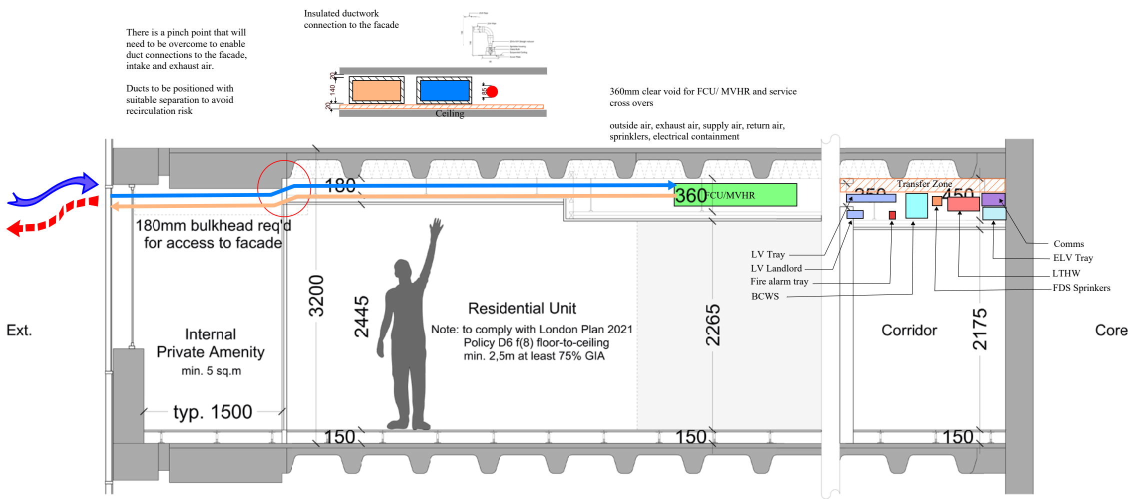


Figure 10.15 Indicative room section for residential use showing services distribution

Overall Servicing Schematics

The diagrams in Figure 10.16 - Figure 10.18 show the overall proposed MEP servicing strategy for all three stacks.

In all use cases, the proposed servicing combines tried-and-tested tower design principles with a future-looking all-electric concept.

Heating and cooling is provided via reversible heat pumps with heat recovery on the roof. High efficiency air-cooled chillers provide peak cooling capacity.

Residential and Office

All major plant is located in the basement or on the roof, with the exception of the decentralised ventilation plant located at every level.

At the levels where the use changes, it is anticipated it may not be possible to have riser continuity. A service transfer zone of approximately 650mm deep is required at these levels. Accordingly the change in use in the stack is set at Level 12, as this was previously an MEP floor and has slightly higher floor to ceiling height. However, there will still be a consequential effect on floor to ceiling heights on this level.

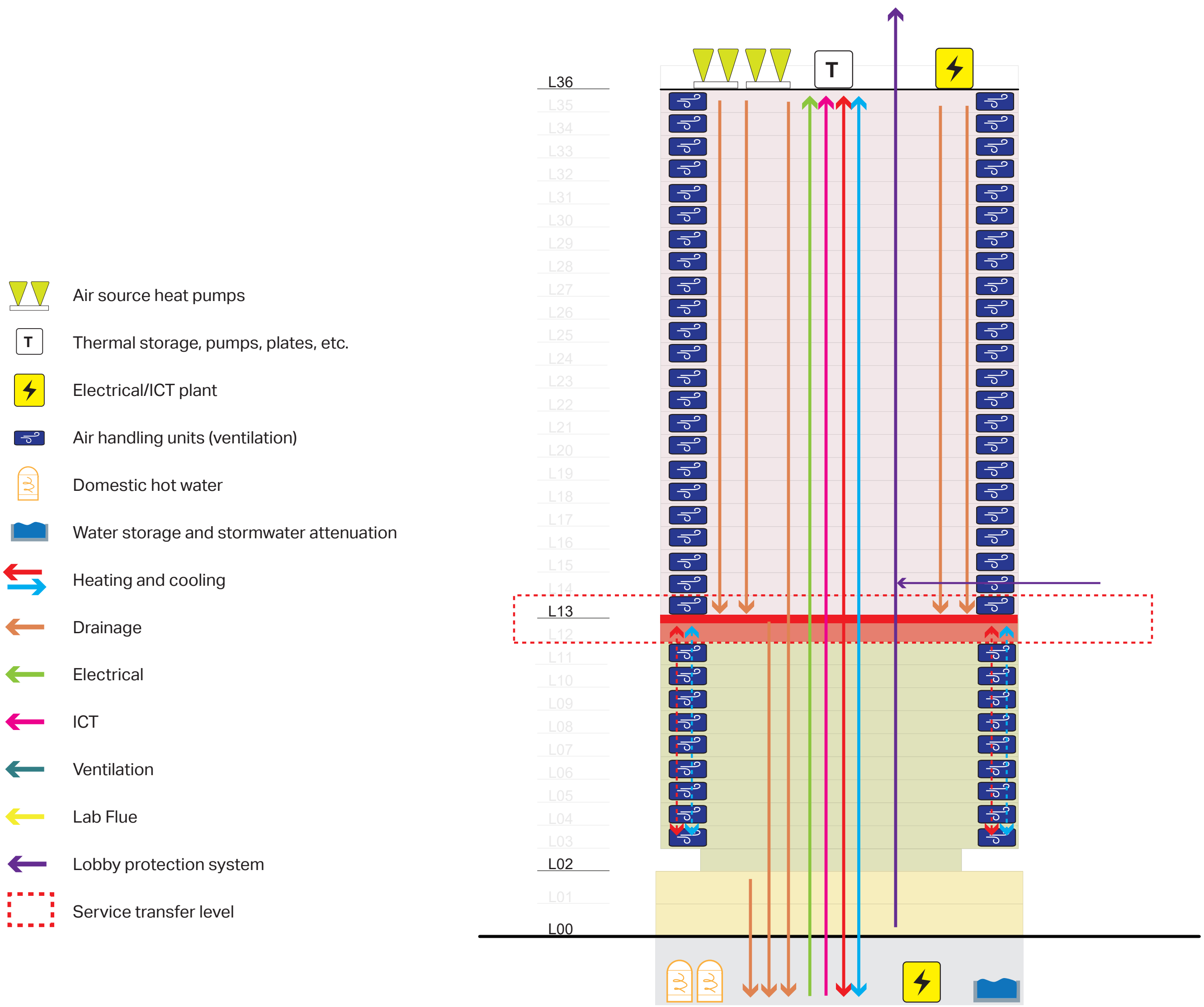


Figure 10.16 Overall servicing schematic for residential and office use case

Residential and Lab-enabled

All major plant is located in the basement or on the roof, with the exception of the decentralised ventilation plant located at every level.

The laboratory use in the lower portion of the stack necessities risers for flues running all the way up the building to roof.

At the levels where the use changes, it is anticipated it may not be possible to have riser continuity. A service transfer zone of approximately 650mm deep is required at these levels. Accordingly the change in use in the stack is set at Level 12, as this was previously an MEP floor and has slightly higher floor to ceiling height.

On the lab floors, drainage points are more dispersed, and therefore a key area is the service transfer zone required above the podium where the drainage is collected and transferred to below. This will result in a compromised floor to ceiling height at Level 02.

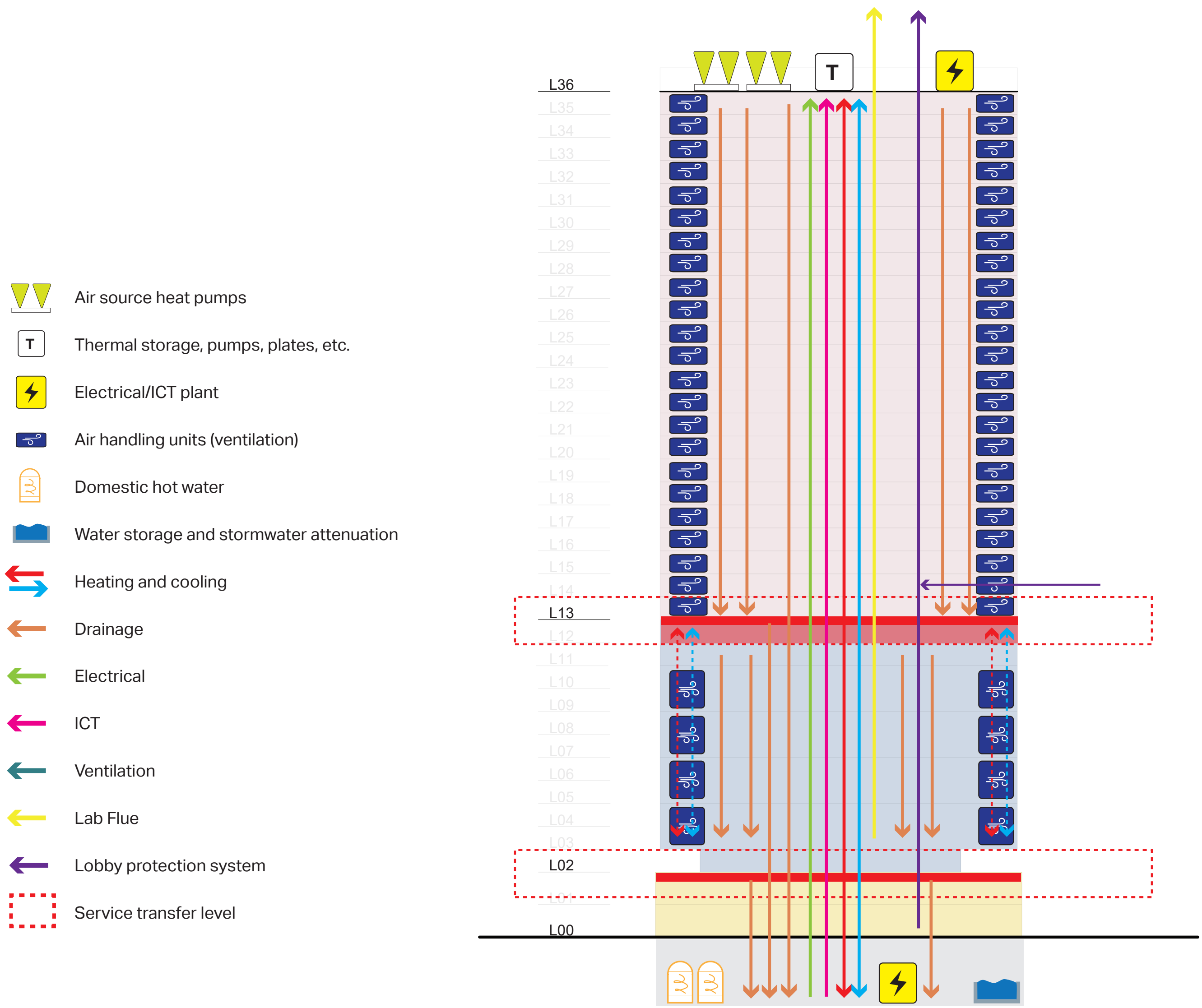


Figure 10.17 Overall servicing schematic for residential and lab-enabled use case

Residential and Hotel
All major plant is located in the basement or on the roof, with the exception of the decentralised ventilation plant located at every level for residential, and grouped on the uppermost level for the hotel.

At the levels where the use changes, it is anticipated it may not be possible to have riser continuity. A service transfer zone of approximately 650mm deep is required at these levels. Accordingly the change in use in the stack is set at Level 12, as this was previously an MEP floor and has slightly higher floor to ceiling height.

On the hotel floors, drainage points are more dispersed, and therefore a key area is the service transfer zone required above the podium where the drainage is collected and transferred to below. This will result in a compromised floor to ceiling height at Level 02.

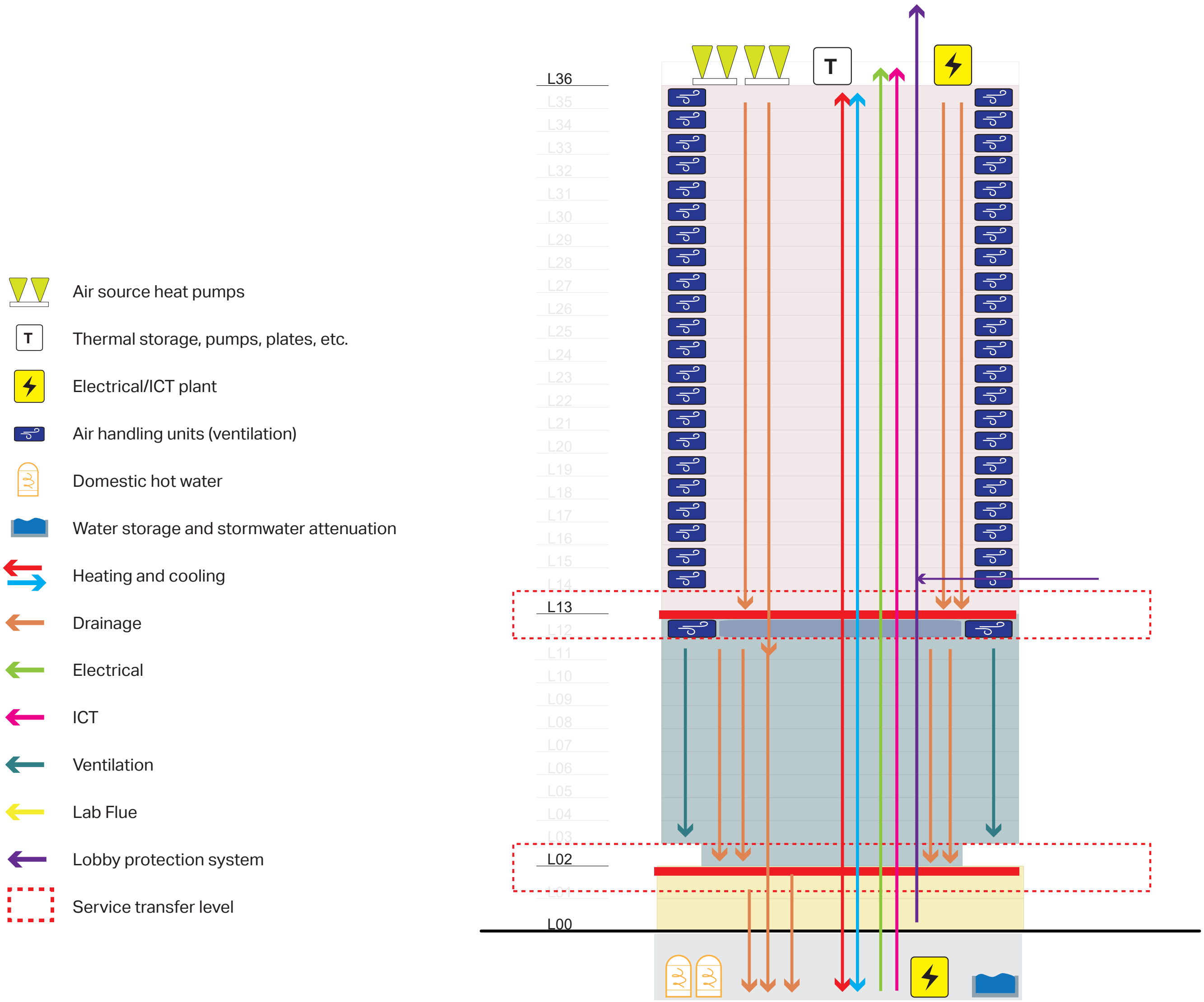


Figure 10.18 Overall servicing schematic for residential and hotel use case

Figure 10.19 Euston Tower at night when it was still occupied

10.3.4 Vertical Transportation

Considering the residential with office/laboratory/hotel use, the reduction in office space results in much less demand than a full office use. With the aim of being as unintrusive as possible, it is anticipated that the current lift provision, considering numbers alone, may be able to provide appropriate service with the residential component being the predominant use.

Critically, as noted in Section 10.3.2, dedicated fire fighting lifts are required and these cannot be shared by different uses. This means that the residential component needs its own 2 no. fire fighting lifts at each fire fighting core, and the lower portion of the stack (be it office, lab, or hotel), has its own 2 no. fire fighting lifts. An evacuation lift is provided at each of the fire fighting cores, resulting in significantly enlarged satellite cores.

The size of these enlarged satellite cores, and the requirement for independent escape cores precludes mixing more than two use cases, as each additional use would necessitate its own independent escape cores.

The existing goods lifts with a duty of 1,360kg are too small for offices or hotel use. Therefore new goods lifts will need to be provided for these uses. In the residential-led scenarios, it would be sufficient to use one of the passenger lifts as goods lift. This would typically require a deeper car (well dimensions of approximately 2,300 (w) x 2,900 mm (d)), so in order not to break out the existing central lift core, it may work to provide a standalone goods lift for the residential accommodation too.

The new goods lifts cannot be taken to basement level without interfering with the existing pile cap. Accordingly it is proposed that a separate goods lift is used from basement to ground, and then transferred to the new goods lift above ground.

Figure 10.20 Existing lift bank at Euston Tower

10.3.5 Facades

As outlined in Section 7.3 of Volume One, the existing façade cannot achieve the level of performance required by current building regulations and standards.

Due to the condition and design, it cannot be realistically upgraded, and therefore a new facade is required. Replacing the façade with a new construction is feasible, however this will have several implications on the design. The implications outlined in Section 9.3.5 are applicable to all use cases.

Thermal performance
In the residential (including student accommodation) and hotel use case, emphasis is likely to be on heat losses through the facade (U-values), where triple glazing is likely to be required. The thermal performance may also drive the design to reduce the amount of glazing and have very high-performance frames. Solar control is less of a concern (especially with pragmatic window-wall ratios), but must be considered in the context of overheating and Approved Document O.

Fire Performance
Generally the use of non-combustible materials for all main facade components is advised, regardless of use case. For the residential use cases however where there exists a sleep risk, Building Regulation 7 then applies to the whole building, which imposes strict requirements on the materials that are permitted in the external wall construction.

Figure 10.21 View from the base of Euston Tower 2022

10.3.6 Logistics and Transport

In the residential use cases, area will be required to accommodate bicycle parking spaces. The London Plan 2021 requires both long-stay and short-stay bicycle parking for dwellings.

The following rates are required by The London Plan:

LONG-STAY	SHORT-STAY
1 space per studio or 1 person 1 bedroom dwelling	5 to 40 dwellings: 2 spaces Thereafter: 1 space per 40 dwellings
1.5 spaces per 2 person 1 bedroom	
2 spaces per all other dwellings	

London Borough of Camden then seeks a 20% uplift on these allowances.

With regards to type of bicycle parking, the following is suggested:

- 5% larger accessible spaces - Sheffield stand with 1.5m spacing (1.5m^2 per space)
- 15% Sheffield stands with 1m spacing (1m^2 per space)
- 80% two tier. (0.5m^2 per space). This can be optimised 0.4m^2 per space with some systems.

Typically all bicycle parking is provided at ground floor or in the basement, as developers try to avoid using passenger lifts with wet/dirty bicycles. However, there are schemes with split provision, with most bicycle parking at low level and a smaller fraction distributed on the above ground levels.

As there is space within the residential core at Euston Tower to accommodate bicycle parking, it is therefore proposed to split the bicycle parking provision to make best use of the floor plate. Long-stay bicycle parking will be provided within the core on every level, see Figure 10.22.

All short stay-spaces would be accommodated at ground level within the public realm.

Waste and recycling facilities for residential would be provided within the existing basement at Regent's Place.

For hotel logistics and transport considerations, refer to Section 11.3.6.

On-floor bicycle parking

Figure 10.22 Typical tower level residential use with long stay bicycle parking provided for within the core (highlighted)

10.3.7 Air Quality

A fully-residential scheme is not considered feasible due to poor air quality at the lower levels of the tower (among other environmental issues such as traffic noise).

Air quality assessments were conducted in 2019 and 2020. The 2019 assessment was based on modelled, historic data, while the 2020 assessment was based on data measured on site between September 2019 and February 2020.

The 2019 assessment found that the local air quality is mainly influenced by vehicle emissions associated with heavily trafficked A501 Euston Road to the south and A400 Hampstead Road to the east. With regards to NO_2 concentrations, it established exceedences from ground to Level 08 at all facades. The influence of the road traffic emissions is very marginal from Level 12 upwards. It recommended that site-specific monitoring was conducted to confirm the modelling.

This road traffic, and the 24 hour A&E department at the nearby hospital, also contribute to the noisy and polluted environment on this corner.

The 2020 assessment found that the local air quality had improved compared to the previous, historic data. It concluded that, on the basis of the monitoring survey, air quality is generally not a constraint to natural ventilation at the site. However, it still expressly recommended against openable windows on the lower levels along the eastern facade facing Hampstead Road.

Not having openable windows at the lower levels precludes residential uses in the lower stack, as residential apartments require openable windows for ventilation (or other localised means of ventilation). Therefore other uses (office, laboratory, hotel, etc.) are proposed for the lower stack, where these can be serviced using centralised ventilation systems with strategically-located air intakes and necessary filtration.

Refer to Appendix D for the Air Quality Assessments.

Furthermore, London Plan Policy D13 recognises that any changes of use to a noise sensitive land use, such as residential development proposals, should manage noise and other potential nuisances by separating new noise-sensitive development where possible from existing noise-generating businesses and uses through distance, screening, internal layout, sound-proofing, insulation and other acoustic design measures. The Agent of Change principle places the responsibility for mitigating the impact of noise and other nuisances firmly on the new development.

This policy continues to note that boroughs should not normally permit development proposals that have not clearly demonstrated how noise and other nuisances will be mitigated and managed. **Euston Road is one of the busiest roads in London, with high levels of noise and very poor air quality. Proposing residential development on this busy interchange is not an appropriate use of land for this reason, together with recognising the strategic land use objectives within the London Plan for this area to promote and enhance commercial development.**

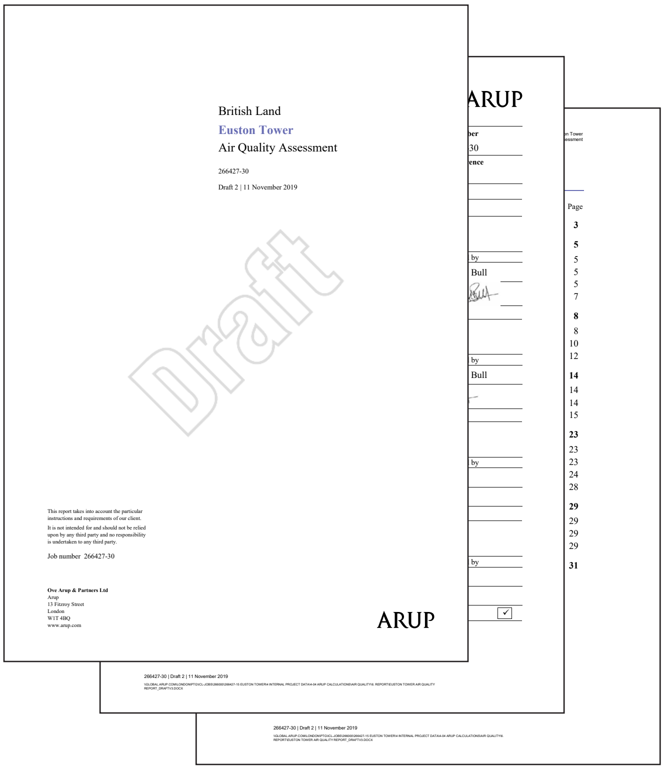


Figure 10.23 Air Quality Assessment produced by Arup

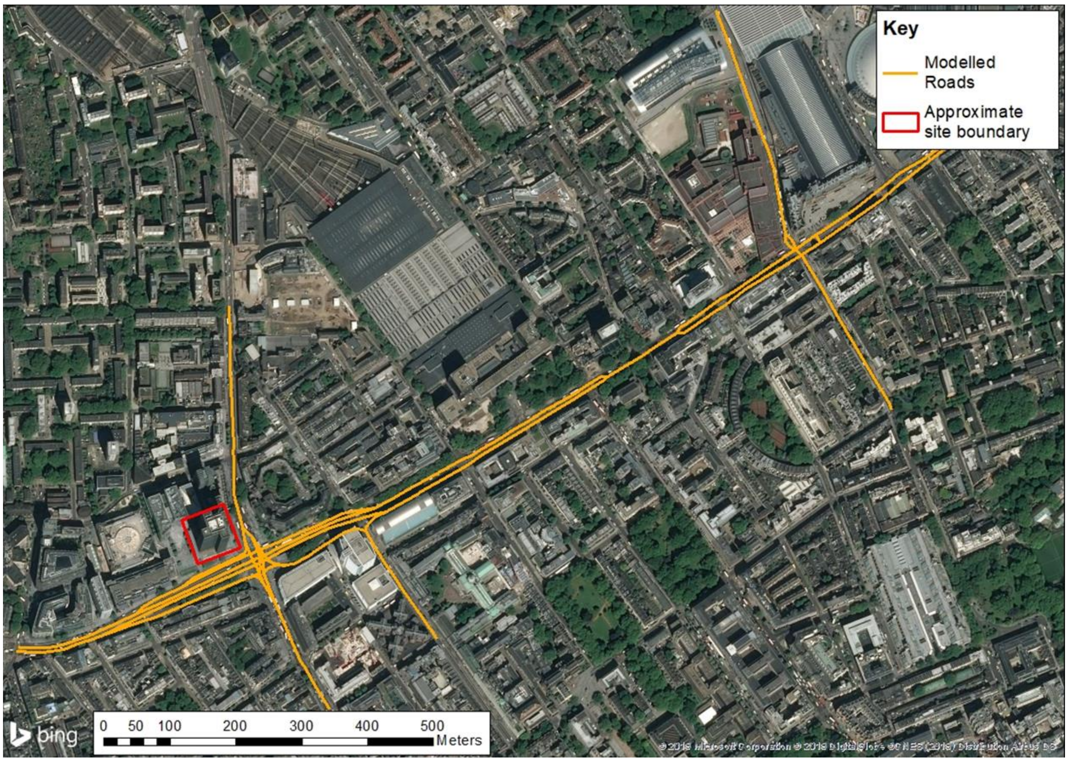


Figure 10.24 Map of modelled road network for 2019 Air Quality Assessment

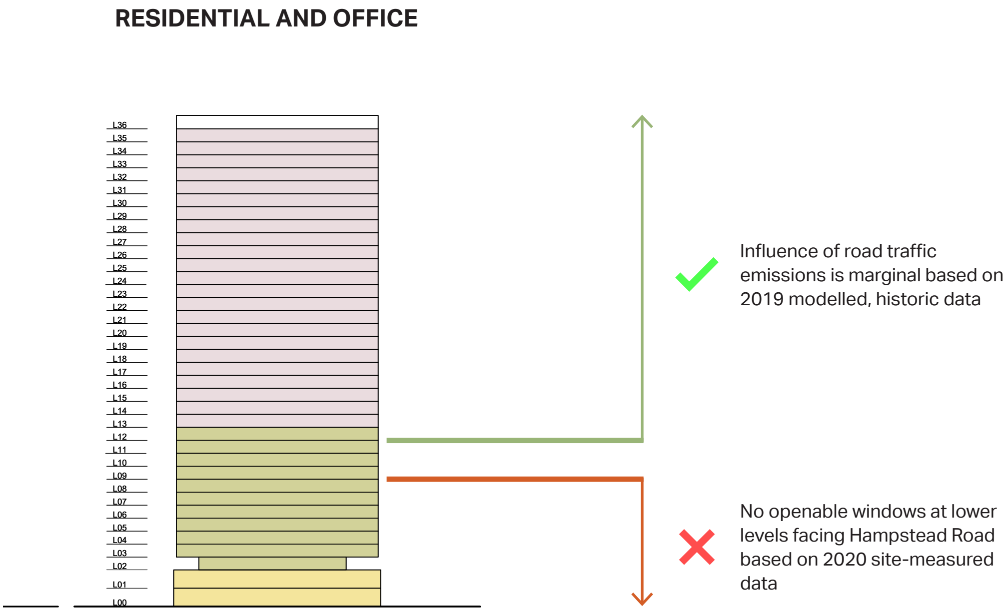


Figure 10.25 Diagram showing limitations on openable windows on the residential stack

10.3.8 Private Amenity and Wind

London Plan 2021 policy D6 requires a degree of private outside space for new dwellings. Such amenity may be delivered by a garden, terrace, roof garden, courtyard garden or balcony. Further guidance is given in the LPG Housing Design Standards (June 2023).

Balconies are the most applicable form of private outdoor space in multi-unit residential high rises. However based on anecdotal evidence, as well as existing wind studies, the conditions at Euston Tower are known to be windy and this increases at higher levels. See wind tunnel models in Figure 10.26.

Due to the local microclimate (sun, rain, and wind), balconies on the tower would be compromised without shelter to create frequent comfortable wind conditions.

Therefore enclosed winter gardens are proposed, as a form of private outdoor space. This strategy eliminates two environmental factors (wind and rain) and enables the spaces to be enjoyed more frequently. This is recognised as being acceptable, in limited circumstances, by the London Plan Housing Design Standards .

However in trying to be unintrusive, the existing facade line would be maintained, making the winter gardens part of the interior thermal zone. This contravenes the guidance which recommends that winter gardens are thermally separated. This would need to be corrected as part of a new facade, that is proposed as part of the MEP/energy overhaul.

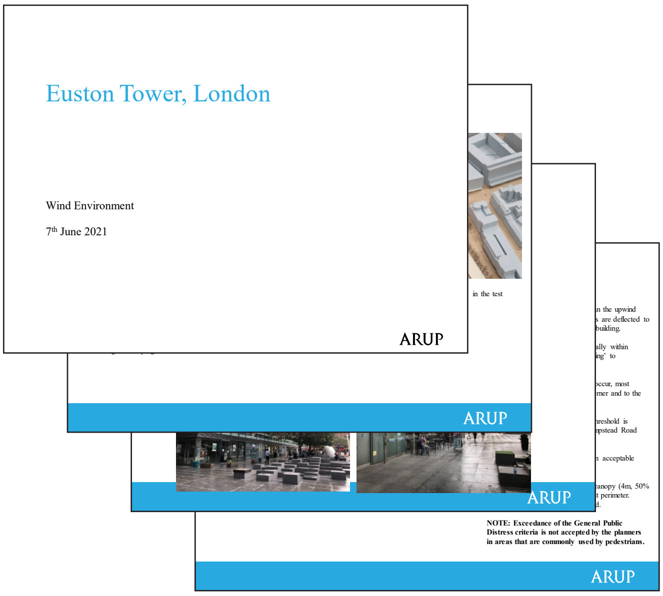


Figure 10.27 Wind studies produced by Arup in 2021

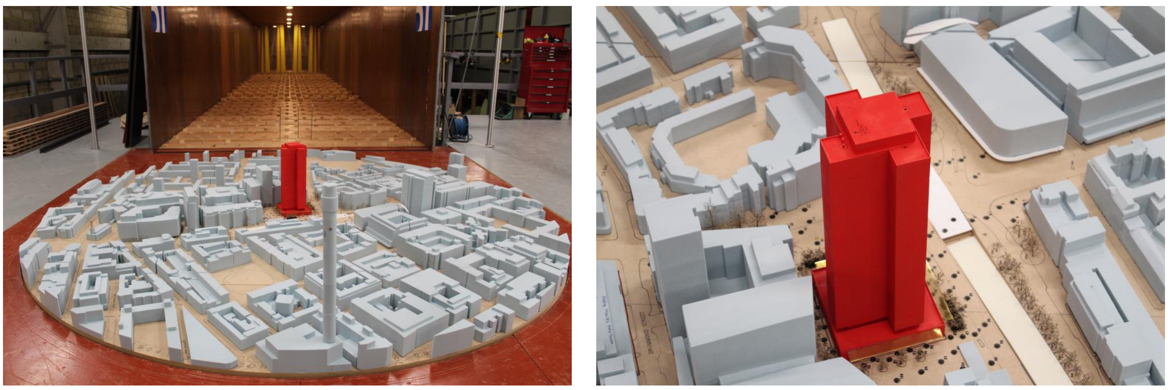


Figure 10.26 Wind tunnel models for the existing tower

Figure 10.28 Typical tower level residential use test-fit. Market rate mix with private amenity (winter gardens highlighted)

10.4 Impact on Existing Floorplate

The diagrams in Figure 10.30 - Figure 10.31 test the impact of the preceding interventions on the existing structure. The aim is to be as unintrusive on the existing structure as possible.

In general the spatial actions required are:
- Dedicated fire fighting lifts at each core
- Dedicated goods lifts
- Additional risers.

Dedicated fire fighting lifts are required as these cannot be shared by different uses. This means that the residential component needs its own 2 no. fire fighting lifts at each fire fighting core, and the lower portion of the stack (be it office, lab, or hotel), has its own 2 no. fire fighting lifts. An evacuation lift is provided at each of the fire fighting cores, resulting in significantly enlarged satellite cores.

It would be sufficient to use one of the passenger lifts as a goods lift. However, the deeper car requirement for the goods lift would create an intrusion in the existing core. To avoid this, new goods lifts are provided at the satellite cores.

The current passenger lift provision is sufficient for a predominantly residential use.

Finally additional risers would be needed to make the floor plate functional for energy and ventilation. It is anticipated that ventilation would be provided decentrally (via MVHR units local to each apartment).

Large portions of the floor slab would be impacted by these interventions cutting through existing slab. It is assumed that local plumbing and drainage risers can be coordinated to fit between ribs, reducing the extent of demolition and re-framing required. However, it is unlikely that the as-built positions of the ribs align adequately from floor to floor, and this will likely result in additional demolition where the local risers cannot be coordinated to pass between ribs.

However, where the existing ribbed slabs are interrupted by new vertical penetrations, they must be demolished for the length of the ribbed portion. This results in significantly more slab being removed than the size of the penetration itself.

It is clear in the diagrams that large areas of the existing floor slab would need to be removed to bring the existing building up to code and current standards. The resulting floorplate is spatially inefficient with a net to gross efficiency of ca. 65%.

The resulting residential accommodation is compromised and of low quality:
- The clear floor to ceiling heights are below the 2.5m requirements of the London Plan
- The plan form results in several single aspect units which impacts quality of housing provided
- The pinwheel results in units that are always self-shaded by the building
- The pinwheel plan and location of the satellite cores results in some narrow units with significant proportions of the area taken up as internal corridor space which impacts overall efficiency
- Maintaining the overall massing results in accommodation with no outdoor private amenity space
- Long, internal corridors with no daylight.

The diagrams in Figure 10.30 - Figure 10.31 show the floorplate development for the residential layout. Floorplate development diagrams for all mixed-use case combinations are included in Appendix A.

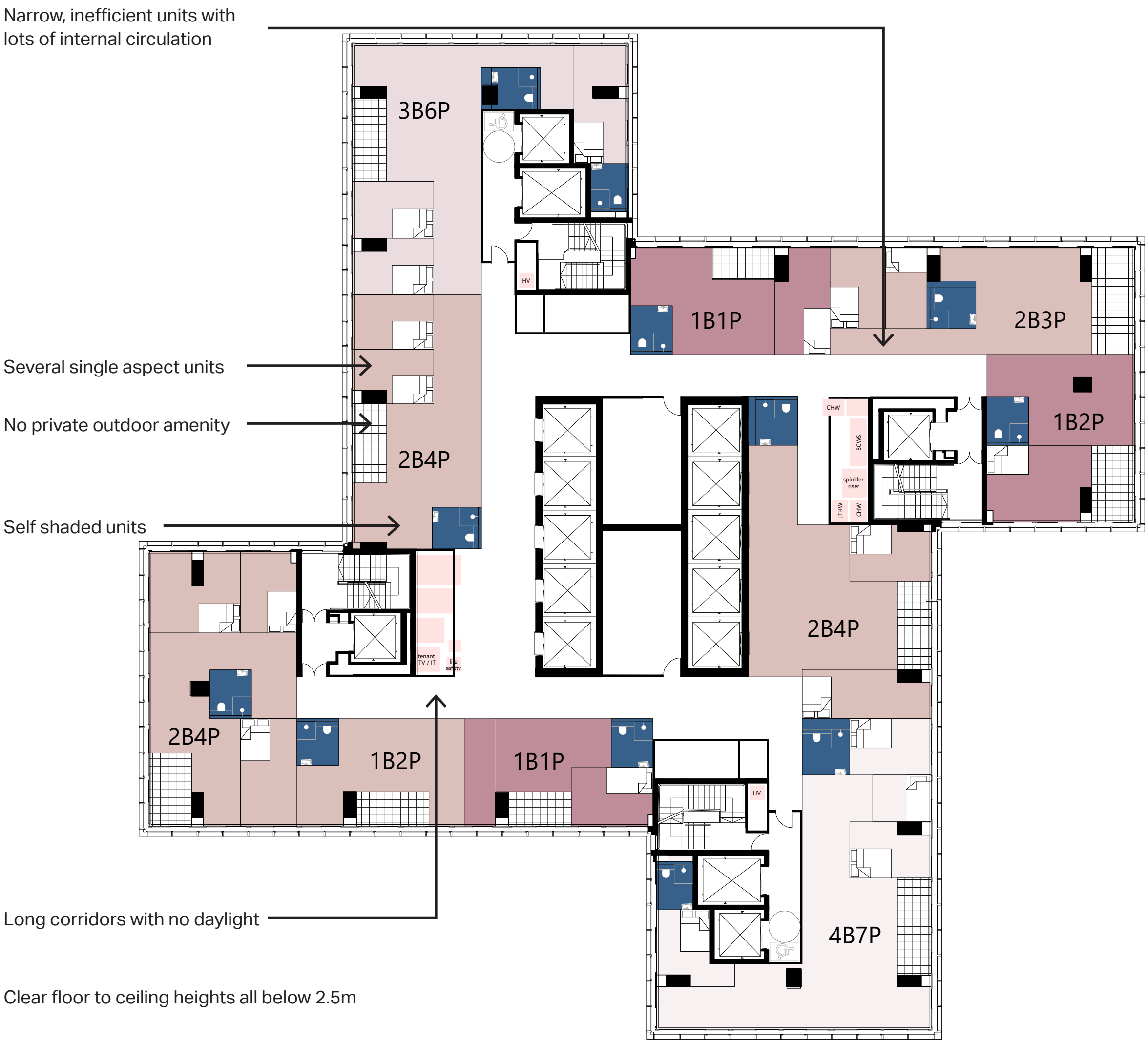
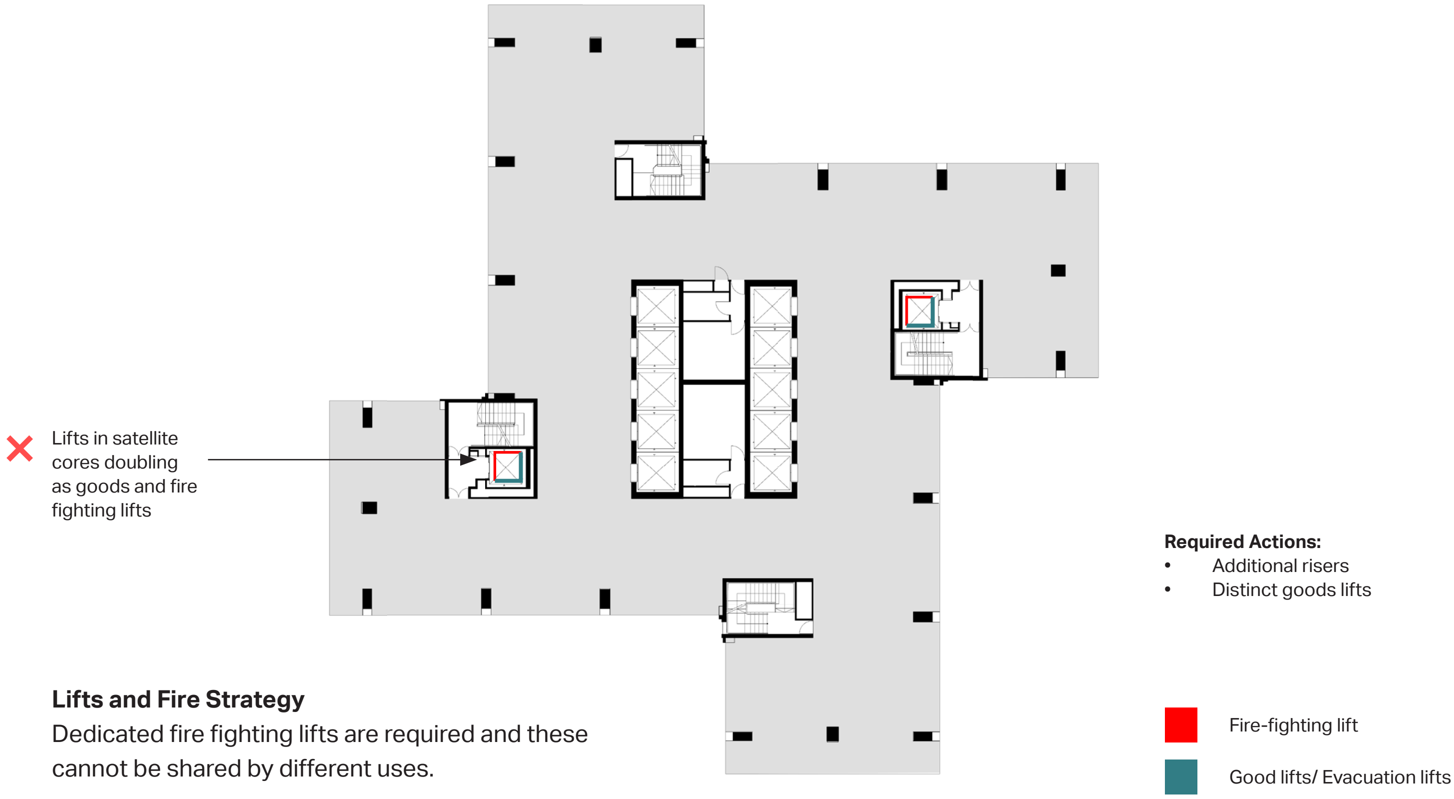
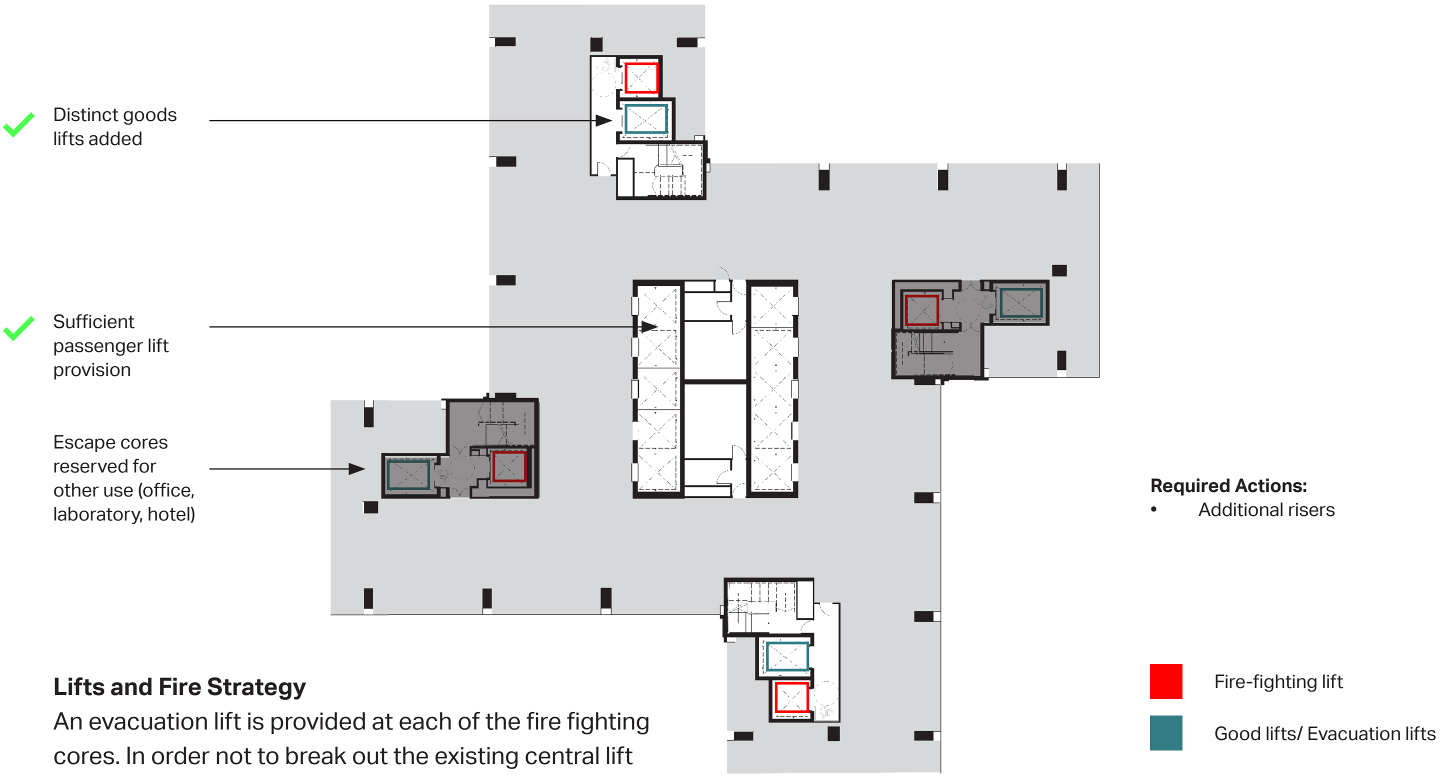


Figure 10.29 The resulting residential accommodation is compromised and of low quality



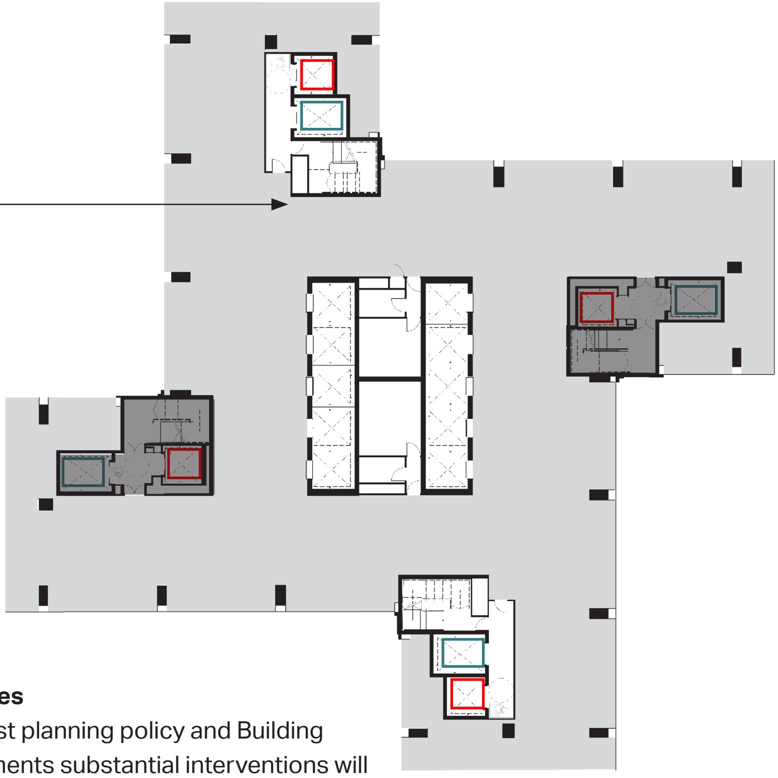
Lifts and Fire Strategy
Dedicated fire fighting lifts are required and these cannot be shared by different uses.



Lifts and Fire Strategy
An evacuation lift is provided at each of the fire fighting cores. In order not to break out the existing central lift core new goods lifts are provided at satellite cores.

Figure 10.30 Impact of changes on existing floorplates for residential use

Insufficient risers



Required Actions:

- Additional risers

Mechanical Services
To comply with latest planning policy and Building Regulation requirements substantial interventions will be required to meet energy conservation targets.

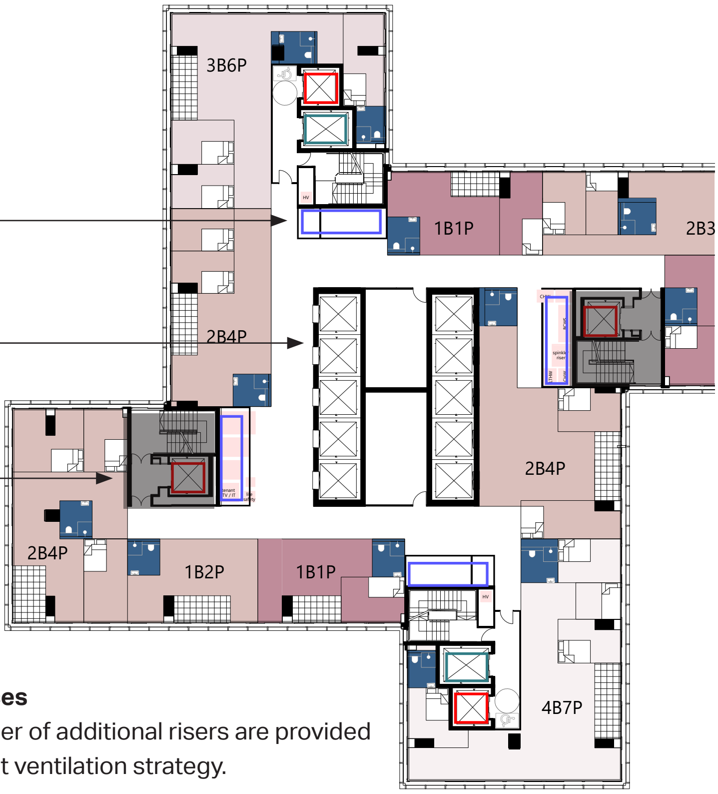
Fire-fighting lift

Good lifts / Evacuation lifts

Sufficient riser space provided

Passenger lifts serve residential floor only

Goods lift drops off

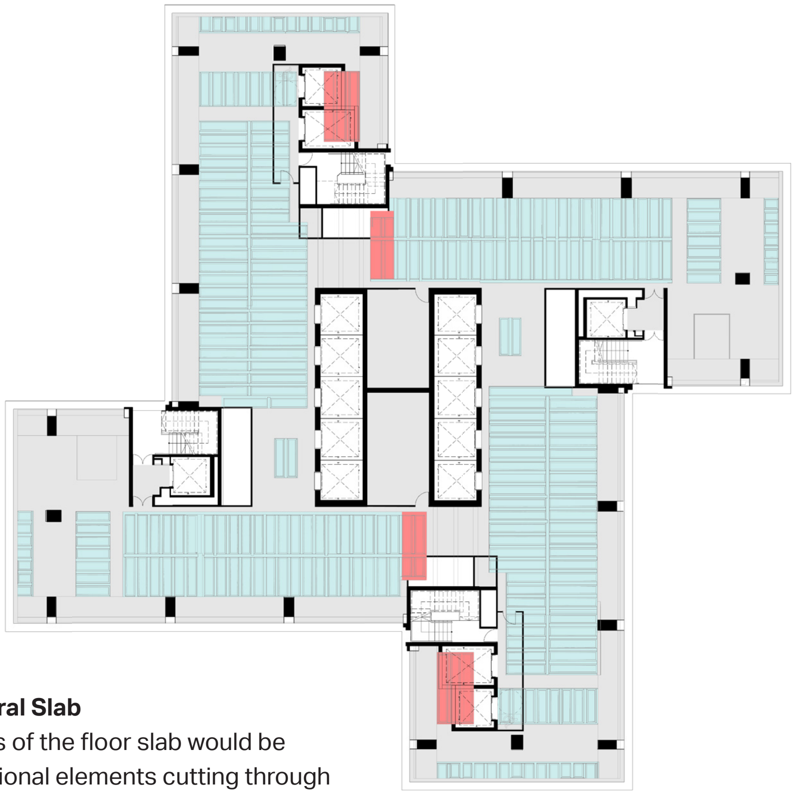


Mechanical Services
A substantial number of additional risers are provided to provide sufficient ventilation strategy.

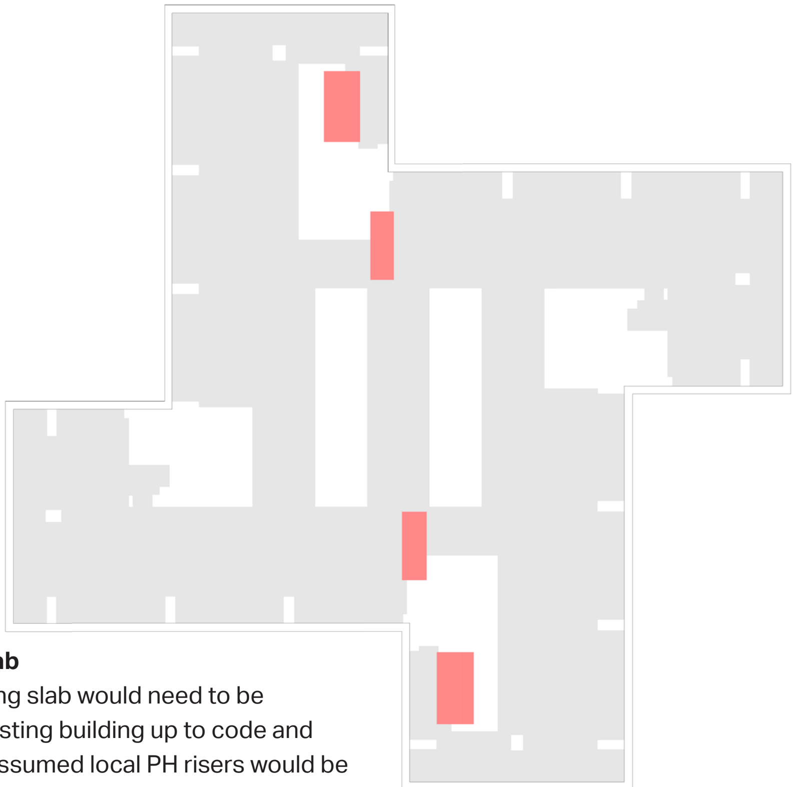
Fire-fighting lift

Good lifts / Evacuation lifts

Risers

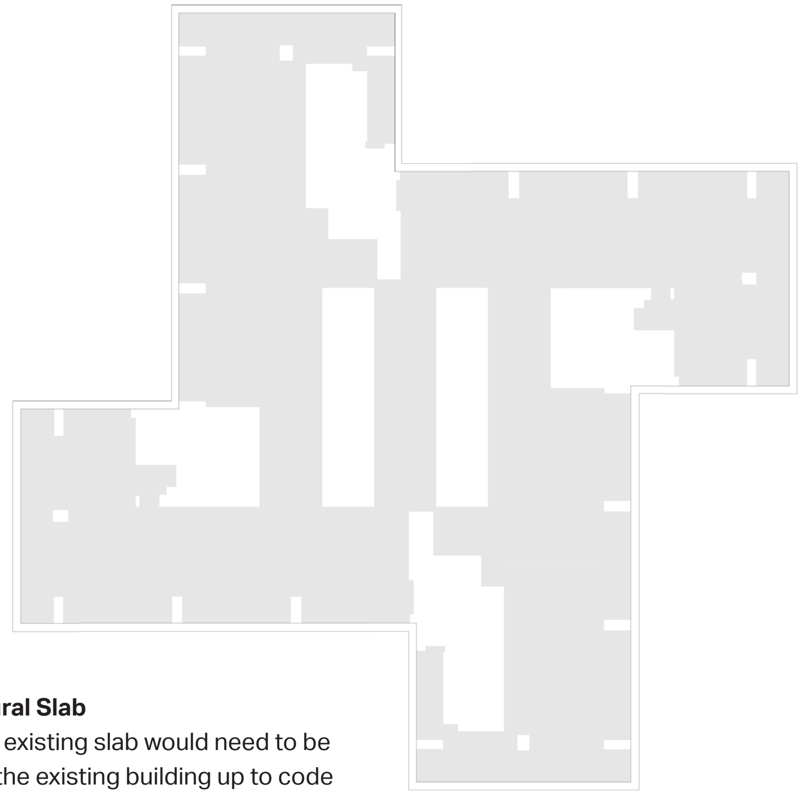


Implications to Structural Slab
Relatively minor portions of the floor slab would be impacted by these additional elements cutting through existing slab. It is assumed local PH risers would be coordinated to fit between the ribs, though these are unlikely to align from floor to floor resulting in additional demo.

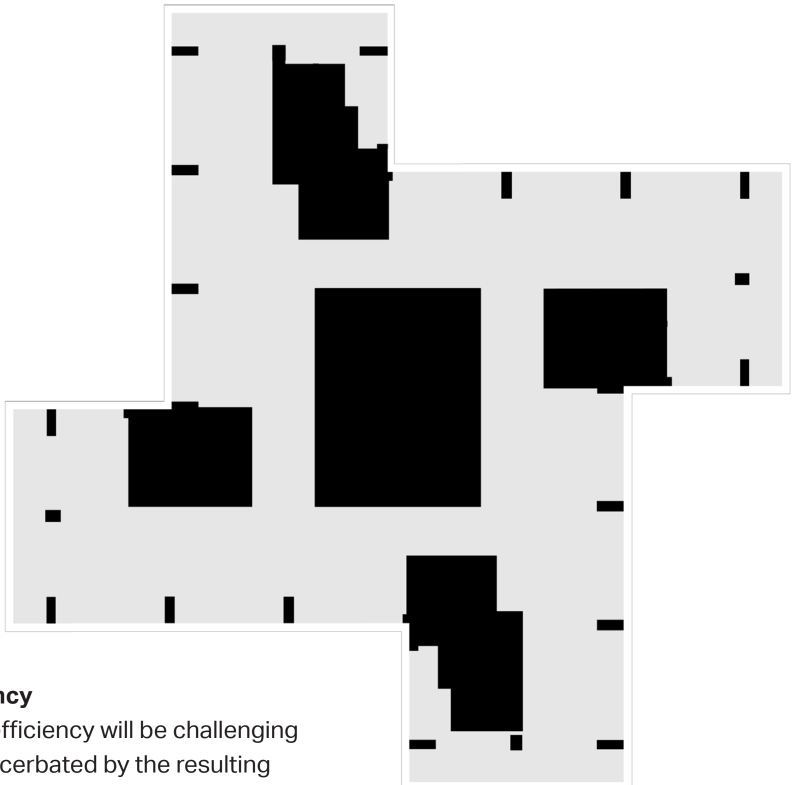


Resulting Structural Slab
A small amount of existing slab would need to be removed to bring the existing building up to code and current standards. It is assumed local PH risers would be coordinated to fit between the ribs.

Figure 10.31 Impact of changes on existing structural floor slab for residential use



Resulting Structural Slab
A small amount of existing slab would need to be removed to bring the existing building up to code and current standards. It is assumed local PH risers would be coordinated to fit between the ribs.



Floorplate Efficiency
Overall floorplate efficiency will be challenging to viability, and exacerbated by the resulting apartments being inefficient once laid out.

Resulting Floor Layouts
Figure 10.32 - Figure 10.34 show the resulting layouts for the ground level and a typical tower level for both use cases. It assumed that Level 01 would be an amenity level.

Level 00
The resulting floor layout for the ground floor (overleaf). The floorplates have 4 no. escape cores and are therefore suitable for two distinct uses.

The additional goods lift is intended as a shuttle between basement and ground, as it is not possible to take the new goods lifts at the satellite cores down to basement without interfering with the existing pile cap.

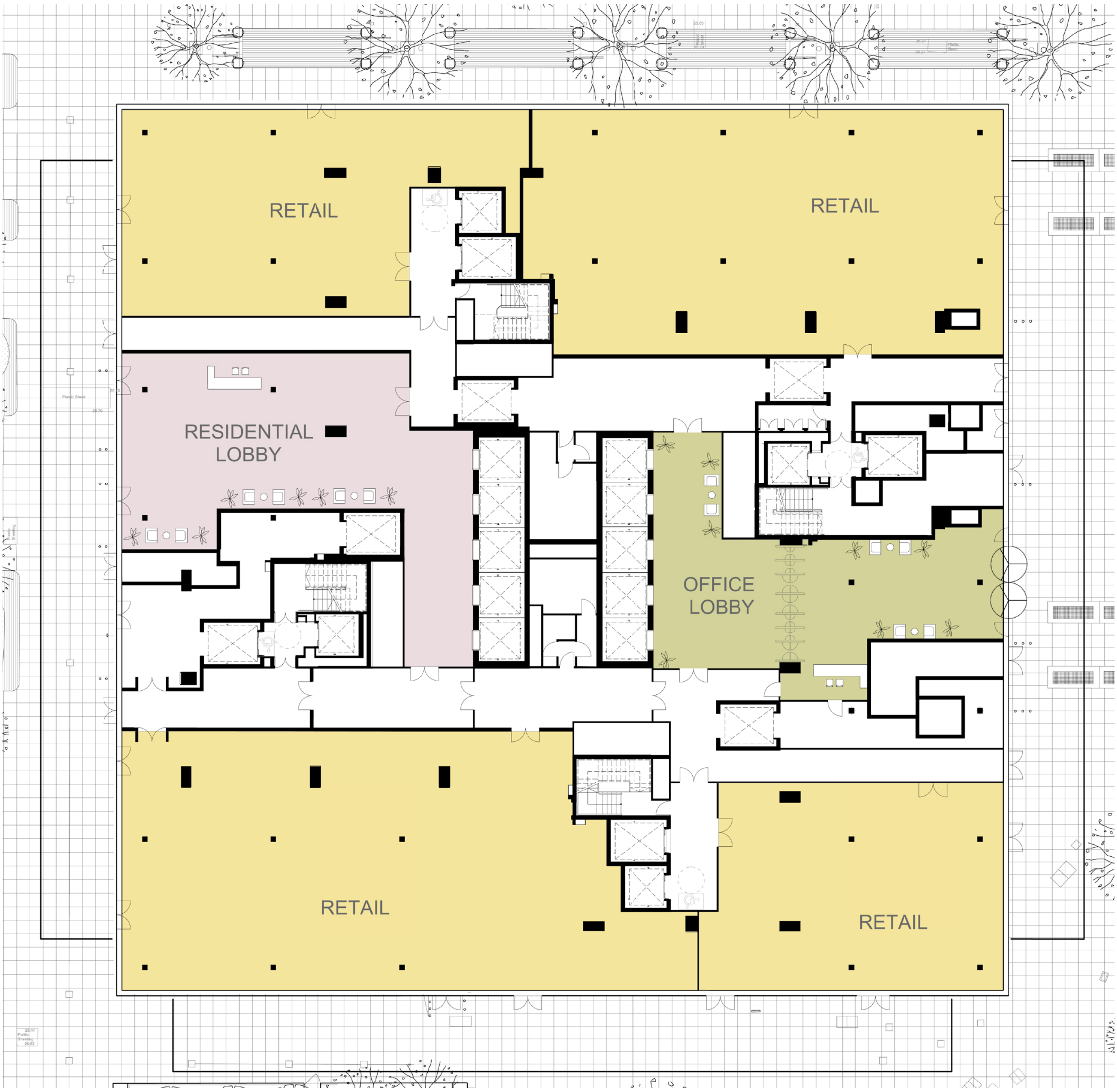


Figure 10.32 The resulting mixed use layout for Level 00

Typical Tower Office Level
The resulting floor layout for a typical tower office level. The floorplates have 4 no. escape cores (to accommodate resi above), and 4 no. local AHUs to maximise floor to ceiling height.

Figure 10.33 The resulting layout for the typical tower office levels

Typical Tower Residential Level
The resulting floor layout for a typical tower residential level. The floorplates have 4 no. escape cores (to accommodate office below).

Figure 10.34 The resulting layout for the typical tower residential levels

10.5 Viability

As part of this feasibility study, a viability analysis of the residential use cases has been undertaken. The following scenarios have been assessed:

- All residential units at market rates (100% market rate)
- Residential units 65% market rate, 35% affordable rate, with hotel.

10.5.1 Configuration and Condition

As shown in the preceding Sections, from a practical perspective, the building's configuration could theoretically lend itself to conversion to residential use. The configuration of the floorplate allows for a variety of residential unit sizes to be accommodated, the majority benefiting from a dual aspect, though noting some are inevitably single aspect.

Technically the building's structure would likely be acceptable to support a conversion the residential use cases. The entire facade and mechanical and electrical equipment would need to be replaced, significant structural interventions delivered for new risers and shafts, and appropriate fire protection measures for a tower be put in place.

However, as noted in Section 10.4, the residential units would be compromised and of generally low quality. **The cost of such a conversion relative to value achieved is highly prohibitive to financial viability.**

As outlined in Section 9.5, the costs of upgrades for the commercial offices/labs and the quality delivered would make viability challenging. **Therefore in the case where residential is mixed with office / lab-enabled spaces, the cost of such a conversion relative to value achieved remains challenging to financial viability and likely prohibitive.**

Figure 10.35 Centre Point is known to be one of London's "Ghost Towers"

11

Euston Tower

Hotel / Student Accommodation Developments

11.1 Introduction

11.1.1 Description

The land use cases studied in this Section are the following:

- Hotel-only
- Hotel and student accommodation.

With the office-only case from Section 9 being the nominal "base case", these options represent true alternative use scenarios.

In the hotel-only scenario, all floors above the podium are considered as hotel (Levels 02-35 inclusive). In the option with student accommodation, the hotel is assumed from Levels 02-12, with all storeys above providing student accommodation (Levels 13-35 inclusive).

The stacking diagrams are shown in Figure 11.1 and the floor plans in Figure 11.2 - Figure 11.4.

The hotel is assumed to be 3-4-star, with 1 or 2 restaurants, and possibly a rooftop bar. In the hotel-only it is anticipated to provide approximately 900 keys.

A student accommodation only scheme is not considered viable due to poor air quality at the lower levels of the tower. See Section 10.3.7.

11.1.2 Architectural Commentary

Hotel
The pinwheel plan allows for a relatively consistent layout of hotel rooms and can be modularised to the structural grid with larger accessible rooms located at the extremities.

Each room has access to daylight, similar to the residential units, the pinwheel results in units that are always self-shaded by the building.

Care has been taken to share, where possible, the risers required for each room, but it still results in significant demolition of the slabs, equivalent to approximately a third of the currently existing concrete.

The requirements for servicing have a significant effect on the floor to ceiling heights. Clear floor to ceiling heights range from an extremely low 2.175m in the corridors and 2.265m in the bathrooms and entryways to the rooms, to 2.475m in the general living areas towards the facade.

Student Accommodation
Like the hotel configuration, the pinwheel plan allows for a relatively consistent layout of student accommodation. However there are issues in aligning the rooms with the structural grid, resulting in an unequal provision of facilities across the rooms.

Care has been taken to share, where possible, the risers required for each room, but it still results in significant demolition of the slabs, equivalent to approximately a third of the currently existing concrete in the slabs.

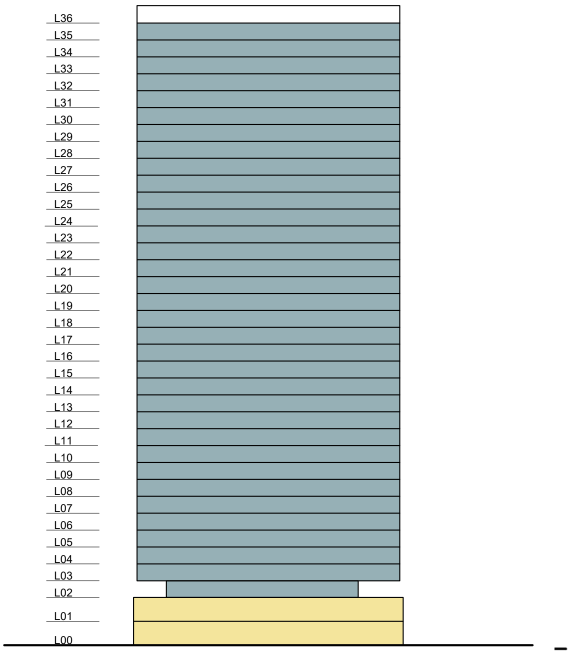
Allowance has been made for accessible rooms and 2 no. shared kitchen/living spaces have been provided. Each room has access to daylight although there are some units that are entirely north-facing.

The requirements for servicing have a significant effect on the floor to ceiling with heights. Clear floor to ceiling heights range from an extremely low 2.175m in the corridors and 2.265m in the bathrooms and entryways to the rooms, to 2.445m in the main living areas towards the facade.

No allowance has been made for more shared facilities, further to the shared kitchen / living spaces already noted.

HOTEL-ONLY

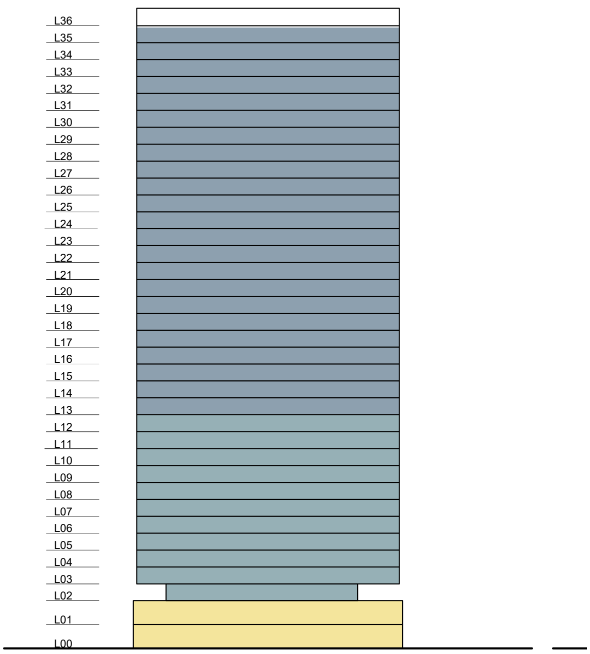
Key
Residential
Student Housing
Hotel
Offices
Labs
Retail



Hotel-only Stack

In this stack all levels above the podium are hotel levels (Levels 02-35 inclusive). All existing floor slabs are retained. The resulting hotel comprises ca. 900 keys. Because this is a single-use case, only two escape cores are required instead of the four that are required in the mixed-use cases. This reduces the interventions required at two of the satellite cores, and frees up some area around the east and west satellite cores (which are not used as escape cores). Because the hotel rooms would be mechanically ventilated from a central system, there is no constraint on providing hotel rooms in the lower portion of the stack (pollution zone).

HOTEL AND STUDENT ACCOMMODATION



Hotel and Student Accommodation Stack

In this stack the lower portion of the stack is hotel, with student accommodation levels above. All existing floor slabs are retained, giving hotel floors from Level 02-12, and student accommodation from Level 13-35. Similar to residential apartments, student accommodation cannot be provided in the lower portion of the stack, as these would need to have openable windows and the lower portion of the stack is within the pollution zone. An Air Quality Assessment recommended no openable windows on the lower levels along Hampstead Road (see Section 10.3.7), accordingly only uses that can be served mechanically, and from a central system, are considered feasible.

Figure 11.1 Hotel-only section stack (above) and hotel with student accommodation (below)

Figure 11.2 Typical floorplates for hotel floors in hotel-only scenario

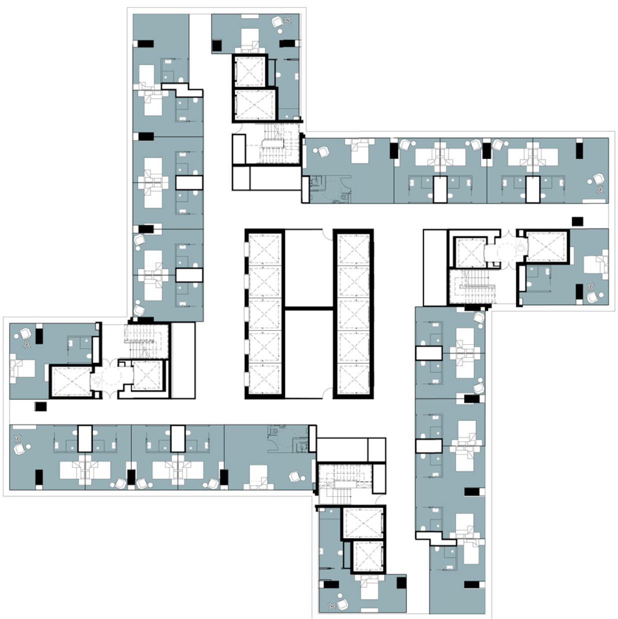


Figure 11.3 Typical floorplates for hotel floors in hotel and student accommodation scenario. One lift bank doesn't open on to the student accommodation floors.

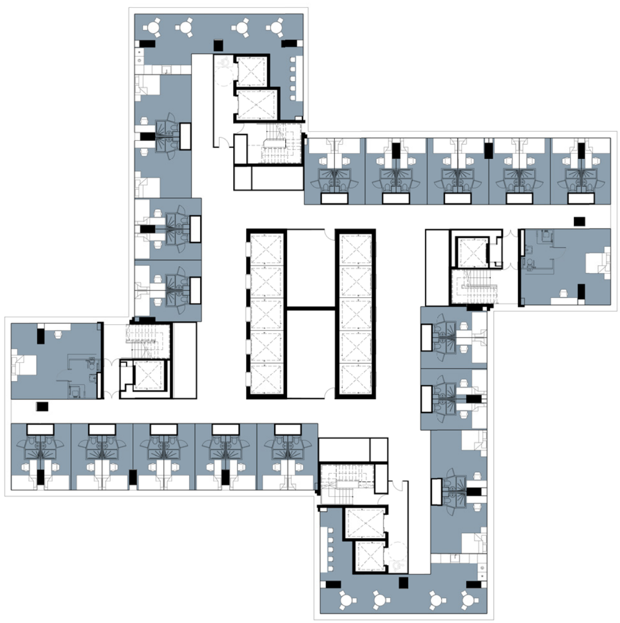


Figure 11.4 Typical floorplates for student accommodation floors in hotel and student accommodation scenario. One lift bank doesn't open on to the hotel floors.

11.2 Planning

11.2.1 Hotel Use

London Plan policy E10 considers that within the Central Activities Zone (CAZ), serviced accommodation should be promoted within Opportunity Areas and a sufficient supply and range of serviced accommodation should be maintained.

Policy E3: Tourism of Camden's Local Plan (2017) recognises the importance of the visitor economy in Camden and will support tourism and visitor accommodation which will be directed to and located in Central London, particularly the growth areas Holborn, King's Cross and Tottenham Court Road.

Sub-text paragraph 5.56 states that Camden provides the second largest number of serviced rooms in London, 17,580, after Westminster, with this number expected to increase which creates a greater need for hotel accommodation in Central London.

37% of the 2036 additional hotel rooms target of 40,000 set out in the London Plan (2021) will be met in Westminster, City of London and Camden.

Overall, a hotel within the existing building would provide approximately 900 keys, which is significant for this area of London and **there is unlikely to be demand for this number of rooms. Furthermore, while jobs may be created, such a use would result in a loss of a significant quantum of commercial floorspace in this strategically significant location.**

11.2.2 Student Accommodation

The National Planning Policy Framework (NPPF) highlights the importance of boosting the housing supply, with Paragraphs 59 and 61 specifically noting the importance of providing for specific housing groups, such as students.

London Plan policy H15 recognises the significant contribution students make to the economy and labour market. This policy seeks to ensure the local and strategic need for purpose-built student accommodation (PBSA) is met.

Specifically, Policy H15 seeks to ensure that the local and strategic need for PBSA is addressed provided that:

- At the neighbourhood level, development contributes to mixed and inclusive neighbourhoods
- The use of the accommodation is secured for students
- The majority of bedrooms in the development, including all affordable, are secured through a nomination agreement for occupation by students of one or more high education provider
- The maximum level of accommodation is secured as affordable student accommodation.

While the existing building is closely located to a number of higher education institutions, **the resulting tower fails to provide acceptable clear floor to ceiling heights for student accommodation. Similarly with a proposal to convert the building to a hotel, the local community would not benefit from the range of benefits a commercial building would offer. This is notwithstanding the strong policy position for the retention of the site as commercial floorspace, to complement the existing offer within the Knowledge Quarter both at a strategic level and for the London Borough of Camden.**

Figure 11.5 View of Euston Tower over Regent's Park

11.3 Technical

11.3.1 Structure

As noted in Section 10.3.1, the governing use case for loading is the hotel which typically demands a loading allowance of 2kN/m^2 + 0.5-1 kN/m^2 for partitions. Accordingly, the existing floorplate loading capacity (understood to be 2.9kN/m^2 + 0.96kN/m^2) will be sufficient for either hotel or student accommodation use cases, noting that lightweight partitions are assumed, and that no additional screed is required over and above the existing 50mm screed.

For vibration, measurements taken by Arup in 2019 show an average response factor (R) of between 1 and 5 varying across the floorplates (higher (R) values generally occur at mid-spans). This will be challenging for hotel, residential, or student accommodation layouts particularly for bedrooms, where (R) of approximately 1-2 is desired, constraining bedrooms to be near to columns which is not always achievable.

Refer to Section 11.4 for the implications of introducing additional risers in the existing slabs.

11.3.2 Fire

The building will need to comply with current fire regulations, including Approved Document B 2021 edition and BS9999 for non-residential uses including hotel. For the residential use cases (in this case, student accommodation) BS9991 applies.

In the case of the student accommodation, due to the residential use case the building will be classed as a Relevant Building and Building Regulation 7 applies.

Critically, a building the height of Euston Tower (more than 30m) requires 120 minutes structural fire rating. Based on a previous Arup assessment, the existing structural fire rating is understood to be between 60 and 90 minutes when tested to current standards. This means that, even in this case where the aim is minimal intervention, areas of the existing structure will need to be upgraded to achieve the required structural fire rating.

In the hotel with student accommodation use case, it is not permissible to share fire escape stairs. Both use cases require minimum 2 no. stairs each and both would need to be fire fighting stairs. This means that in total 4 no. fire fighting stairs are required. This requirement for independent escape cores precludes mixing more than two use cases, as each additional use would necessitates its own independent escape cores.

Additionally, each escape stair would need an associated dedicated fire fighting lift and an evacuation lift, meaning many new lifts will be required above those already provided.

In the hotel-only use case, this could be reduced somewhat as only 2 no. fire fighting shafts are required. These are provided at the north and south satellite cores. The existing building stair provision is suitable in this case.

As previously noted, the structural fire rating may need upgrading to 120 minutes regardless of these use cases.

For life safety systems for the hotel levels, a commercial fire sprinkler system would be required per BS EN 12845 and likely LPC insurance requirements, as well as an automatic L1 detection/alarm system. For the student accommodation levels, a fire sprinkler system would be required per BS 9521, as well as LD1 + L1 (to 5839-1 and -6) fire detection and alarm system + BS 8629 (all out system). It is possible that some areas will require sprinklers to BS EN 12845 depending on amenity provisions.

Regardless of use case scenario, because the existing building is not sprinklered, allowing for a full system will have implications on plant and riser provision that must be accommodated.

In the student accommodation use case, the building is considered a Relevant Building meaning Building Regulation 7 applies and the materials used in the facade construction are strictly controlled. Beyond external fire spread, the existing facade does not have adequate fire stopping provisions at slab edge, meaning it does not achieve acceptable fire compartmentation between floors. This would need to be corrected as part of a new facade, that is proposed as part of the MEP/energy overhaul.

The following lists other key fire design implications for the hotel/student accommodation uses:

- Evacuation strategy for hotel would be "simultaneous", with "simultaneous" or "phased" evacuation for the student accommodation levels subject to design development
- Travel distances vary depending on uses. For hotel 9m within the room, and 13m or 35m in common corridor depending on whether these are single or multiple direction respectively
- Travel distances for student accommodation are 15m in single direction, and 35m in double direction (with AWFSS). Maximum distance in residential common corridors is 15m.
- Occupancies in the student accommodation are limited by the number of accommodations provided, noting that these present a sleeping risk. Similarly in the hotel, occupancy is limited by the number of keys, noting that hotel amenity may vary. Sleeping risk still applies.
- Fire fighting provisions include vehicle access to all stair cores (4 cores in the hotel with student accommodation scenario, or 2 cores in the hotel-only scenario), wet risers and a fire control centre.

11.3.3 MEP

The building will need to comply with current Building Regulations, particularly Approved Document L (ADL) and Approved Document F (ADF) for MEP services. For domestic uses cases specifically, the new Approved Document O (ADO) on overheating applies.

In general, whether for hotel or student accommodation use, the need to introduce a raised floor zone and also a service bulk head in the modest ceiling void depth is not enough space to support modern building services. To modernise this, the servicing zone required in the floor and or ceiling would need to increase. See Figure 11.6 and Figure 11.9.

Hotel
For the hotel, the level or servicing is assumed to be commensurate with a 3-4 star hotel. Depending on the grade of hotel being targeted additional services may be required with consequential space requirements (e.g. enhanced ventilation to conference facilities).

ADF was first published in 1985, (15 years post construction of Euston Tower) and was most recently updated in 2021 with changes to post-Covid ventilation.

- The existing central plant, complete with its riser provision, does not support the ventilation requirements outlined for a hotel.
- Unlike the residential apartments, it is anticipated that ventilation would be provided from a central system for optimal energy efficiency and ducted to the hotel suites.
- New ventilation risers would need to be integrated directly into the individual hotel suites, which are remote from the core. The ventilation requirements would dictate a distribution size greater in size than the space available between the structural ribs.

ADL was first published in 1985 and most recently updated in December 2021.

- The building would require extensive upgrades to meet the latest regulations with the existing carbon intensive oil fired boilers being replaced with new all-electric central plant to provide a low carbon heat source to the building (and in-line with London Plan requirements for air quality). This would result in revised riser and plant space requirements including upgrading electrical infrastructure.
- The minimum efficiency for fixed building services installations has also increased across all systems, ventilation heat recovery which is not a feature of the existing system, heating and cooling minimum efficiencies and domestic hot water generation.
- The existing energy performance is impacted by the poor condition and outdated design of the façade. It is not consistent with the latest energy requirements.

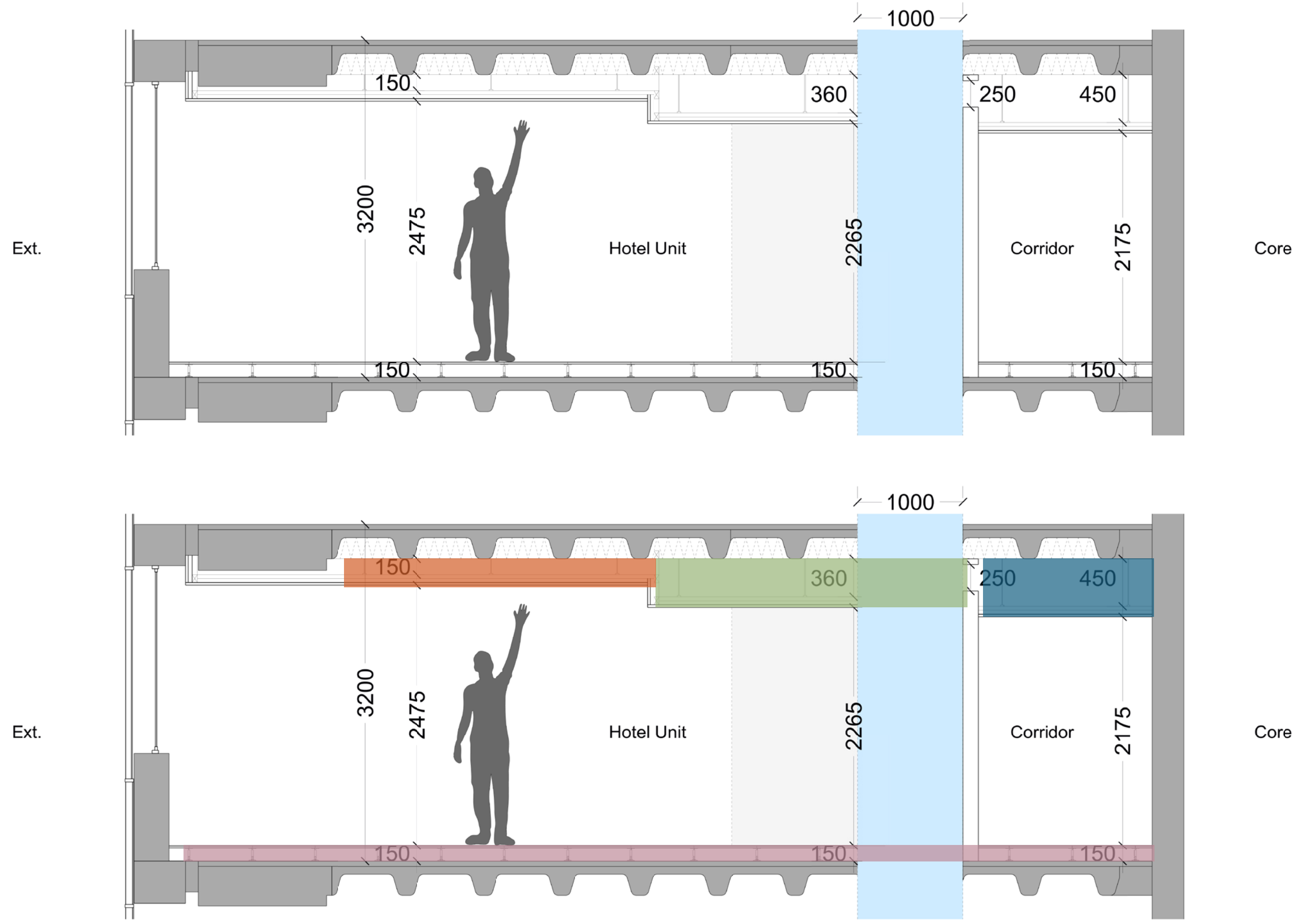
Approved Document O (ADO) was first published in 2021 as a brand-new regulation limiting the overheating in new residential buildings. While ADO does not apply to hotels, it is anticipated that cooling will need to be provided to satisfy market expectations in hotels.

Room Section
A room section is shown in Figure 11.6, and an indicative hotel riser schedule is shown in Figure 11.7.

In the bedrooms a 150+100mm ceiling zone is anticipated for distribution, lighting, etc. In the WCs, this would need to be 360+100mm to accommodate denser servicing like connections and a fan coil unit. A raised access floor of 150mm is anticipated throughout. This results in a clear floor to ceiling height of 2,475mm.

Each hotel suite would be served by an in-room combined service riser of size 1,000x1,000mm. The structural penetrations required support this are larger than could be integrated into the existing ribbed slab. This would require demolition, re-framing, and from an MEP perspective, additional riser area to co-ordinate vertical stacks across several openings, taking additional area.

To keep riser sizes to an acceptable level it is likely that intermediate plant floors will be required to house centralised air handling plant, extract fans and hot water generation. This would further reduce the overall area efficiency by taking up area that could otherwise be used for hotel suites.



- Bedrooms - 150mm void depth + 100mm ceiling zone
- WCs - 360mm void depth + 100mm ceiling zone
- Corridor - 450mm service zone + 100mm ceiling zone
- 150mm raised access flooring
- Riser space 1,000x1,000m in plan

	LENGTH (MM)	WIDTH (MM
Tenant power	2,000	1,200
Tenant broadband/TV	1,000	1,000
Landlord power	1,600	1,000
HV	500	500
Smoke extract	1,000	1,200
Smoke extract	1,000	1,200
Life safety	500	500
HV	500	500
PH vent	400	400
Sprinkler riser	600	1,200
BCWS	600	2,100
Landlord IT	1,000	1,200
LTHW high rise	850	600
CHW high rise	850	600
LTHW low rise	850	600
CHW low rise	850	600
In room combined service riser	1,000	1,000

Figure 11.6 Internal hotel on floor section showing 2,475mm clear floor to ceiling height

Figure 11.7 Hotel riser schedule

Student Accommodation
MEP provisions for the student accommodation are similar to the residential requirements described previously.

In the student accommodation, a new offering would need to provide minimum fresh air rates in accordance with ADF 2021.

- The existing central plant, complete with its riser provision, does not support the ventilation requirements outlined for student accommodation.
- Ventilation would be provided from localised ventilation systems (MVHR) fully contained within the individual demise.
- Air intake and extract would be ducted to the MVHR via openings in the facade in each apartment, necessitating a ceiling zone between the facade and the MVHR unit.

Beyond ventilation, the scheme would also need to comply with ADL 2021.

- The building would require extensive upgrades to meet the latest regulations with the existing carbon intensive oil fired boilers being replaced with new all-electric central plant to provide a low carbon heat source to the building (and in-line with London Plan requirements for air quality). This would result in revised riser and plant space requirements including upgrading electrical infrastructure.
- The minimum efficiency for fixed building services installations has also increased across all systems, ventilation heat recovery which is not a feature of the existing system, heating and cooling minimum efficiencies and domestic hot water generation.
- The existing energy performance is heavily impacted by the poor condition and outdated design of the façade. It is not consistent with modern insulation requirements which would require a significant increase in thickness to meet the latest limiting U-value requirements, improved air tightness, and management of solar gain to meet the latest energy requirements.

The substantial revision in riser area requirement to support a student accommodation offering will also have significant structural implications including additional penetrations through the existing structure. The structural penetrations required for local risers are larger than could be integrated into the existing ribbed slab. This would require demolition, re-framing, and from an MEP perspective, additional riser area to co-ordinate vertical stacks across several openings, taking additional area.

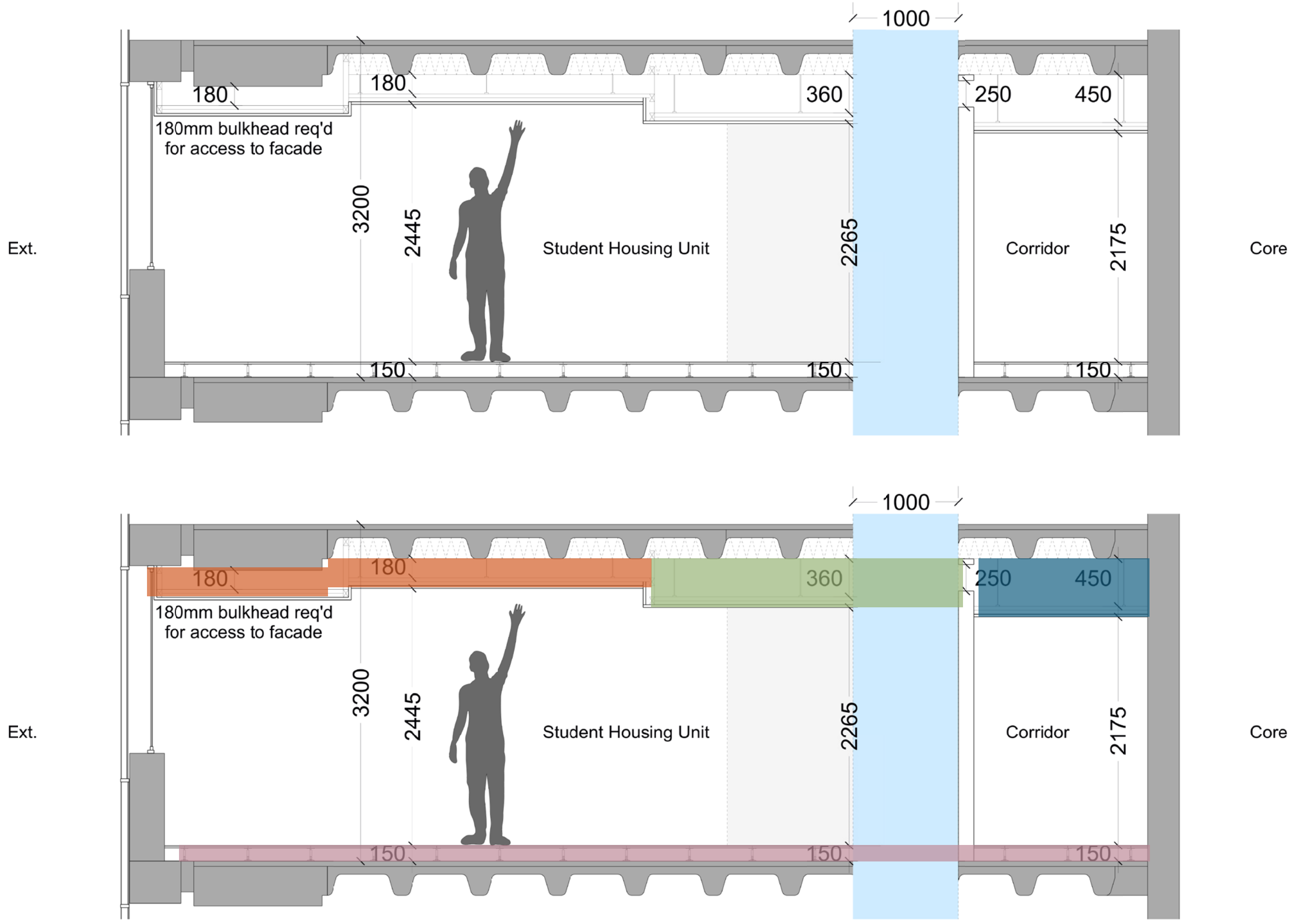
Approved Document O (ADO) was first published in 2021 as a brand-new regulation limiting the overheating in new residential buildings.

- The building façade would require significant intervention to upgrade its performance to meet these requirements.

Room Section
On the room side, in the bedrooms / living areas a 180+100mm ceiling zone is anticipated for distribution, ventilation, lighting, and the like. In the WCs, this would need to be 360+100mm to accommodate denser servicing, crossovers, connections, etc. A raised access floor of 150mm is anticipated throughout. From the existing clear concrete to concrete height, this results in a floor to ceiling height of 2,445mm in bedrooms / living areas. This means that no part of the demise would be compliant with the London Plan 2021 ceiling height requirement of minimum 2,500mm for at least 75% of the GIA.

This ceiling zone cannot realistically be reduced any further due to the pinch point at the facade where the fresh air and exhaust ductwork would need to offset below the ring beam.

A room section is shown in Figure 11.9, and an indicative student accommodation riser schedule is shown in Figure 11.10.



Bedrooms / living area - 180mm void depth + 100mm ceiling zone

WC and kitchen - 360mm void depth + 100mm ceiling zone

Corridor - 450mm service zone + 100mm ceiling zone

150mm raised access flooring

Riser space

Figure 11.9 Internal student acc. on floor section showing 2,475mm clear floor to ceiling height

	LENGTH (MM)	WIDTH (MM
Tenant power	2,000	1,200
Tenant broadband/TV	1,000	1,000
Landlord power	1,600	1,000
HV	500	500
Smoke extract	1,000	1,200
Smoke extract	1,000	1,200
Life safety	500	500
HV	500	500
Fuel pipe	500	500
PH vent	400	400
Sprinkler riser	600	1,200
BCWS	600	2,100
Landlord IT	1,000	1,200
LTHW high rise	850	600
CHW high rise	850	600
LTHW low rise	850	600
CHW low rise	850	600
In room combined service riser	1,000	1,000

Figure 11.10 Student accommodation riser schedule

Overall Servicing Schematics

The diagrams in Figure 11.11 and Figure 11.12 show the overall proposed MEP servicing strategy for both stacks.

In both use cases, the proposed servicing combines tried-and-tested tower design principles with a future-looking all-electric concept.

Heating and cooling is provided via reversible heat pumps with heat recovery on the roof. High efficiency air-cooled chillers provide peak cooling capacity.

Hotel-only

All major plant is located in the basement or on the roof, with the exception of the ventilation plant which is located at roof and at a mid-level plant floor to enable distribution and optimise riser sizes.

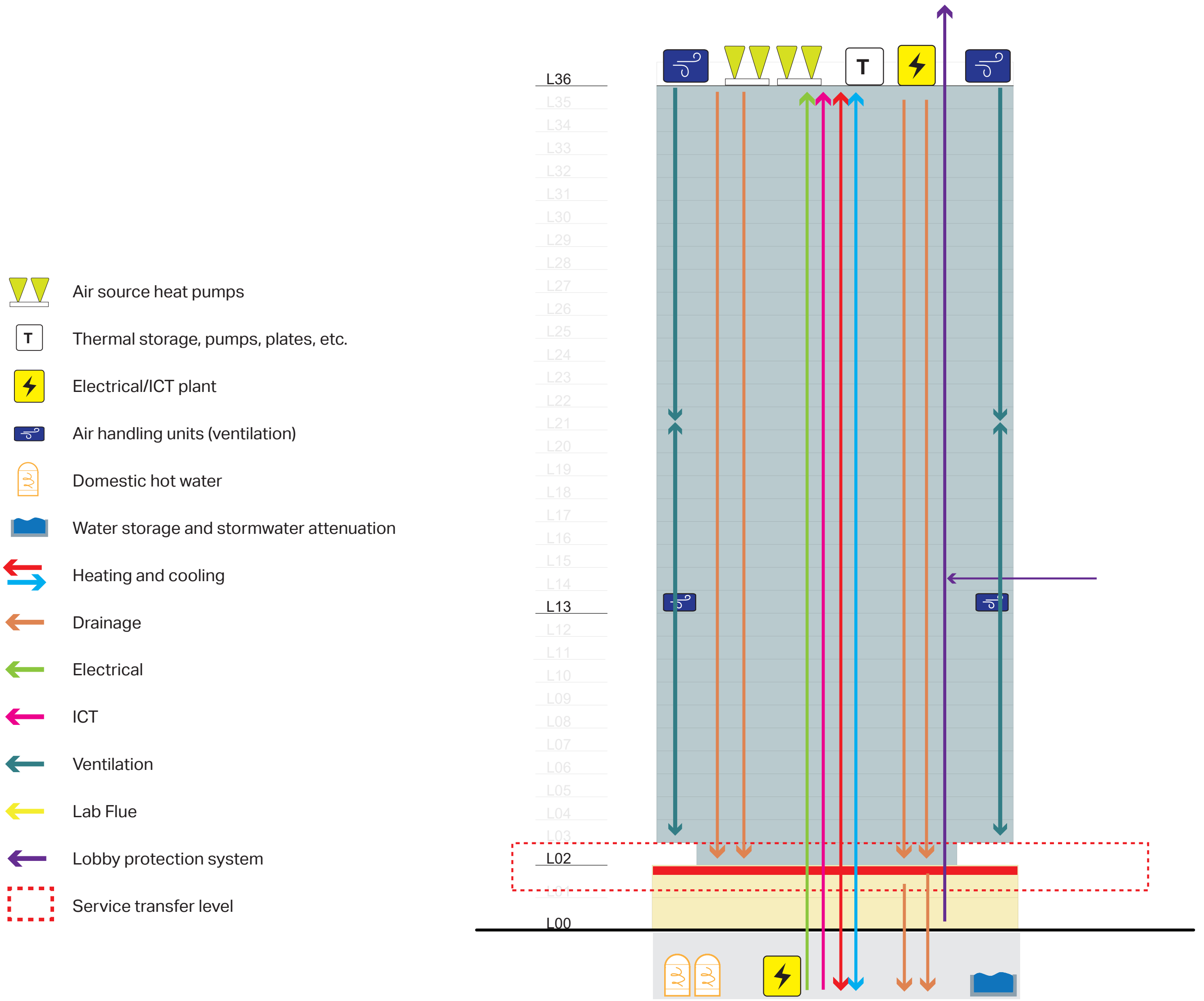


Figure 11.11 Overall servicing schematic for the hotel-only use case

Hotel and Student Accommodation
All major plant is located in the basement or on the roof, with the exception of the central ventilation plant for the hotel which is located at the uppermost hotel level.

At the levels where the use changes, it is anticipated it may not be possible to have riser continuity. A service transfer zone of approximately 650mm deep is required at these levels. Accordingly the change in use in the stack is set at Level 12, as this was previously an MEP floor and has slightly higher floor to ceiling height.

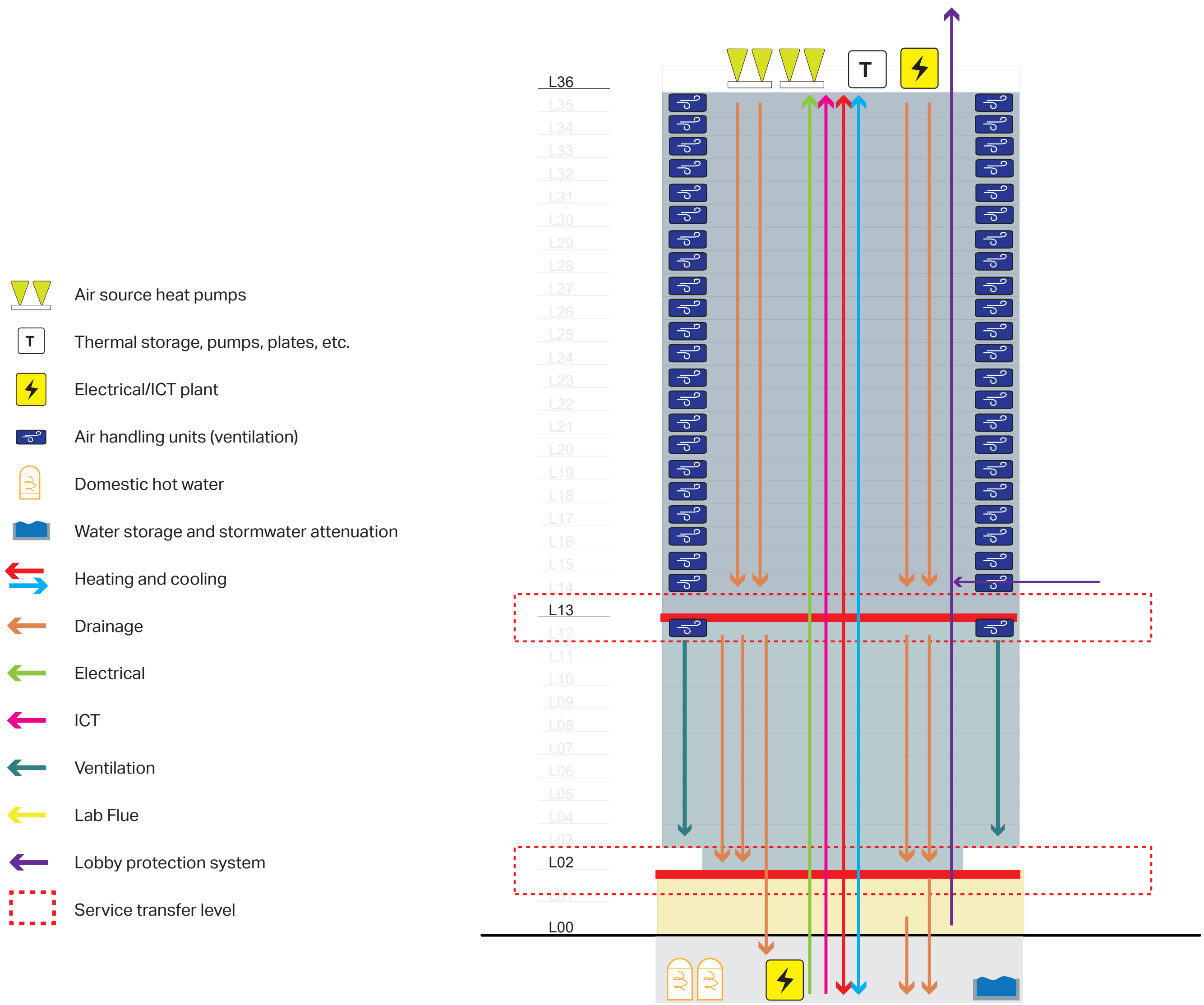


Figure 11.12 Overall servicing schematic for the hotel and student accommodation use case

11.3.4 Vertical Transportation

Considering the hotel-only or hotel with student accommodation uses, the lack of office space results in much less demand than a full office use (the original building design). With the aim of being as unintrusive as possible, it is anticipated that the current lift provision, considering numbers alone, may be able to provide appropriate service, albeit the existing lifts would need to be replaced as they are at the end of their serviceable life.

Critically, as noted in Section 11.3.2, dedicated fire fighting lifts are required and these cannot be shared by different uses. This means that in the mixed use case, the hotel component needs its own 2 no. fire fighting lifts at each fire fighting core, and the student accommodation has its own 2 no. fire fighting lifts. An evacuation lift is provided at each of the fire fighting cores, resulting in significantly enlarged satellite cores.

This is not the case in the hotel-only scenario, where only 2 no. fire fighting cores are required (complete with fire fighting and evacuation lifts).

The existing goods lifts with a duty of 1,360kg are too small for hotel or student accommodation use. Therefore new goods lifts will need to be provided.

In the hotel-only scenario this would require 2 no. goods lifts with well dimensions of approximately 2,450 mm (w) x 2,800 mm (d). These are provided as shared evacuation lifts at the north and south satellite cores. In the mixed use scenario, 1 no. goods lift would be sufficient if the student accommodation can use one of the passenger lifts as a goods lift. This would typically require a deeper car, so in order not to break out the existing central life core, a standalone goods lift for the student accommodation would be required too. Because in the mixed-use scenario four escape cores are required, two new goods lifts are provided which double up as evacuation lifts.

The new goods lifts cannot be taken to basement level without interfering with the existing pile cap. Accordingly it is proposed that a separate goods lift is used from basement to ground, and then transferred to the new goods lift above ground.

11.3.5 Facades

For facade replacement implications, refer to Section 9.3.5 and Section 10.3.5.

11.3.6 Logistics and Transport

For a hotel use case, there can be significant requirements for logistics and waste. The hotel-only scheme is assumed to be 3-4 star with 1 or 2 restaurants and possibly a rooftop bar, comprising approximately 900 keys.

Servicing
Westminster Park Plaza (4*) which has ca. 1,000 keys, conferencing and restaurant space, and is therefore comparable, was surveyed and used as a reference. 50 servicing vehicle arrivals per day accommodated in 4 servicing bays. The Euston Tower servicing yard has capacity to accommodate a hotel use.

For a hotel a private waste contractor is used meaning there can be daily waste collections and space for waste storage is therefore minimised.

Drop-off / pick up
The key constraint anticipated with a hotel use at Euston Tower is provision for drop-off / pick-up activity at ground floor. The bigger hotels have dedicated drop-off spaces on private land, off the public highway – these can be very large to accommodate coaches.

It is possible that the drop-off will need to support up to 700 cars/taxis/private hire vehicles, including 10 coaches per day. TfL will not accept queueing drop-off / pick-up vehicles to block passing traffic/buses.

Given that the site is accessed from a strategic TfL highway, the position of nearby bus stops and the like, and the existing space constraints, an appropriate drop-off facility would be difficult to accommodate to support a hotel use at Euston Tower. As noted in Section 5.2 of Volume One, the road profile was amended by TfL in 2012 due to pedestrian numbers in this area, so any drop off or pull in point on either Euston Road or Hampstead Road would erode this benefit in pavement space for pedestrians, and is therefore unlikely to be considered acceptable.

11.3.7 Air Quality

For air quality implications and the rationale for not exploring a fully student accommodation scheme, refer to Section 10.3.7.

11.4 Impact on Existing Floorplate

The diagrams in Figure 11.15 - Figure 11.18 test the impact of the preceding interventions on the existing structure assuming a mix of hotel and student accommodation use. A 100% hotel scheme would be too large for any interest from operators or investors (see Section 11.5). The aim is to be as unintrusive on the existing structure as possible.

In general the spatial actions required are:

- Dedicated fire fighting lifts at each core
- Dedicated goods lifts
- Additional risers.

Dedicated fire fighting lifts are required as these cannot be shared by different uses. This means that the student accommodation component needs its own 2 no. fire fighting lifts at each fire fighting core, and the lower portion of the stack with hotel use, has its own 2 no. fire fighting lifts. An evacuation lift is provided at each of the fire fighting cores, resulting in enlarged satellite cores. The result is that the floor plates have 4 no. total escape cores,

The existing goods lifts with a duty of 1,360kg are too small for hotel or student accommodation use. Therefore new goods lifts will need to be provided. These are provided as shared evacuation / goods lifts.

The current passenger lift provision is sufficient for a predominantly hotel or residential accommodation use.

Finally additional risers would be needed to make the floor plate functional for energy and ventilation. It is anticipated that both hotel and student accommodation topologies are served via a central landlord system which will require larger riser provisions.

Large portions of the floor slab would be impacted by these interventions cutting through existing slab. The structural penetrations required are larger than could be integrated into the existing ribbed slab. This would require demolition, re-framing, and from an MEP perspective, additional riser area to coordinate vertical stacks across several openings, taking additional area.

It is clear in the diagrams that large areas of the existing floor slab would need to be removed to bring the existing building up to code and current standards.

The resulting hotel accommodation is of medium quality:

- The clear floor to ceiling heights are constrained, particular in the corridors (2.175m) and WCs and entryways to the rooms (2.265m)
- The pinwheel results in units that are always self-shaded by the building
- Rooms at the satellite cores are inefficient and have awkward in-room circulation.

Inefficient rooms at the satellite cores with awkward in-room circulation

Self shaded units

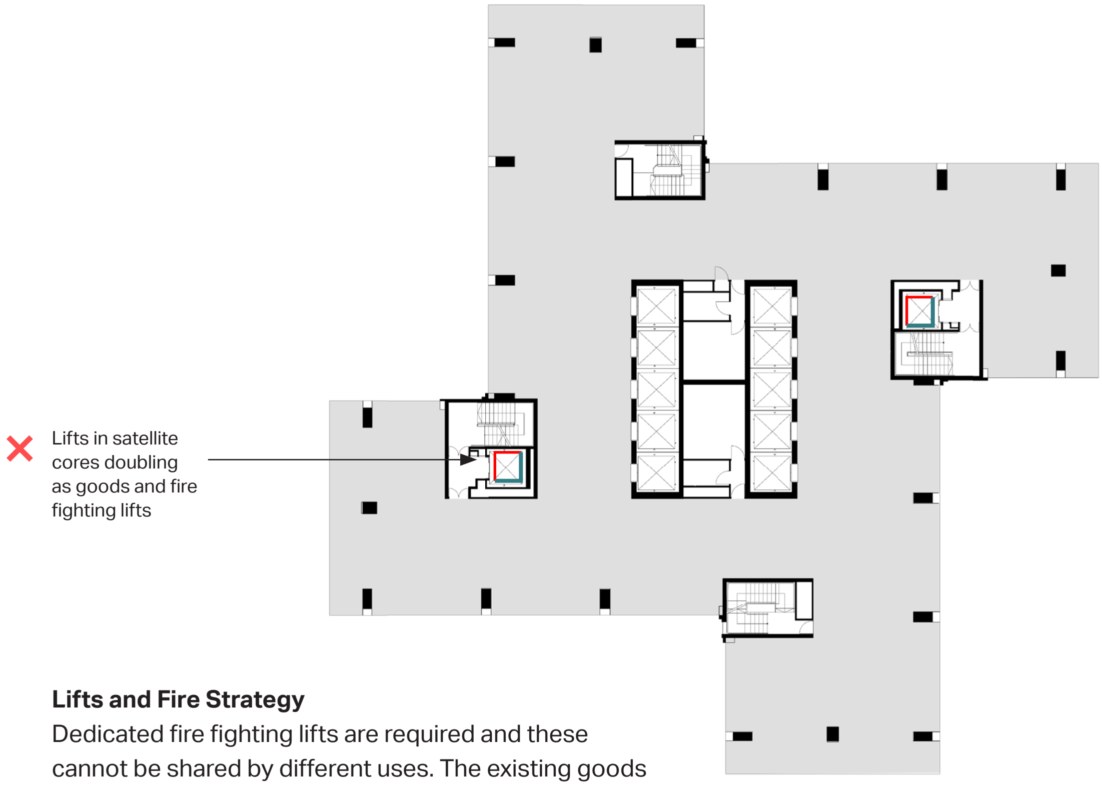
Constrained clear floor to ceiling heights of between 2.175m and 2.265 in the corridors, and WCs and entryways respectively

Figure 11.13 The resulting hotel accommodation is of medium quality (hotel in mixed use configuration)

The resulting student accommodation is of medium quality:

- The clear floor to ceiling heights are constrained, particular in the corridors (2.175m) and WCs and entryways to the rooms (2.265m)
- The plan form results in several single aspect units which impacts quality of accommodation provided
- The layout results in several north-facing units
- The pinwheel results in units that are always self-shaded by the building
- Long, internal corridors with no daylight.

Figure 11.14 The resulting student accommodation is of medium quality

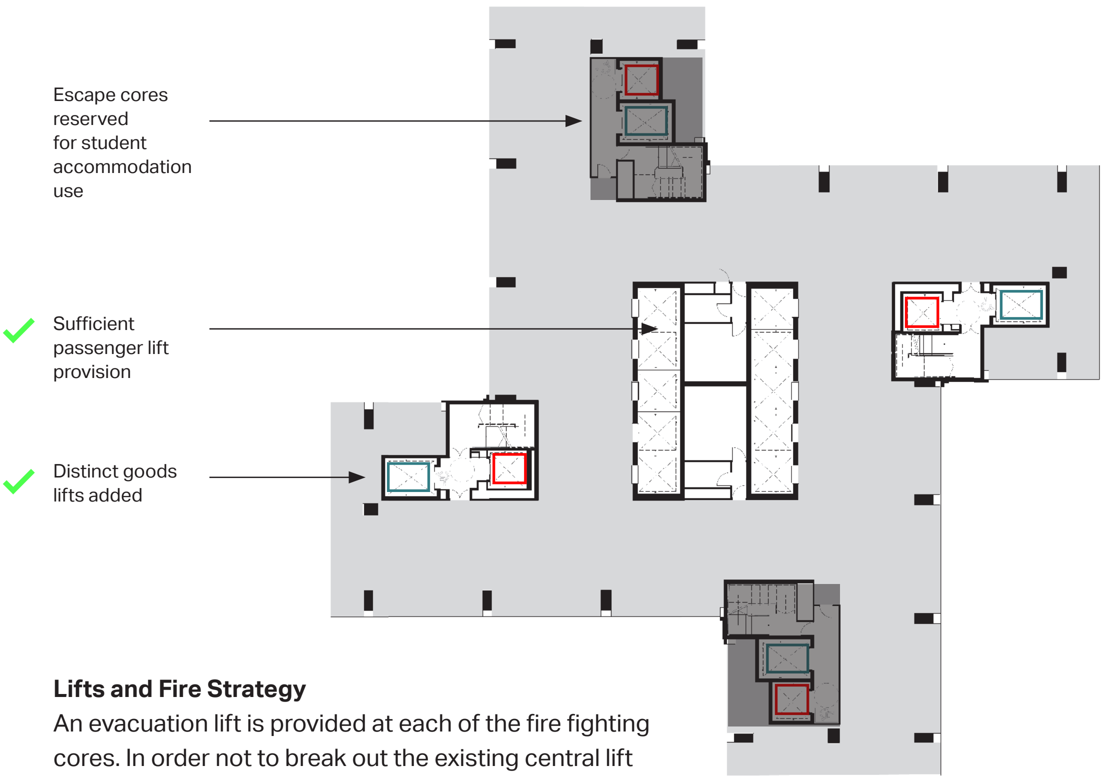


Required Actions:
- Additional risers
- Distinct goods lifts

Fire-fighting lift

Good lifts/ Evacuation lifts

Lifts and Fire Strategy
Dedicated fire fighting lifts are required and these cannot be shared by different uses. The existing goods lifts with a duty of 1,360kg are too small for hotel or student accommodation use.



Required Actions:
- Additional risers

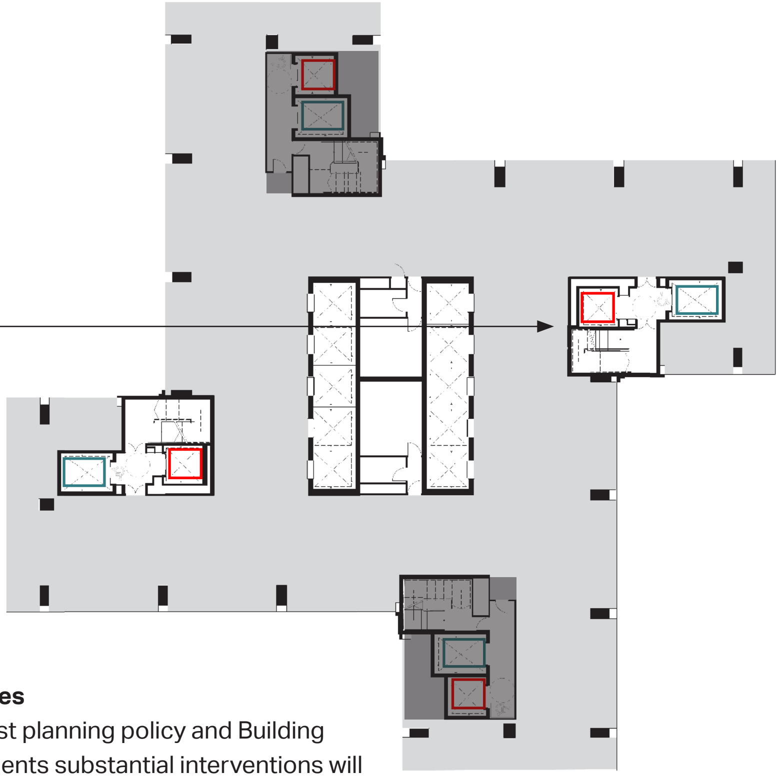
Fire-fighting lift

Good lifts/ Evacuation lifts

Lifts and Fire Strategy
An evacuation lift is provided at each of the fire fighting cores. In order not to break out the existing central lift core new goods lifts are provided.

Figure 11.15 Impact of changes on existing floorplates for hotel use

✗ Insufficient risers



Required Actions:
- Additional risers

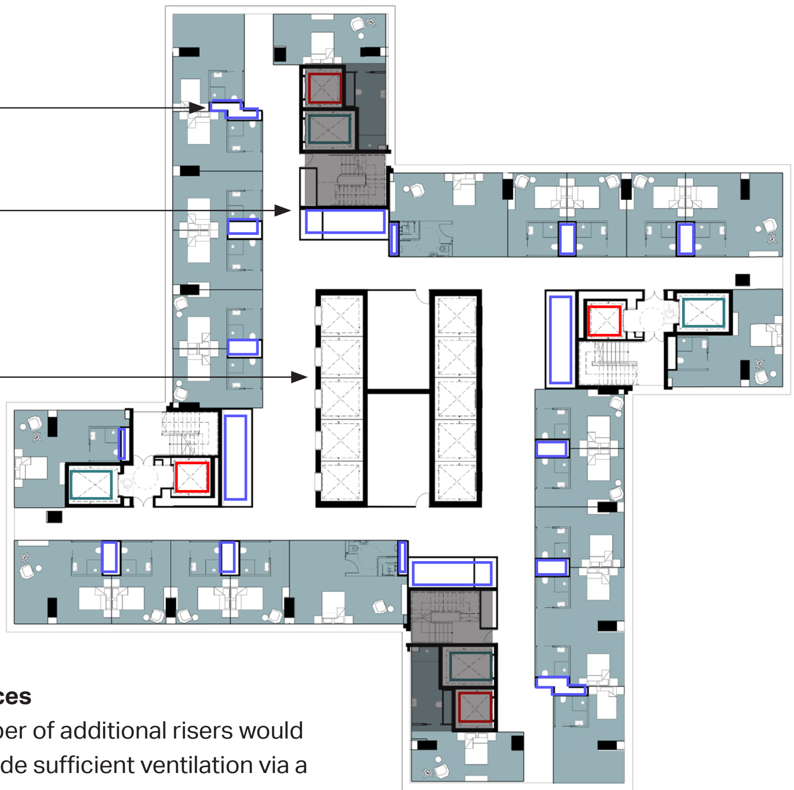
Fire-fighting lift
Good lifts / Evacuation lifts

Mechanical Services
To comply with latest planning policy and Building regulation requirements substantial interventions will be required to meet energy conservation targets.

✓ Localised risers

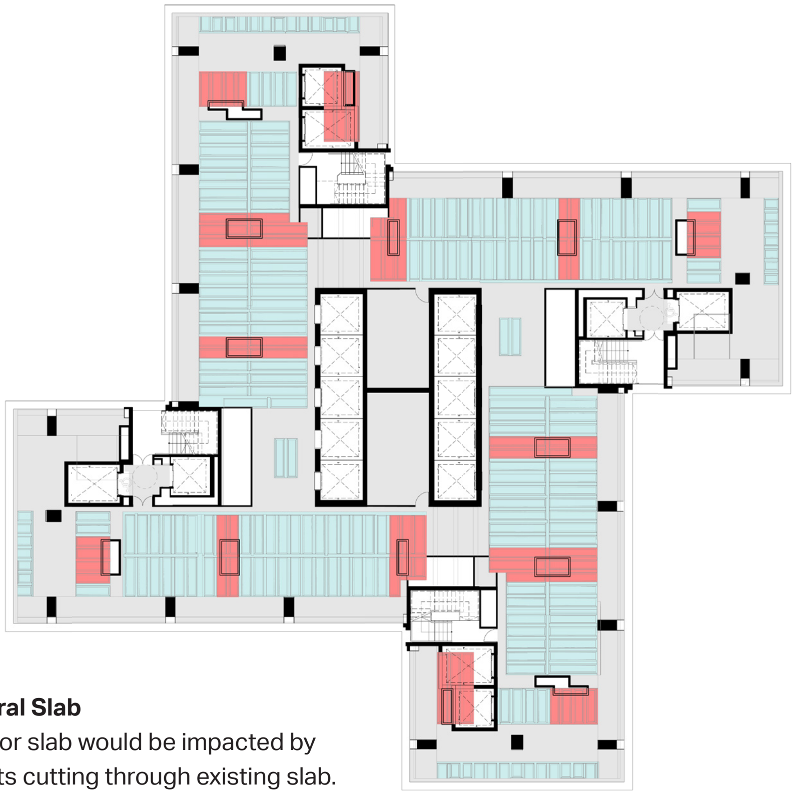
✓ Sufficient riser space provided

Passenger lifts serve hotel floor only



Fire-fighting lift
Good lifts / Evacuation lifts
Risers

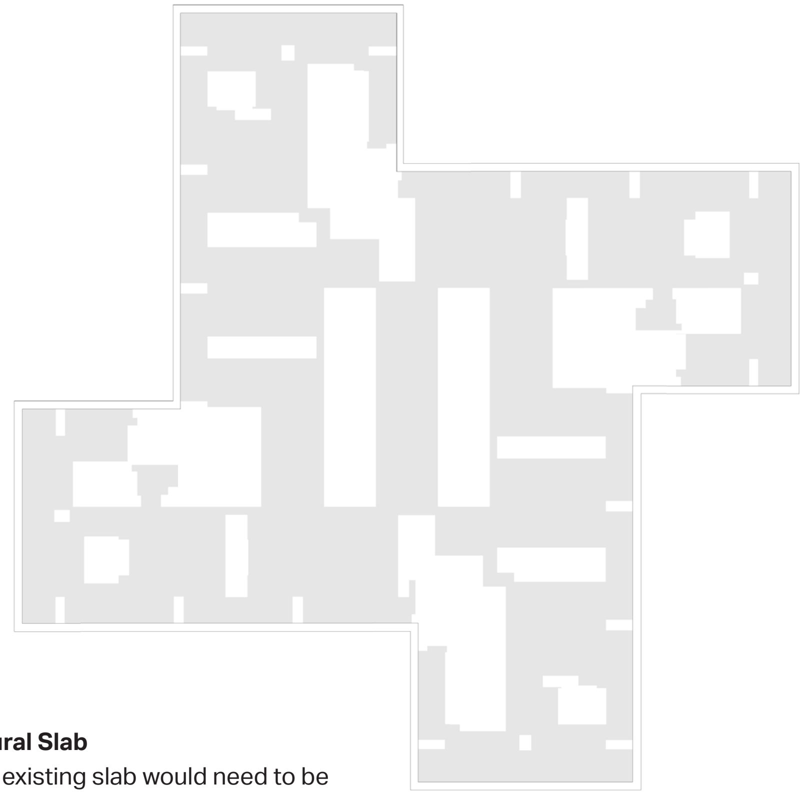
Mechanical Services
A substantial number of additional risers would be needed to provide sufficient ventilation via a centralised landlord system.



Implications to Structural Slab
Large portions of the floor slab would be impacted by these additional elements cutting through existing slab. Entire ribbed slab zones would need to be removed if overlapped with new vertical shafts.

Resulting Structural Slab
Large amounts of existing slab would need to be removed to bring the existing building up to code and current standards.

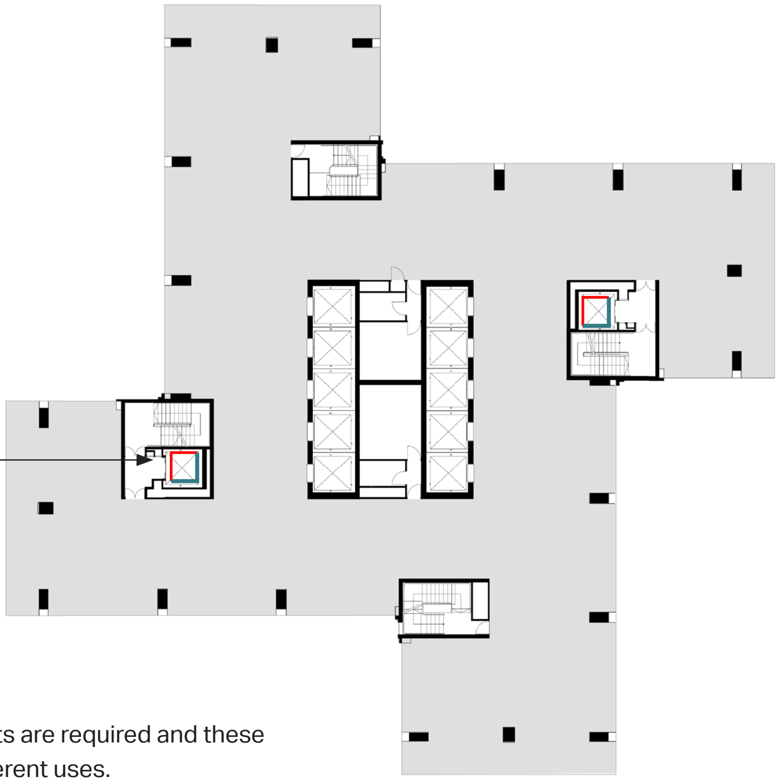
Figure 11.16 Impact of changes on existing structural floor slab for hotel use (mixed use)



Resulting Structural Slab
Large amounts of existing slab would need to be removed to bring the existing building up to code and current standards.

Floorplate Efficiency
The large amount of additional area required for risers and lifts would result in an inefficient floorplate.

Lifts in satellite cores doubling as goods and fire fighting lifts



Required Actions:
- Additional risers
- Distinct goods lifts

Fire-fighting lift

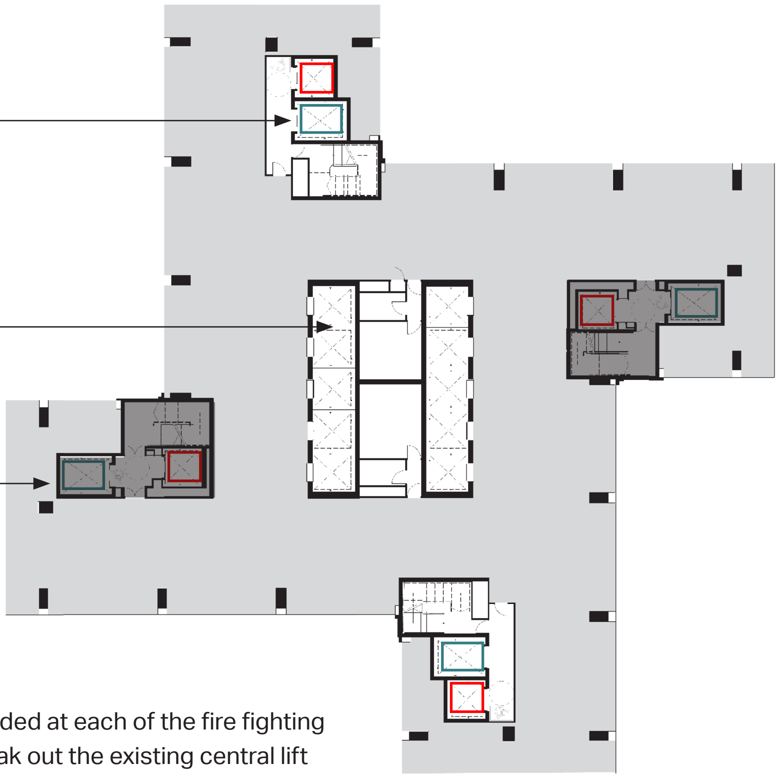
Good lifts/ Evacuation lifts

Lifts and Fire Strategy
Dedicated fire fighting lifts are required and these cannot be shared by different uses.

Distinct goods lifts added

Sufficient passenger lift provision

Escape cores reserved for hotel use



Required Actions:
- Additional risers

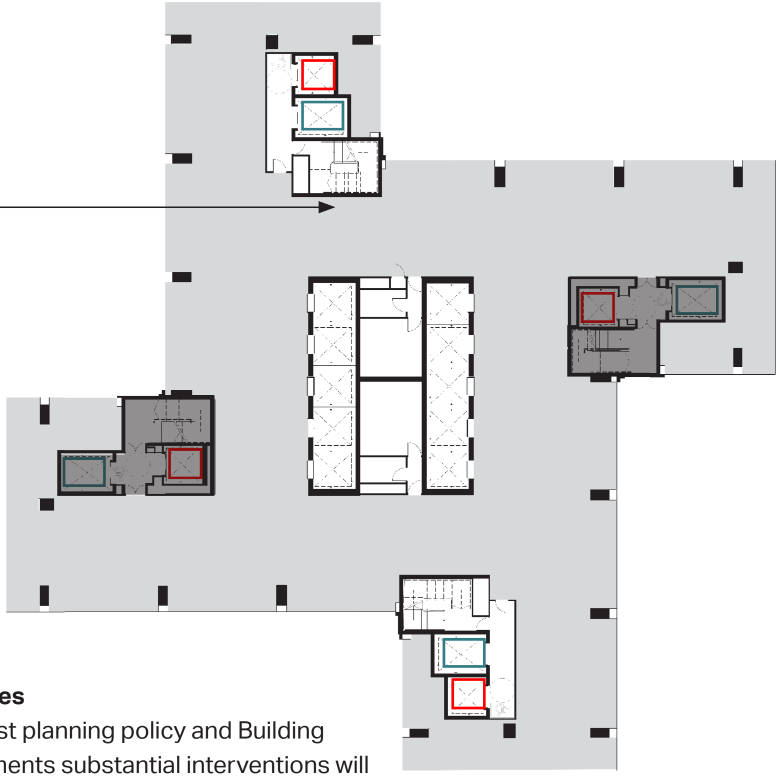
Fire-fighting lift

Good lifts/ Evacuation lifts

Lifts and Fire Strategy
An evacuation lift is provided at each of the fire fighting cores. In order not to break out the existing central lift core new goods lifts are provided.

Figure 11.17 Impact of changes on existing floorplates for student accommodation use

✗ Insufficient risers



Required Actions:
- Additional risers

Fire-fighting lift

Good lifts / Evacuation lifts

Mechanical Services
To comply with latest planning policy and Building Regulation requirements substantial interventions will be required to meet energy conservation targets.

✓ Sufficient riser space provided

Passenger lifts serve student accommodation floor only

Goods lift drops off

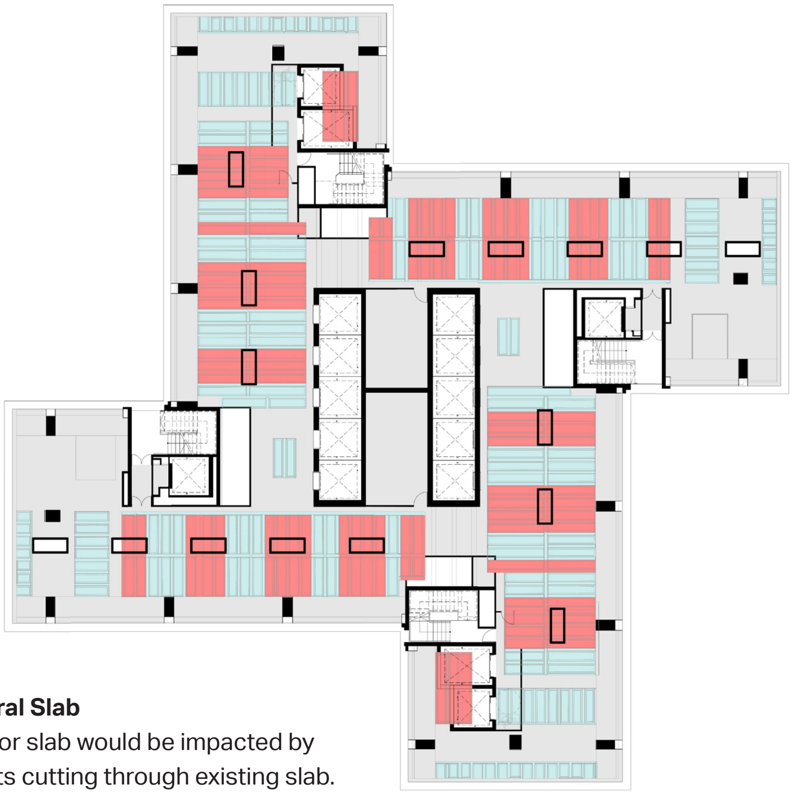
✓ Localised risers

Fire-fighting lift

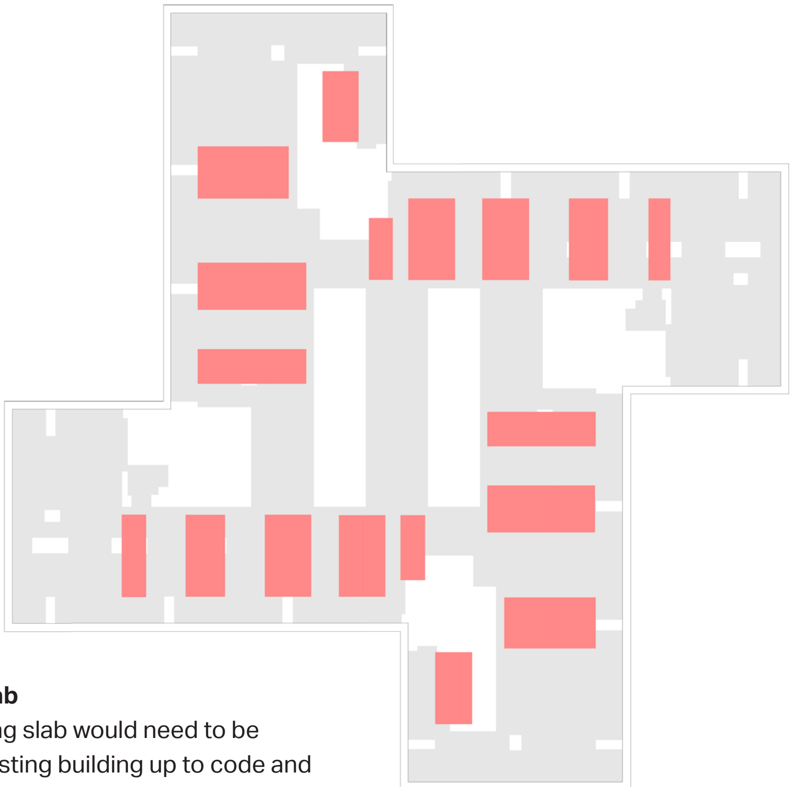
Good lifts / Evacuation lifts

Risers

Mechanical Services
A substantial number of additional risers would be needed to provide sufficient ventilation via a centralised landlord system.

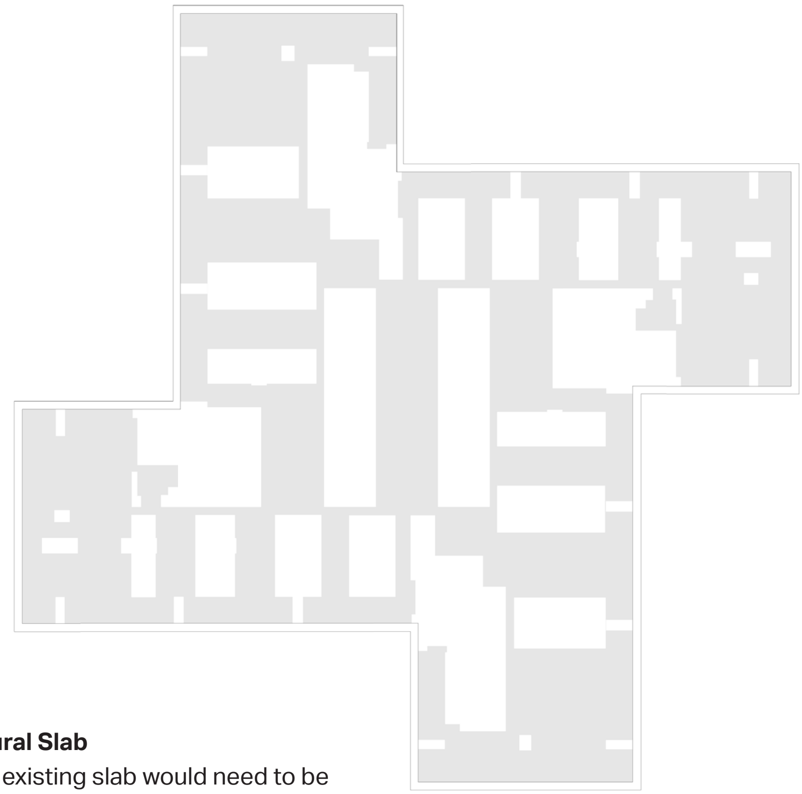


Implications to Structural Slab
Large portions of the floor slab would be impacted by these additional elements cutting through existing slab. Entire ribbed slab zones would need to be removed if overlapped with new vertical shafts.

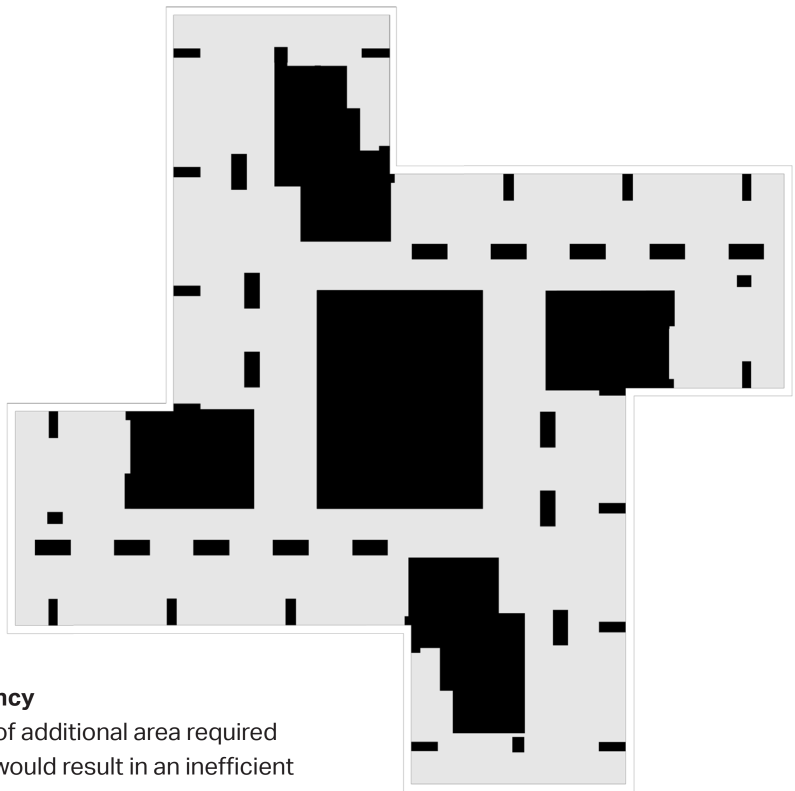


Resulting Structural Slab
Large amounts of existing slab would need to be removed to bring the existing building up to code and current standards.

Figure 11.18 Impact of changes on existing structural floor slabs for student accommodation use



Resulting Structural Slab
Large amounts of existing slab would need to be removed to bring the existing building up to code and current standards.



Floorplate Efficiency
The large amount of additional area required for risers and lifts would result in an inefficient floorplate.

11.5 Viability

As part of this feasibility study, a viability analysis of the hotel use cases has been undertaken. The following scenarios have been assessed:

- Hotel-only
- Hotel with student accommodation.

11.5.1 Configuration and Condition

As shown in the preceding Sections, from a practical perspective, the building's configuration could lend itself to conversion to hotel or student accommodation uses.

Technically the building's structure would likely be acceptable to support a conversion the hotel use case, which is the more onerous. The entire facade and mechanical and electrical equipment would need to be replaced, significant structural interventions delivered for new risers and shafts, and appropriate fire protection measures for a tower be put in place.

As a 100% hotel the building would create circa 900 keys (depending on extent of amenity) making it one of London's biggest hotels. Based on current operator and investor demand a hotel of this scale would be considered too large. **Accordingly such a scheme would not viable from the outset due to lack of operator or investor interest.**

Therefore a hotel scheme combined with residential units above is also considered. Refer to Section 10.5.

The case of hotel with student accommodation falls between the hotel-only case and the residential with hotel case. As shown in Section 10.5, the residential with hotel case is not viable, therefore, since student accommodation has typically lower margins, it is expected that the hotel and student accommodation would also not be viable, due to **the cost of such a conversion relative to value achieved being prohibitive to financial viability.**

Figure 11.19 Westminster Park Plaza is one of the largest hotels in London. A conversion at Euston Tower would be a similar size.

12

Euston Tower

Conclusion

12.1 Conclusion

The preceding sections have shown the extent of upgrades that are required to bring the existing tower up to the requirements of current Building Regulations and standards, for a variety of alternate use cases.

In general terms, the following summarises the minimum requirements for compliance with current Building Regulations, regardless of use case:

- Structural fire performance upgraded to 120 minutes
- Sprinkler provision added throughout
- Fire compartmentation added to facade as part of facade replacement
- Mechanical smoke ventilation added
- Dedicated fire fighting lifts required (not shared with goods lifts)
- Distinct and dedicated escape cores in the mixed-use scenarios
- Fire fighting lifts upgraded to current standards
- New air handling plant with higher fresh air rates to meet ADF, and heat recovery to meet ADL
- New central plant provisions with energy efficiency to meet ADL
- Facade thermal performance upgraded to meet energy efficiency requirements in ADL via facade replacement.

Substantial structural alterations are necessary to deliver these upgrades, including new lift shafts and new risers. Large portions of the floor slab are impacted by these interventions, where entire slab zones need to be removed if any portion of the existing ribbed system is overlapped by new vertical penetrations. This is exacerbated in the mixed-use options, where each use requires two, independent escape cores, further reducing net area, precluding the possibility of mixing more than two distinct use cases.

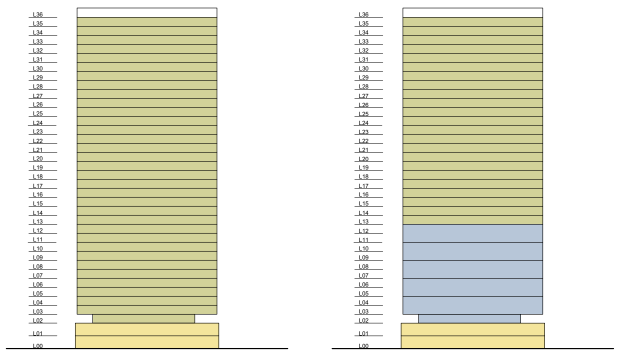
To accommodate modern MEP services, an increased floor and ceiling zone is required. For the offices, regardless of whether exposed services or a dropped ceiling are pursued, there are extensive areas of the floorplate that are not compliant with the BCO recommendations for floor to ceiling heights, and this would challenge lettability. For the residential schemes (incl. student accommodation), the resulting clear floor to ceiling height is between 2,265-2,445mm, which contravenes the requirements of the London Plan for clear heights in residential apartments.

In all cases, the resulting floorplates are compromised and generally of low quality. The residential apartments and student accommodation units have low floor to ceiling heights, lack outdoor amenity, have noise and pollution issues, and there are several single-aspect units. The hotel suites are similarly compromised, and a full-hotel scheme on the site would be one of the largest hotels in London. Based on current operator and investor demand a hotel of this scale would be considered too large.

In the preceding analysis, there is no single reason not to pursue any of the alternative use cases. Rather the reasons are layered: low quality units, quanta of compromised spaces, and policy non-conformances.

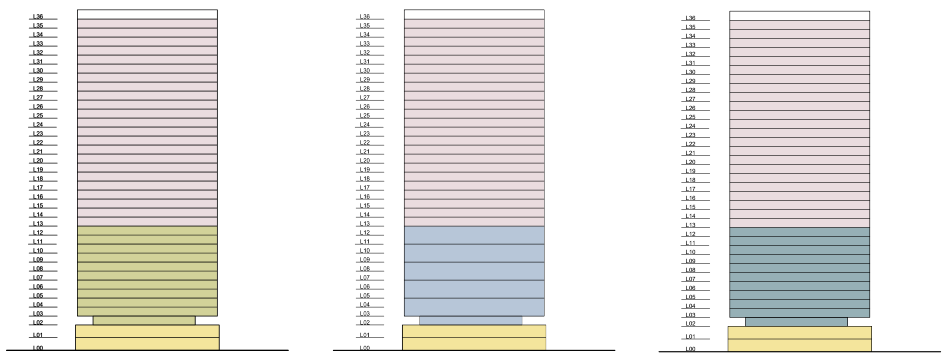
Ultimately even if these technical and policy hurdles were to be overcome, the alternative use schemes challenge economic viability. Accordingly, only continued commercial use is appropriate, and options that generate additional lettable area should be explored. These options are studied in Volume Three of this feasibility study.

COMMERCIAL-LED DEVELOPMENTS



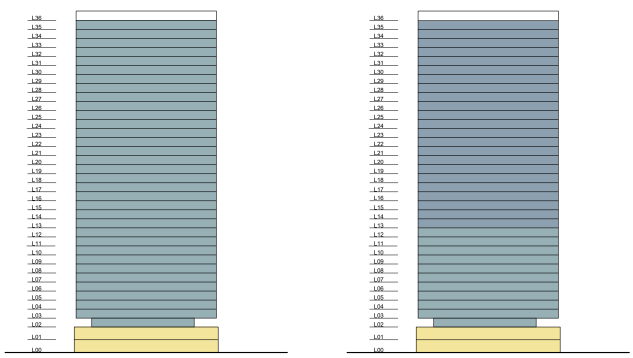
- ❌ Constrained floor to ceiling heights
- ❌ Inefficient floorplates
- ❌ Over-dimensioned lab-enabled space

RESIDENTIAL-LED DEVELOPMENTS



- ❌ Low floor to ceiling heights
- ❌ Inefficient floorplates
- ❌ Noise and pollution issues
- ❌ No outdoor amenity
- ❌ Single aspect units
- ❌ Loss of commercial space

RESIDENTIAL-LED DEVELOPMENTS



- ❌ Low floor to ceiling heights
- ❌ Inefficient floorplates
- ❌ Noise and pollution issues
- ❌ Single aspect units
- ❌ Loss of commercial space

Figure 12.1 Summary of considerations for the alternate use studies

A

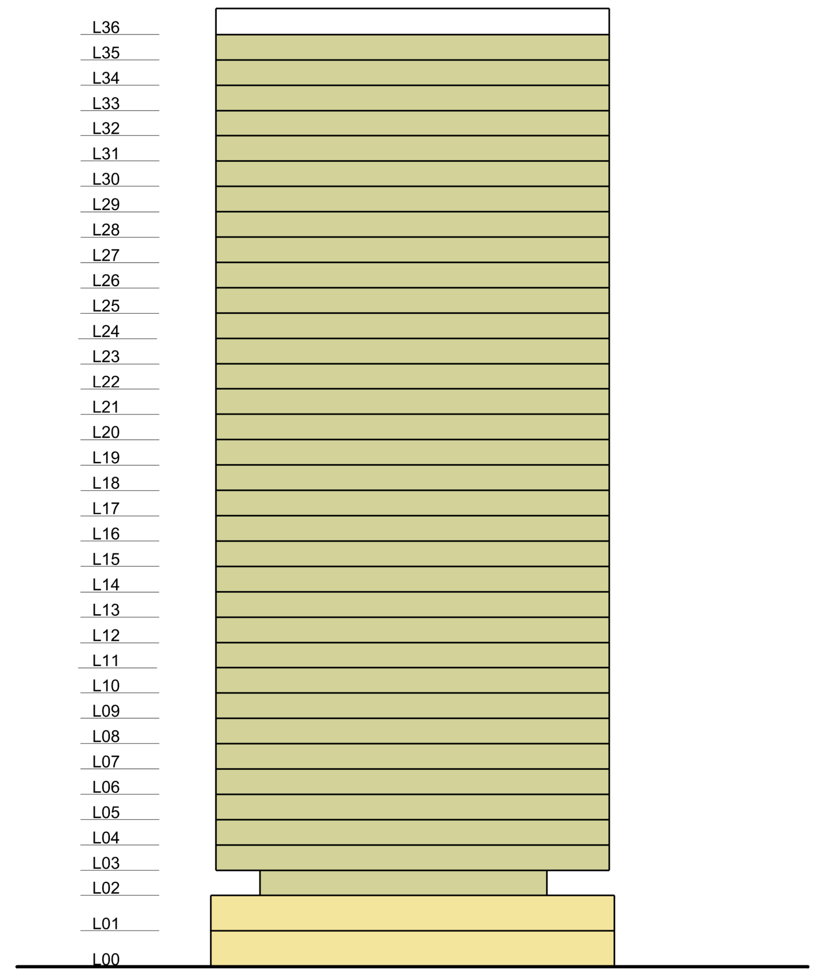
Euston Tower

Appendices

Appendices

List of Appendices

Euston Tower



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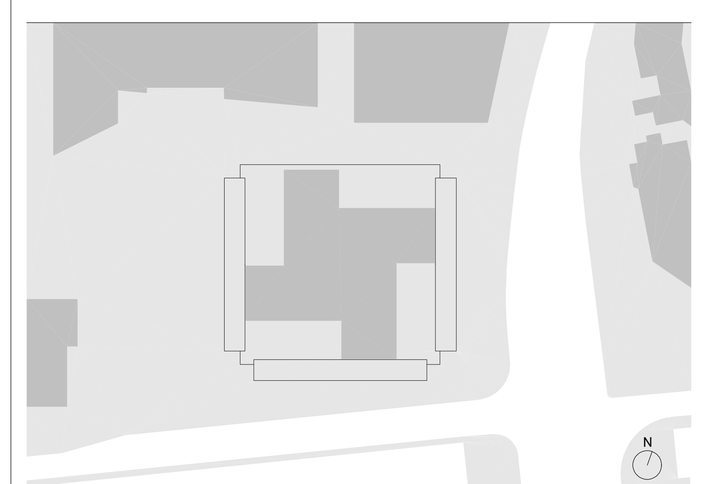
PROJECT NAME	EUSTON TOWER
AUTHOR PROJECT NUMBER	1312
PROJECT PHASE	**PLANNING APPLICATION**
CLIENT	
	British Land Property Management Limited
	York House 45, Seymour Street, London. W1H 7LX
	info@britishland.com / Tel: +44 20 7486 4466



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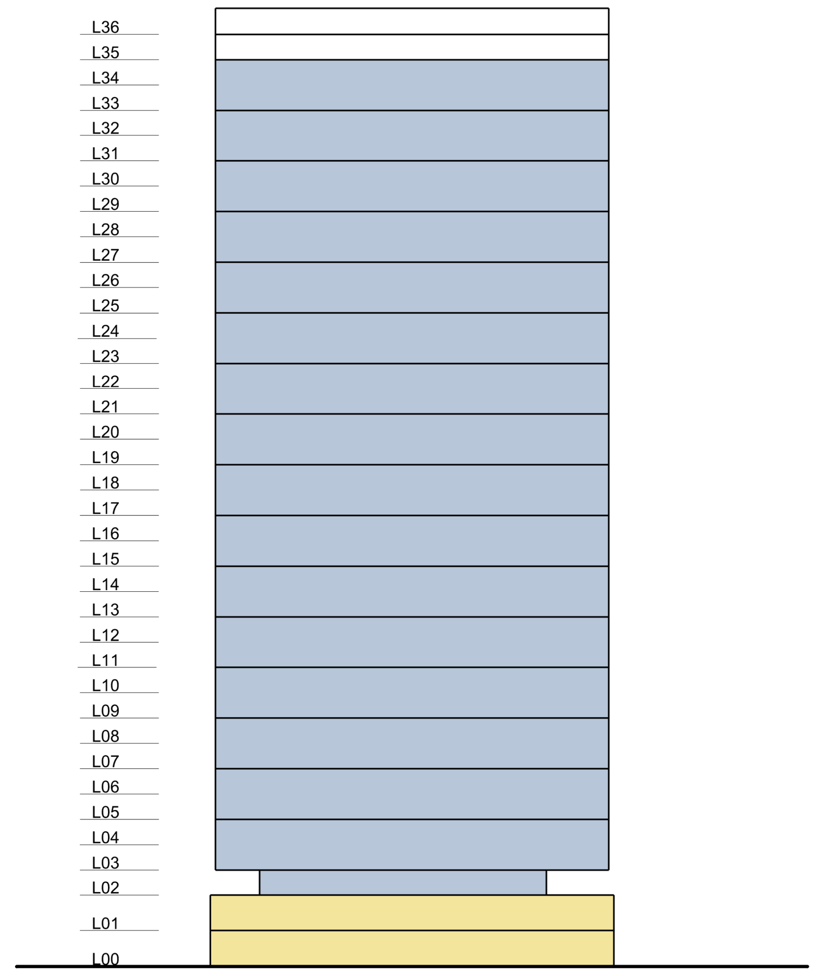
AUTHOR	3XN
REVISION	-
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Office Test Fit-Out - 2AHUs Single-Use Option
DRAWING NUMBER	N/A

Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Euston Tower



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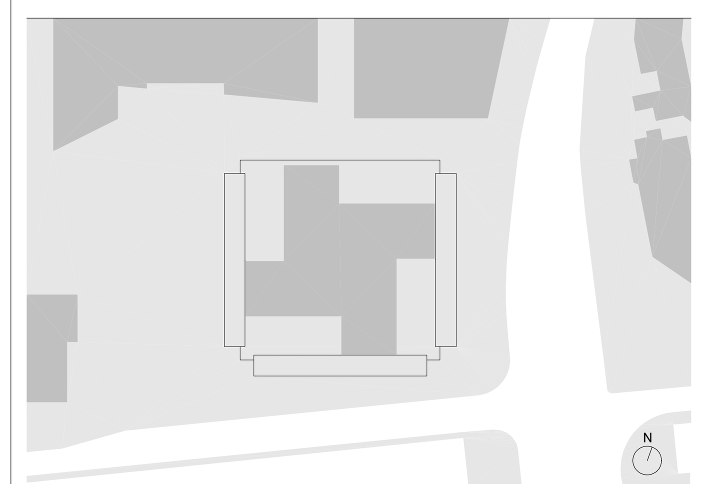

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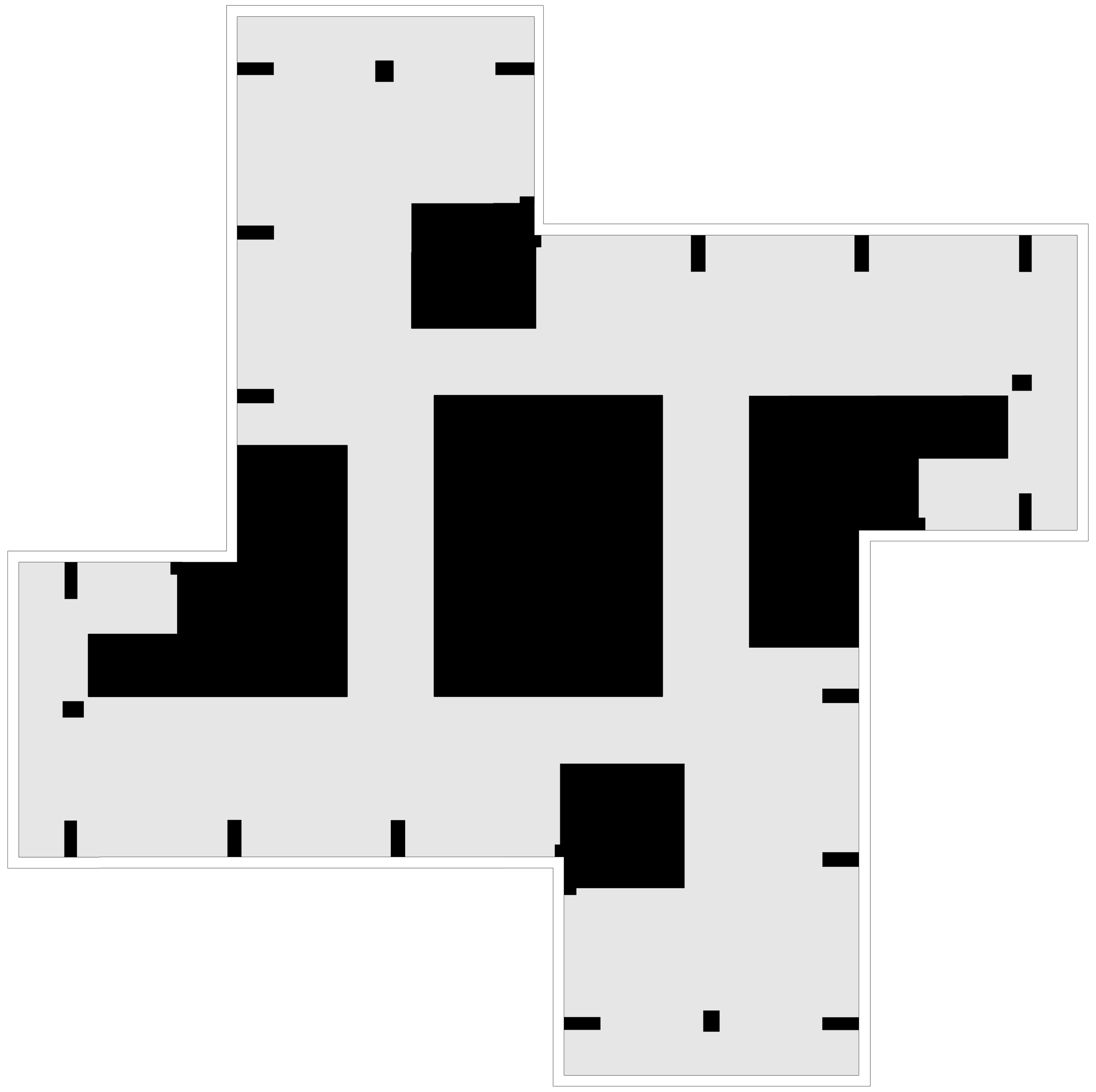
Offices_Single Use_2AHUs

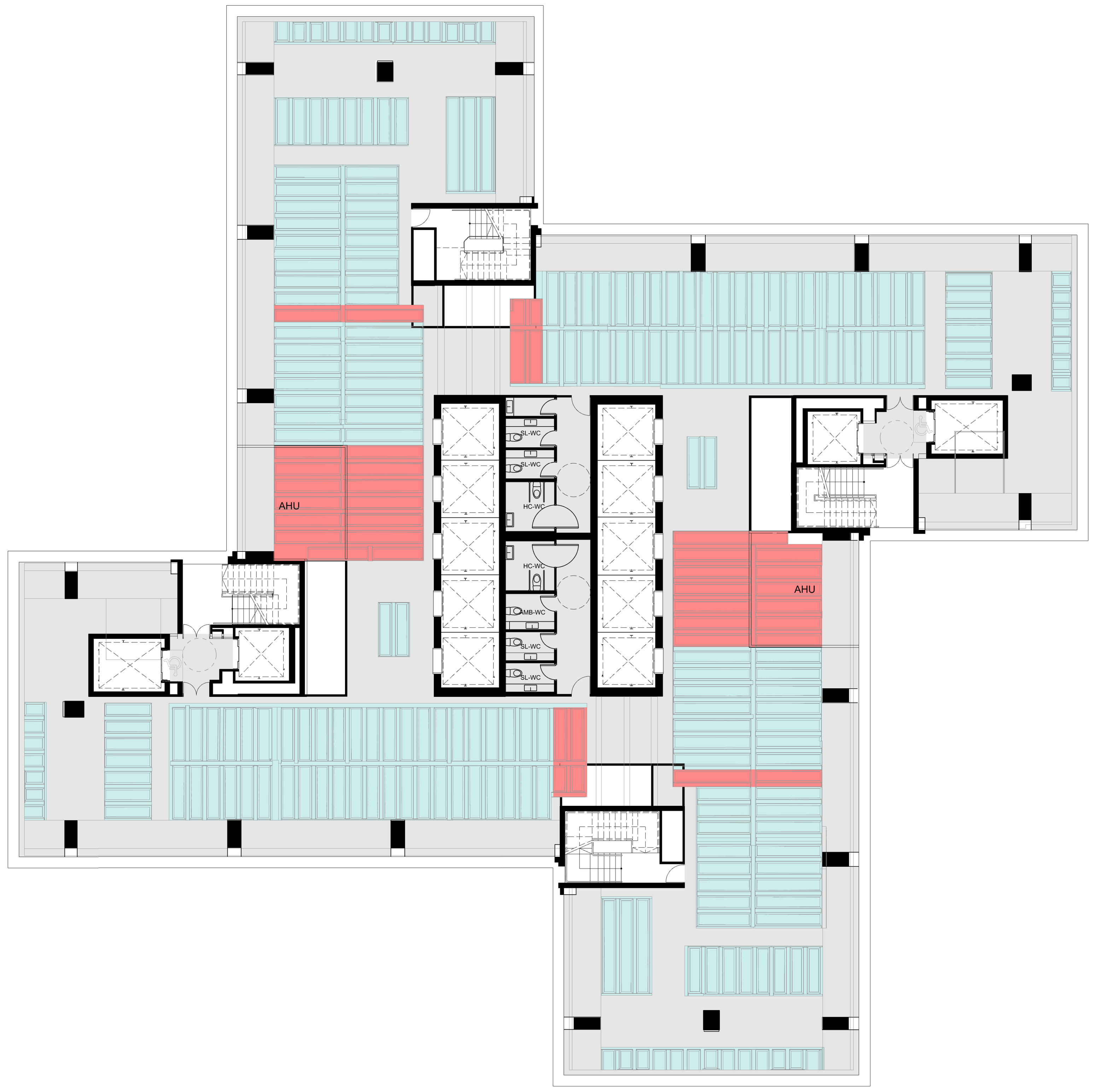
Floorplate Figure Ground



NIA:GIA Efficiency 70,1%

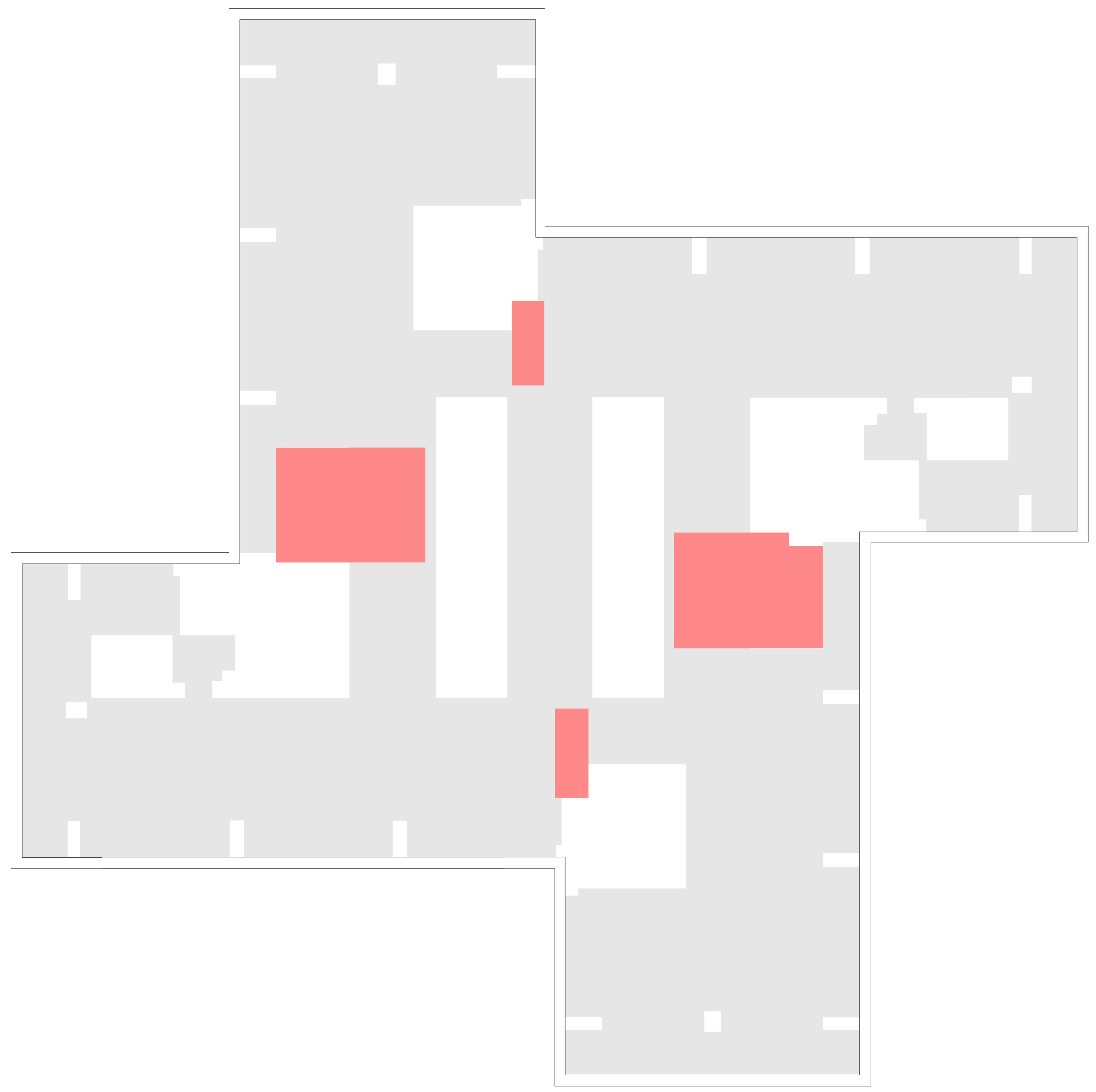
Offices_Single Use_2AHUs

Impact on Existing Slabs



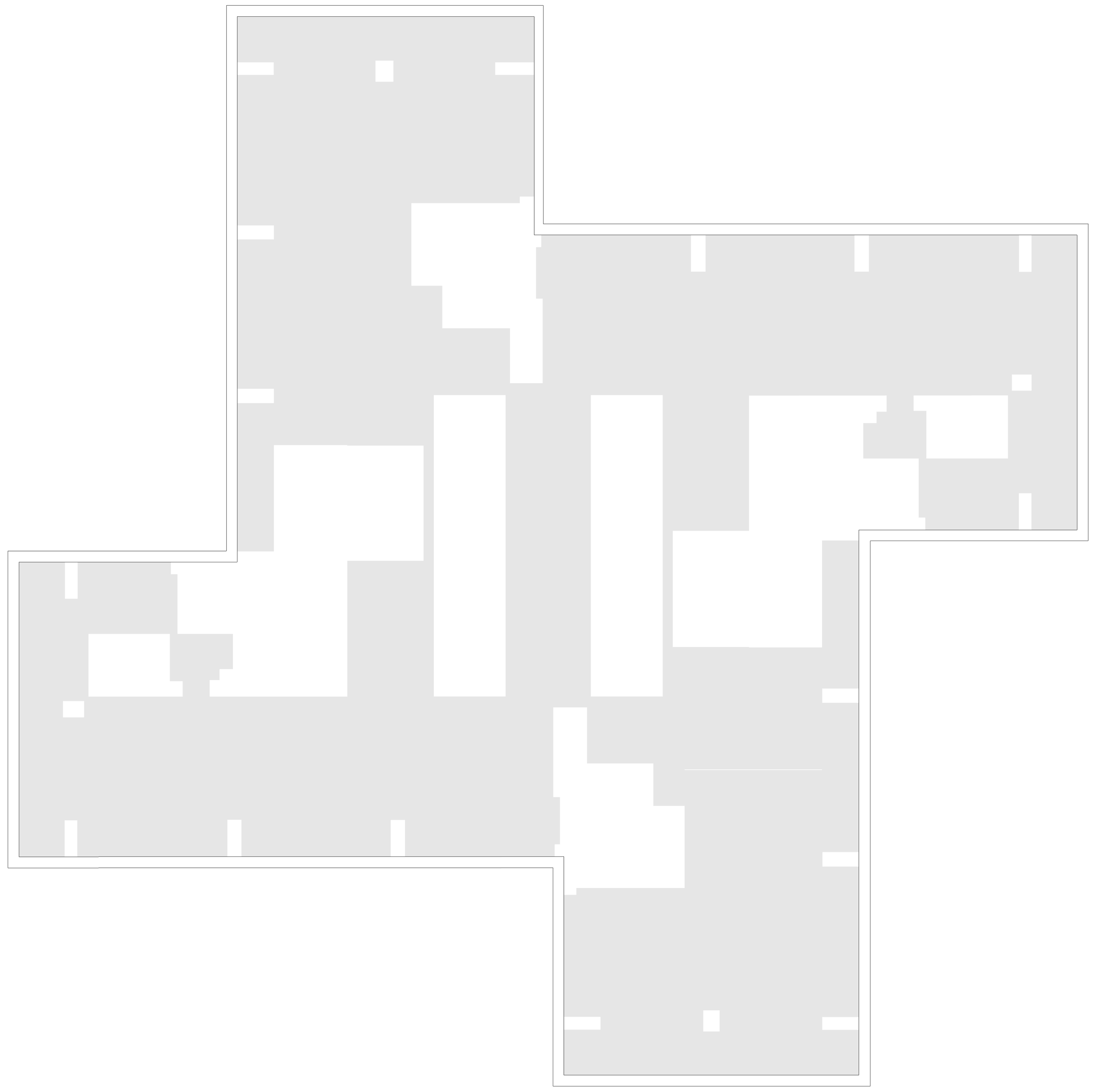
Offices_Single Use_2AHUs

Slab Areas to be Demolished



Offices_Single Use_2AHUs

Resultant Slab Areas Retained



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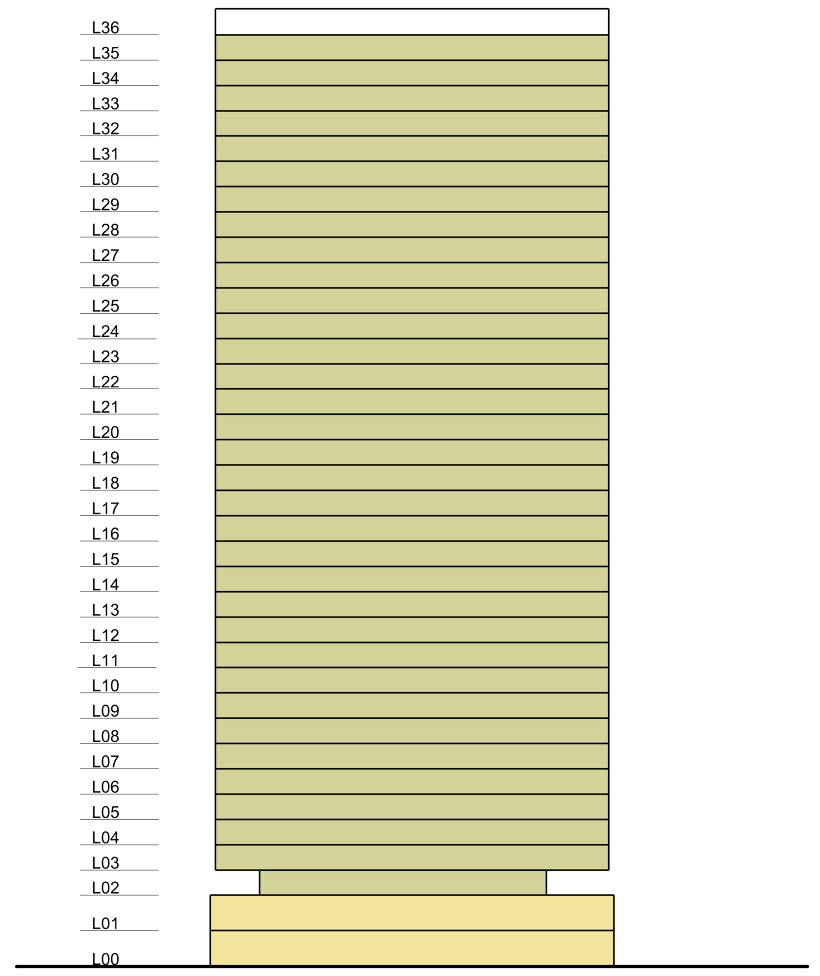

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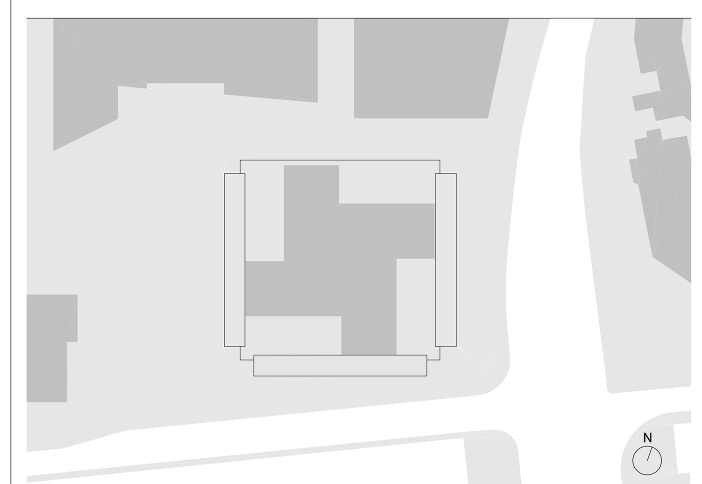

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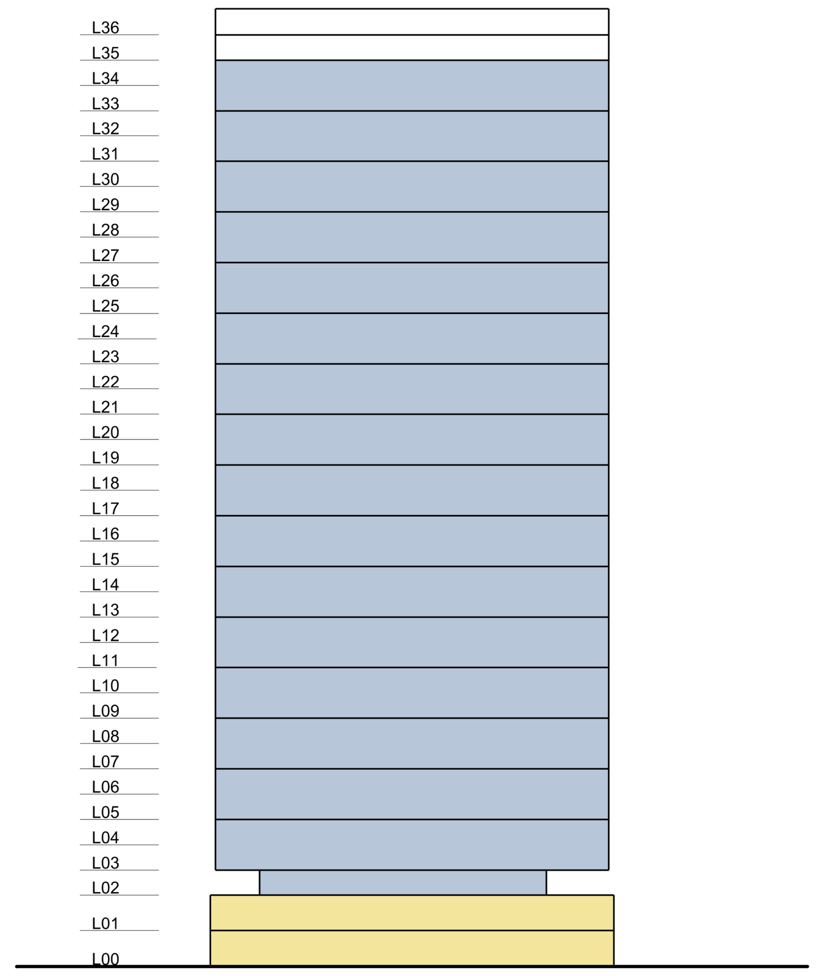

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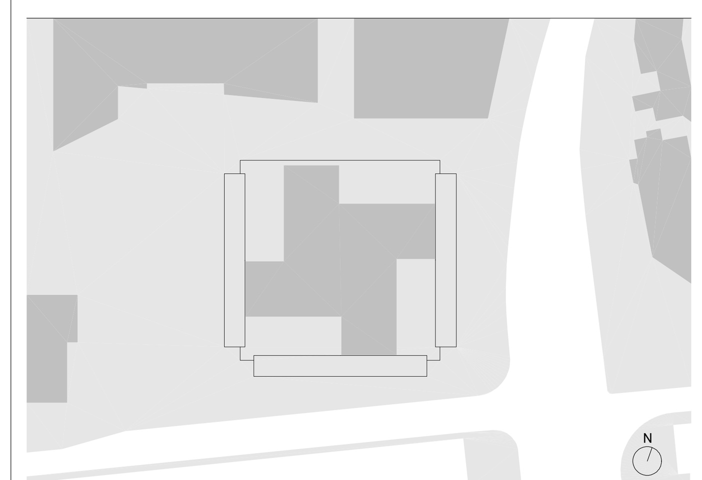

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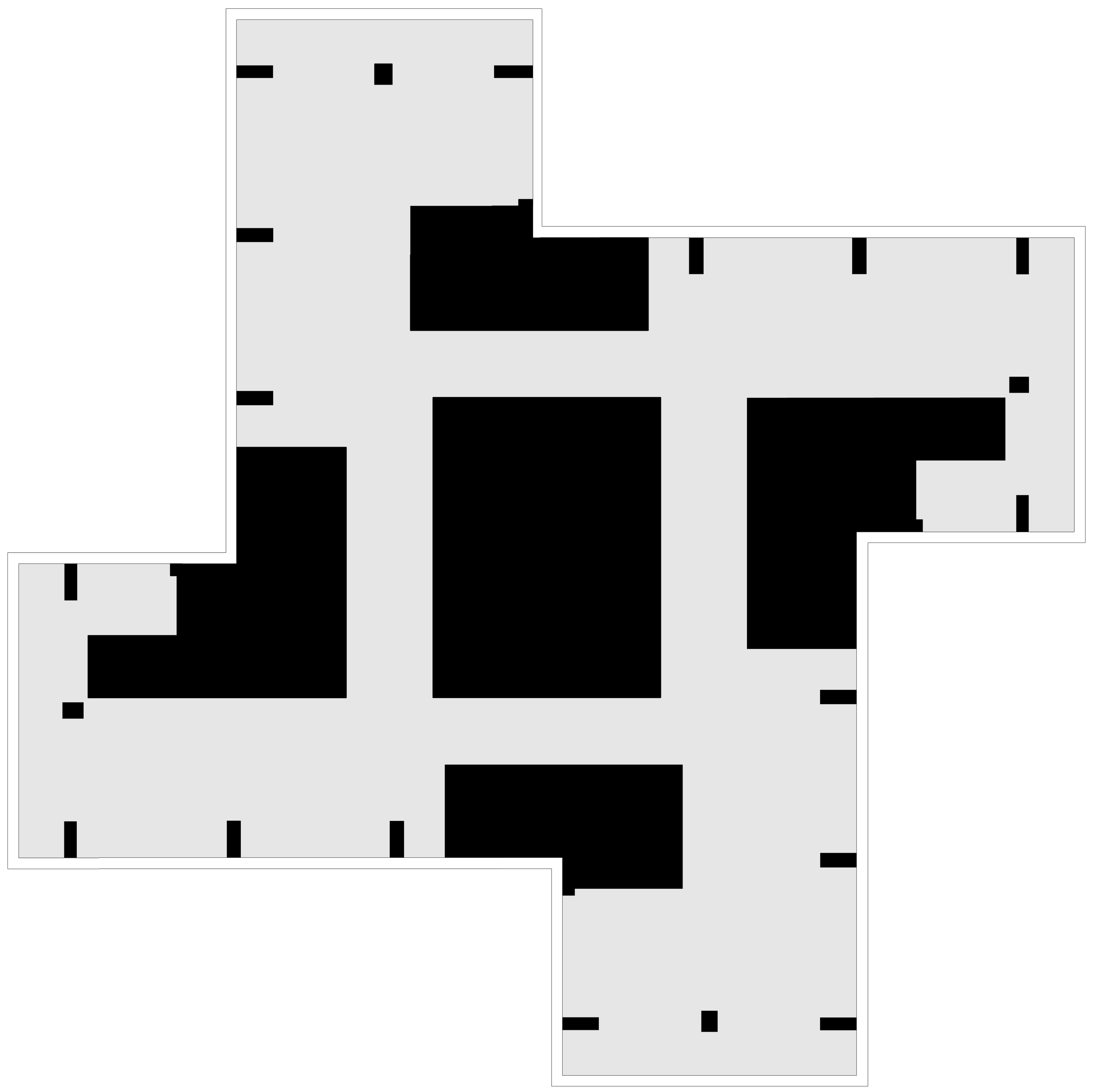
Offices_Single Use_4AHUs

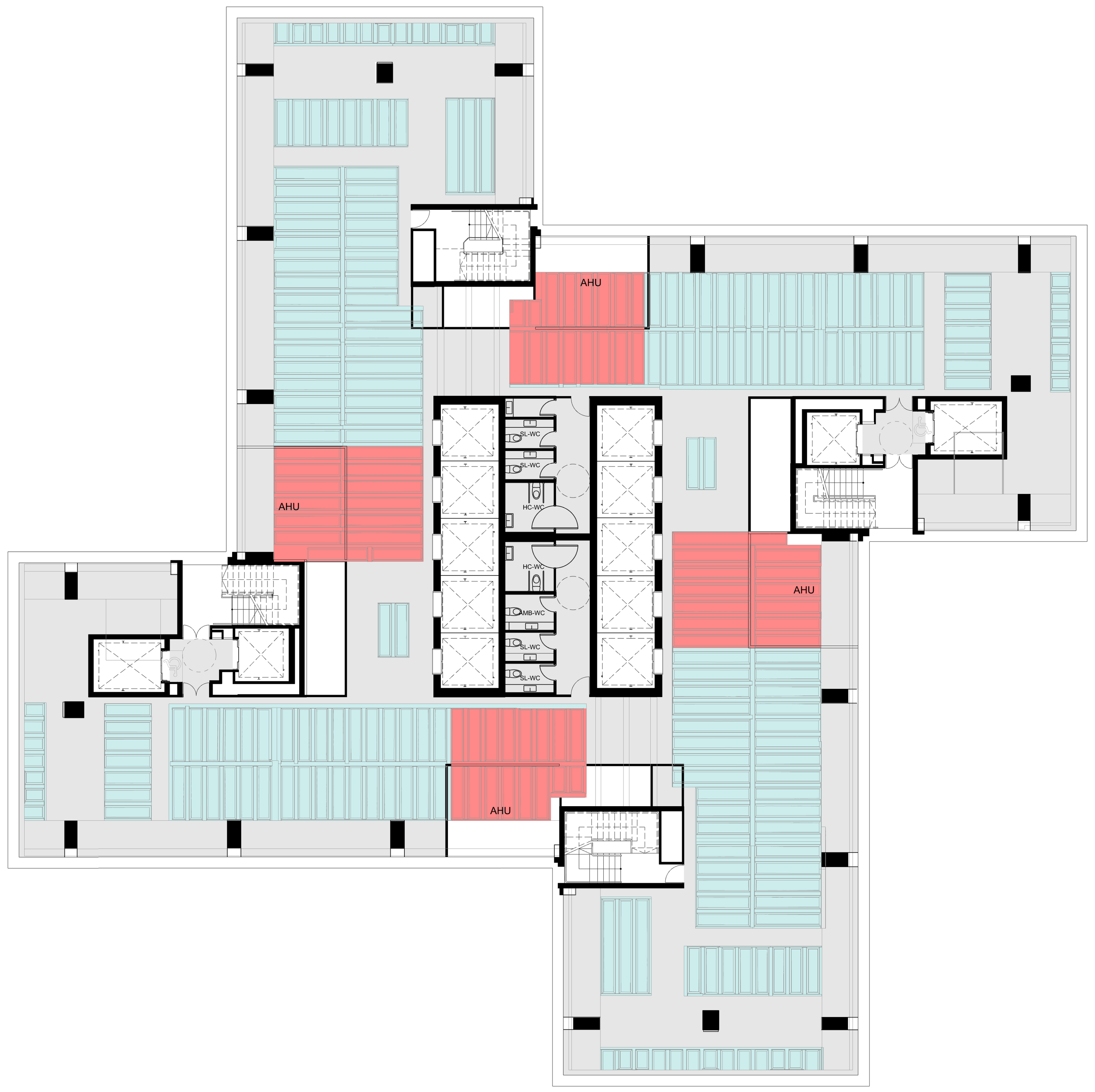
Floorplate Figure Ground



NIA:GIA Efficiency 66,8%

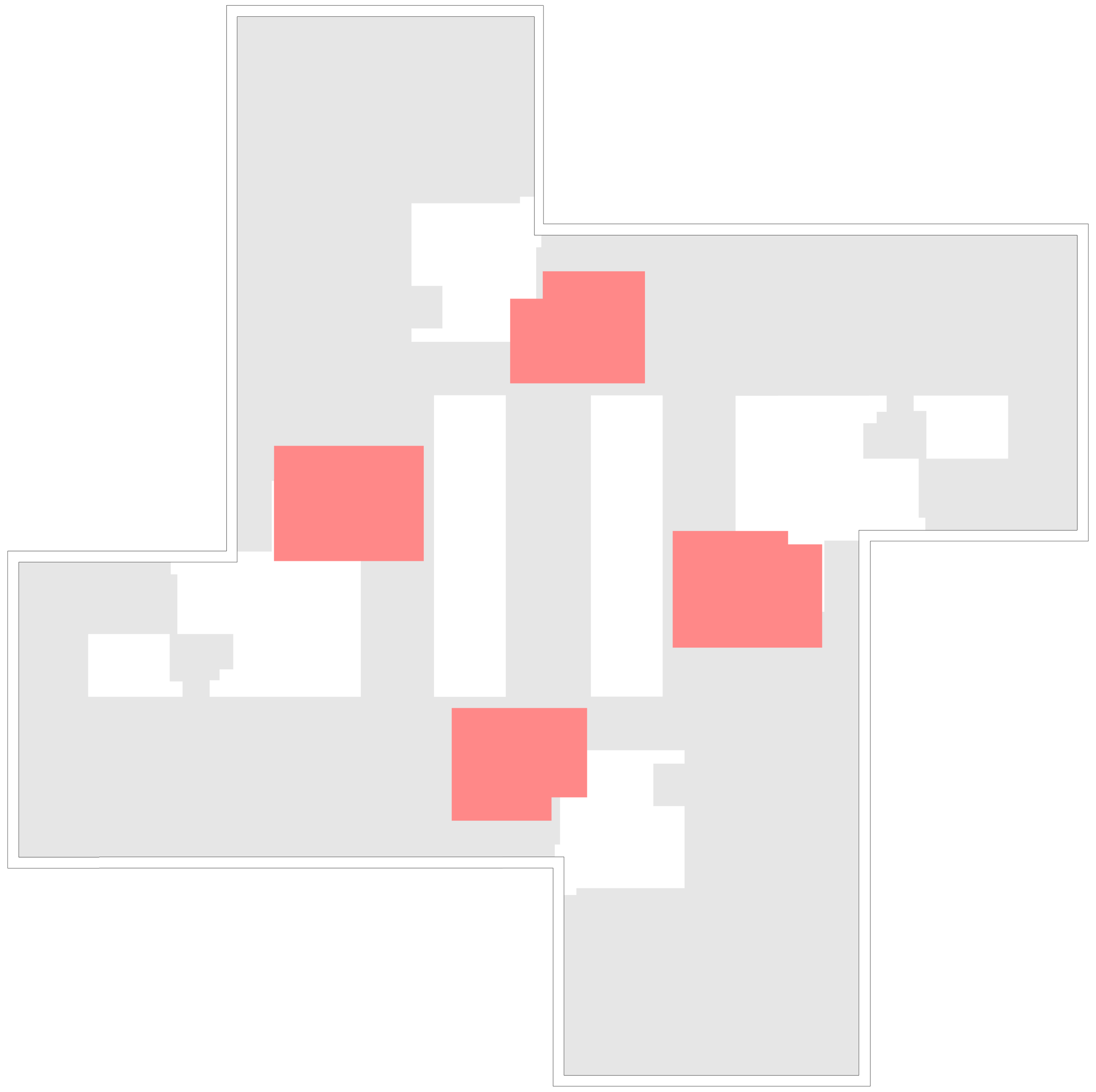
Offices_Single Use_4AHUs

Impact on Existing Slabs



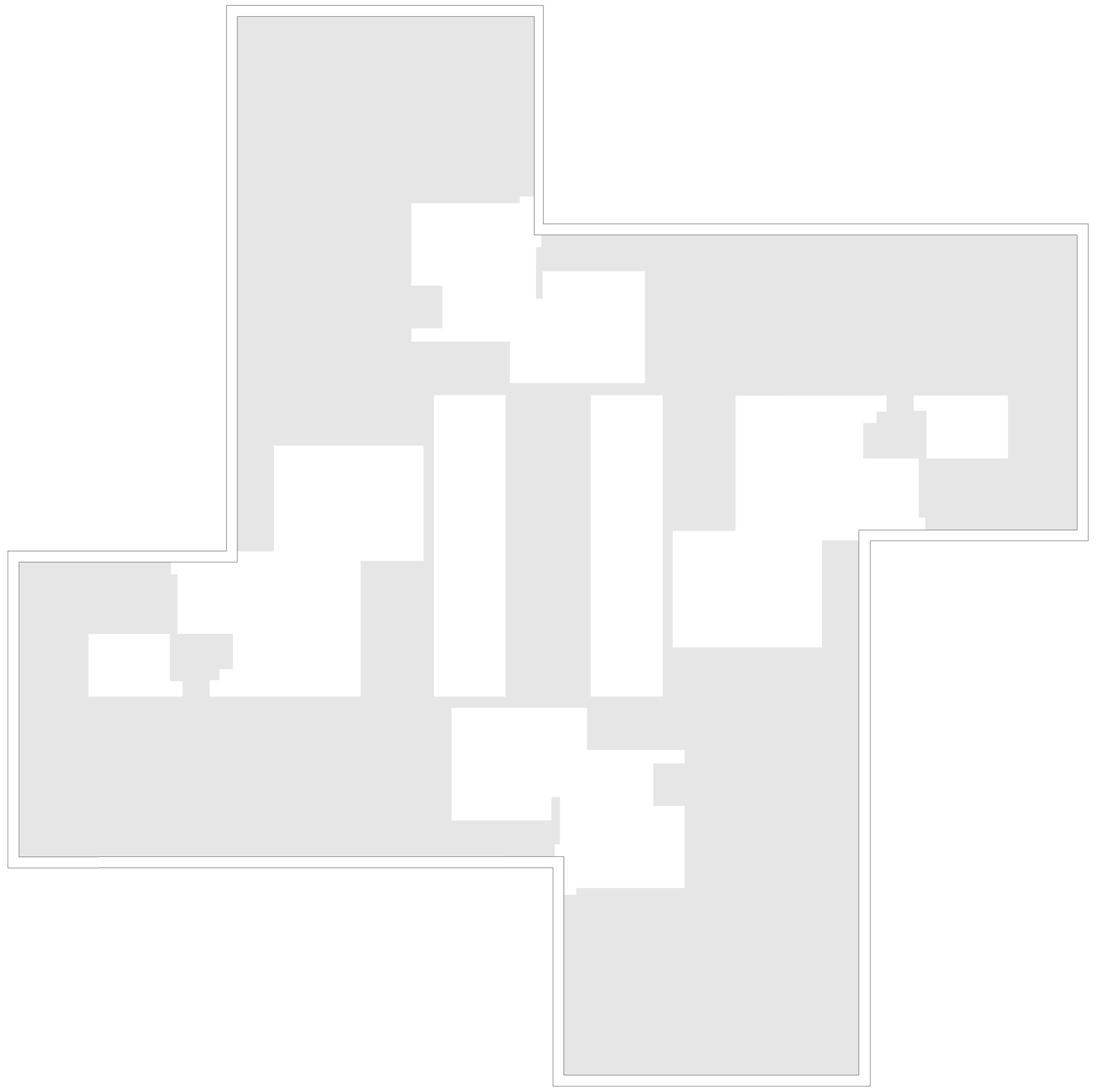
Offices_Single Use_4AHUs

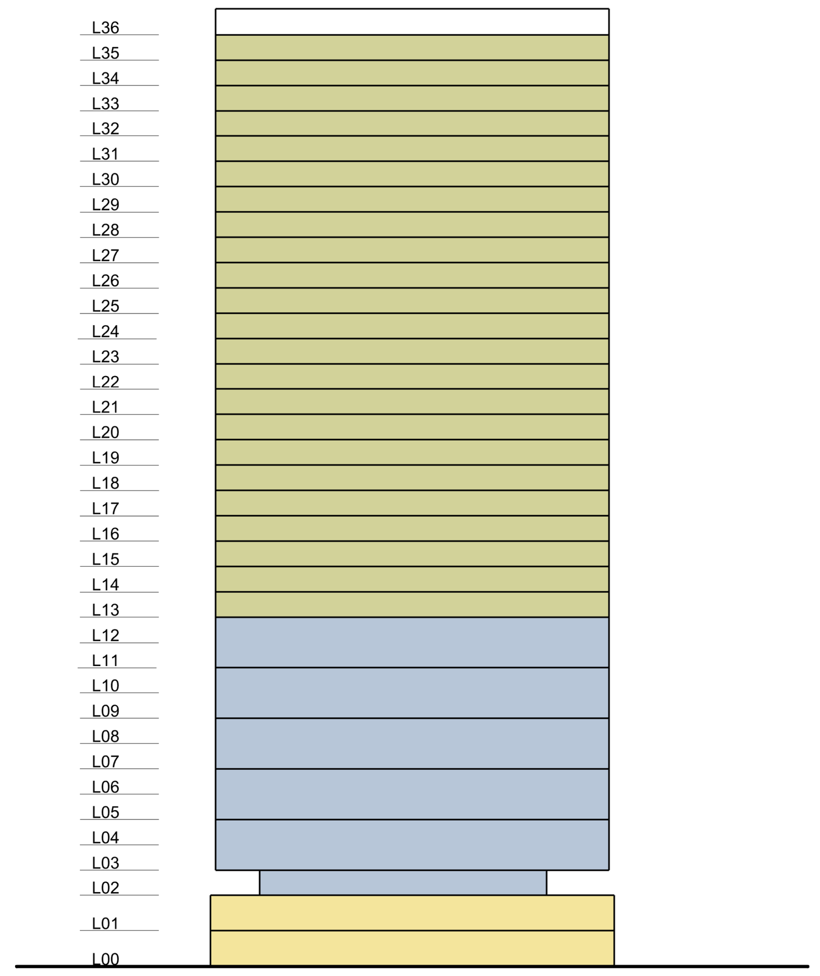
Slab Areas to be Demolished



Offices_Single Use_4AHUs

Resultant Slab Areas Retained





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Euston Tower

Notes

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Revisions:

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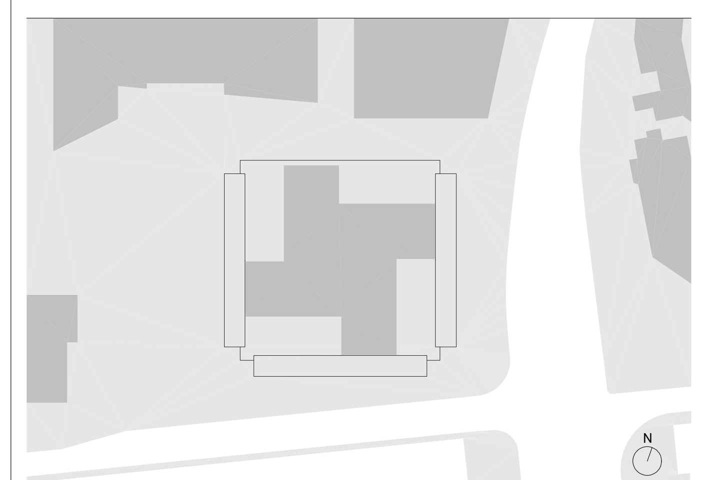
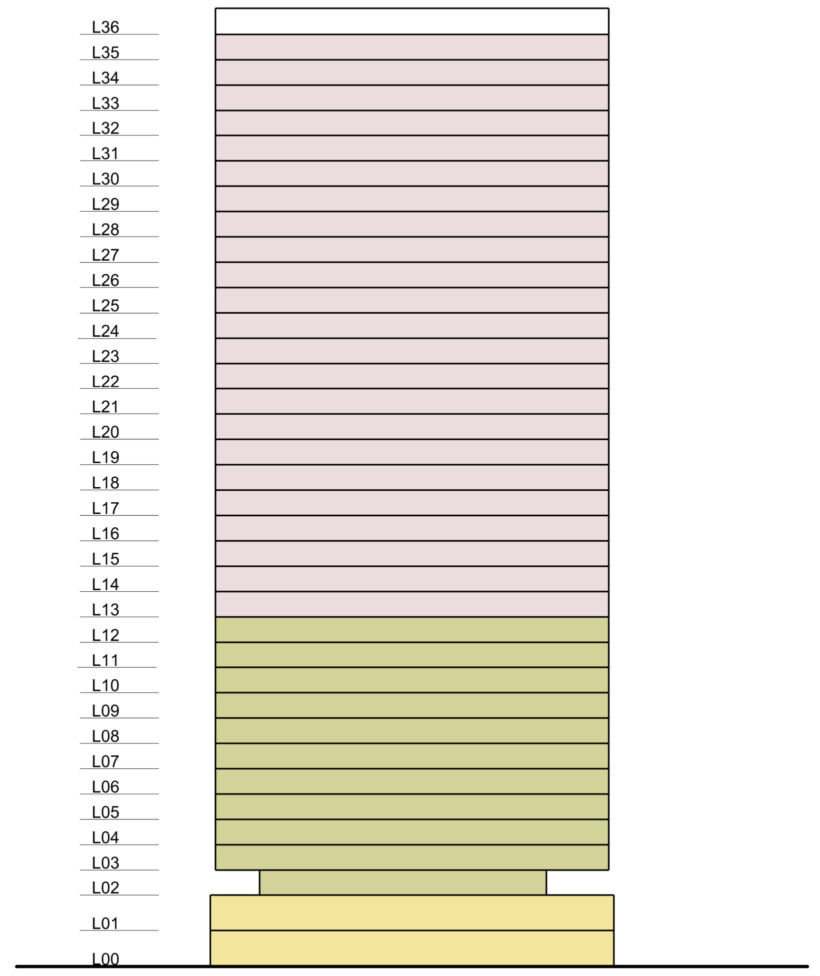
PROJECT NAME	EUSTON TOWER
AUTHOR PROJECT NUMBER	1312
PROJECT PHASE	**PLANNING APPLICATION**
CLIENT	

British Land Property Management Limited
York House 45, Seymour Street, London. W1H 7LX
info@britishland.com / Tel: +44 20 7486 4466



GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Office Test Fit-Out - 2AHUs Mixed-Use Option - Upper Tower
DRAWING NUMBER	N/A

Euston Tower



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Revisions:

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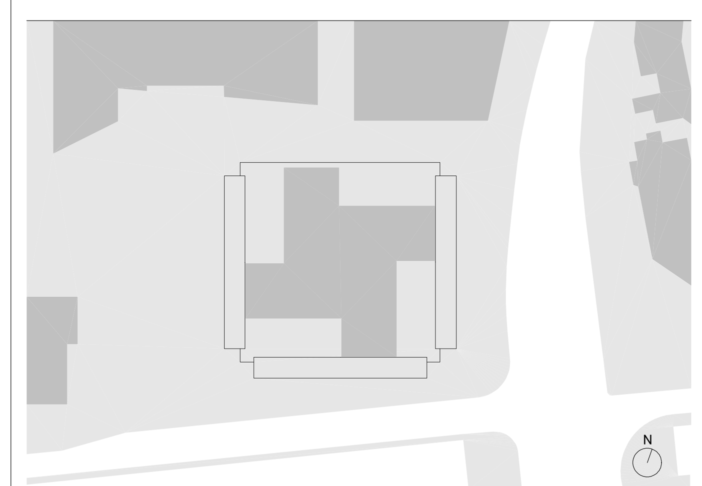
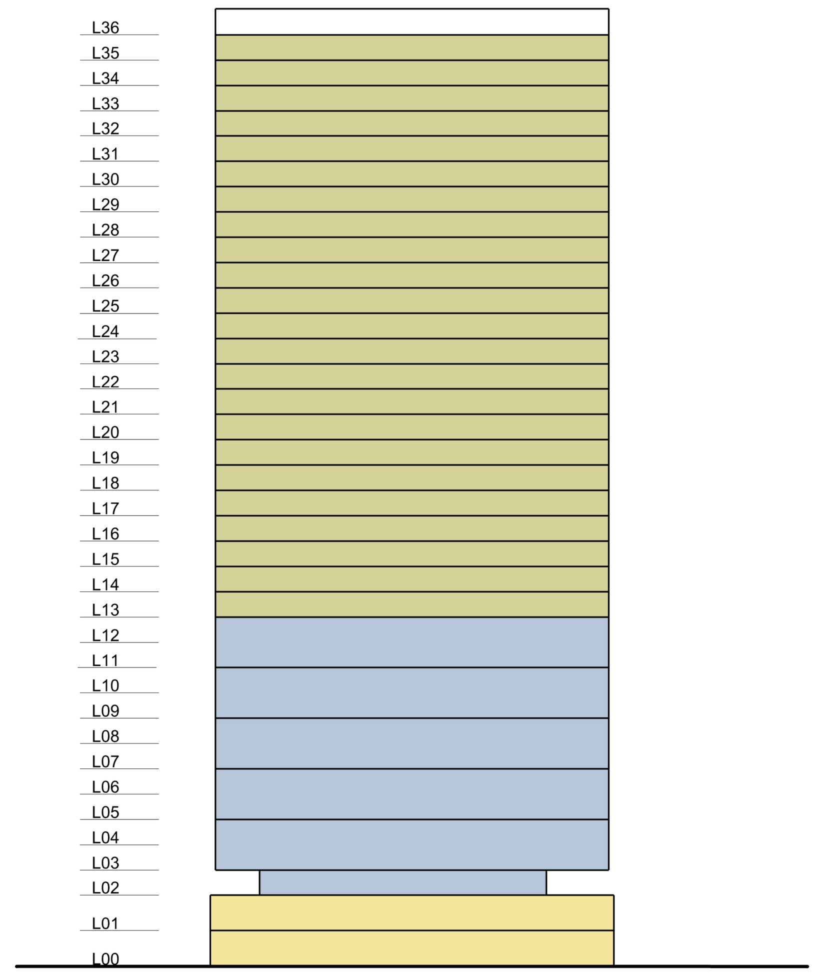
PROJECT NAME	EUSTON TOWER
AUTHOR PROJECT NUMBER	1312
PROJECT PHASE	**PLANNING APPLICATION**
CLIENT	
	British Land Property Management Limited
	York House 45, Seymour Street, London. W1H 7LX
	info@britishland.com / Tel: +44 20 7486 4466

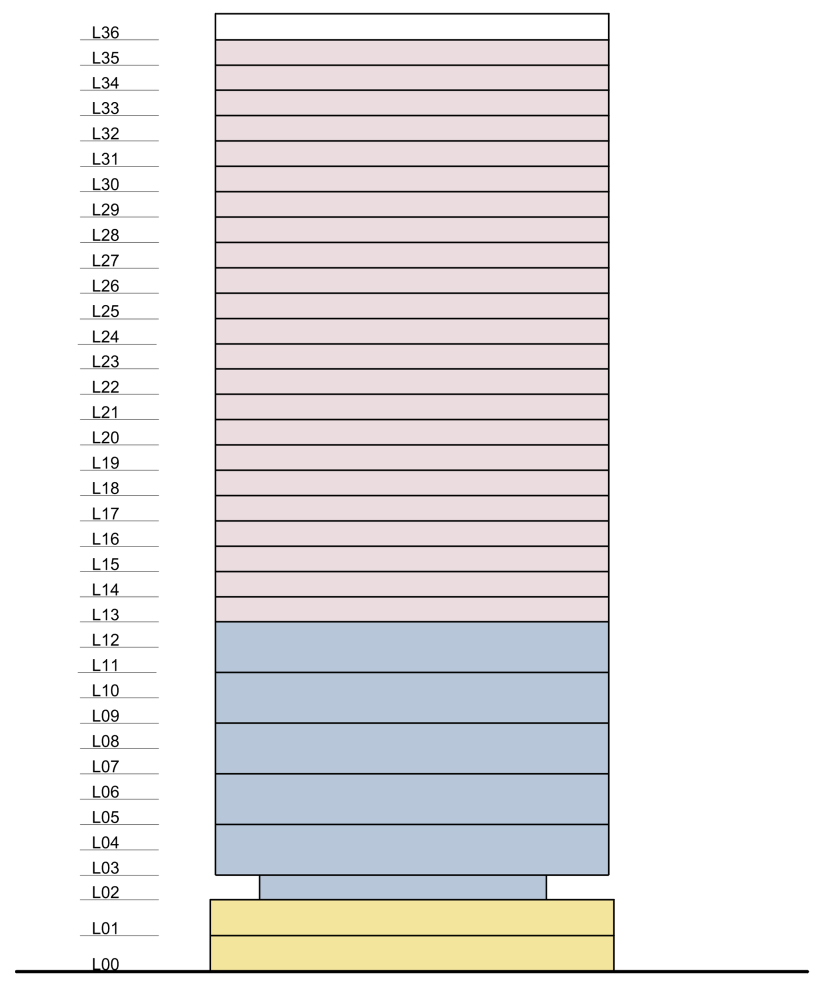


GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Office Test Fit-Out - 2AHUs Mixed-Use Option - Lower Tower
DRAWING NUMBER	N/A

Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Euston Tower





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AUTHOR PROJECT NUMBER	1312
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CLIENT	
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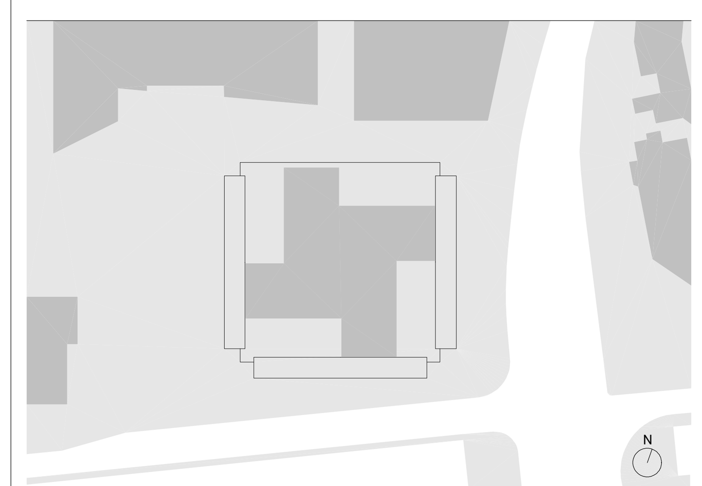
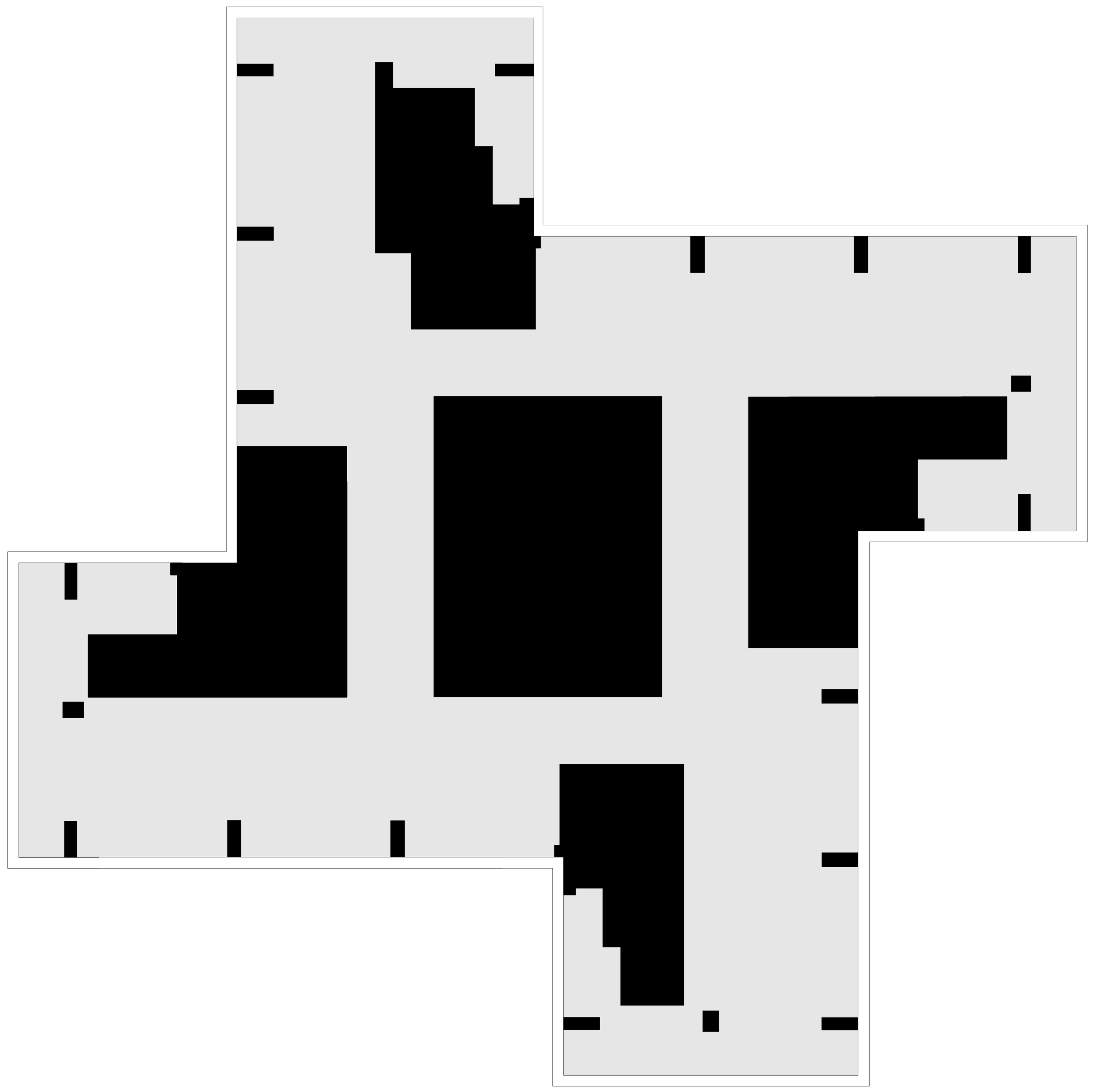


GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Labs Test Fit-Out - 2AHUs Mixed-Use Option - Lower Tower
DRAWING NUMBER	N/A

Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Offices_Mixed-Use_2AHUs

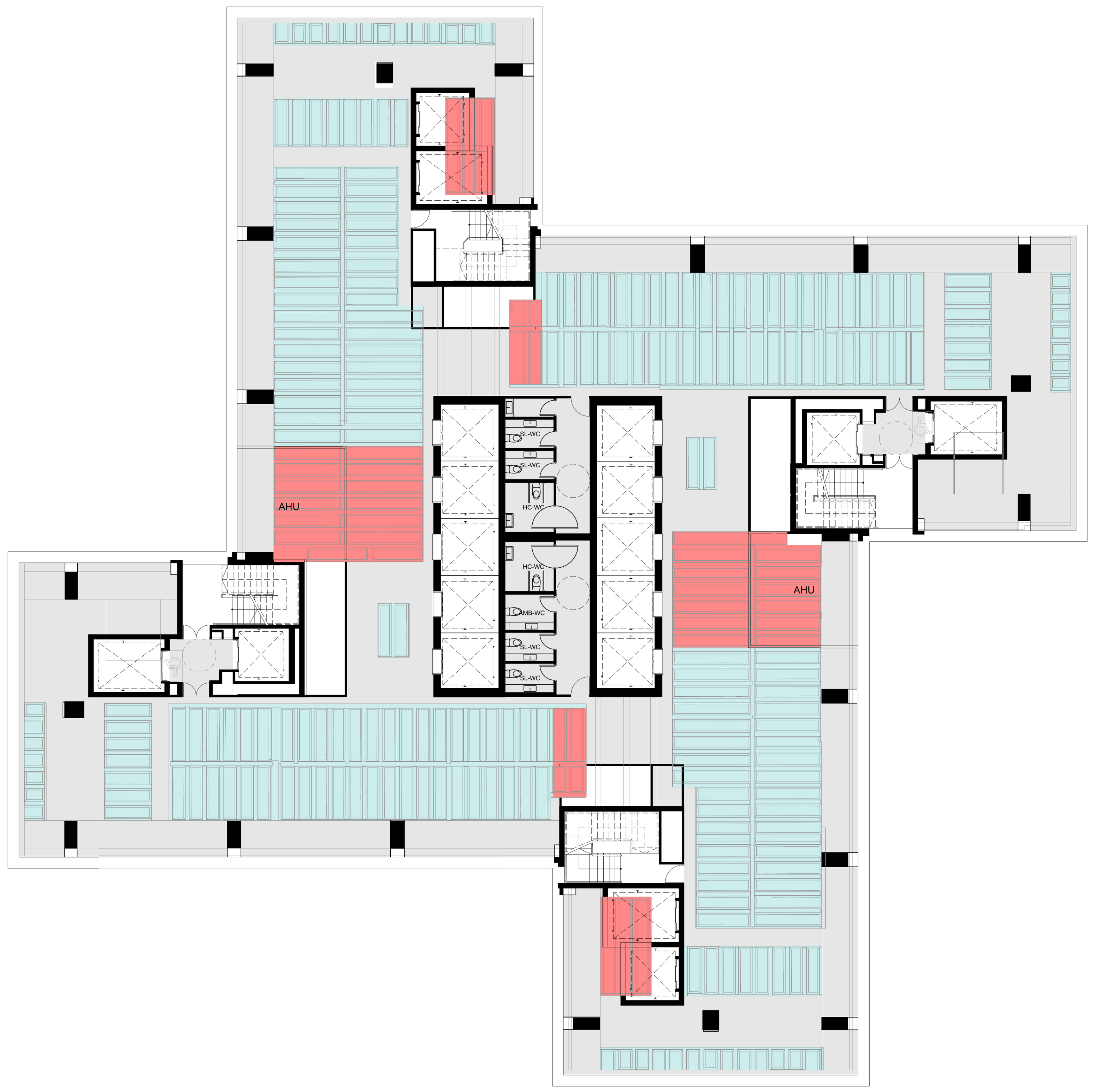
Floorplate Figure Ground



NIA:GIA Efficiency 65,7%

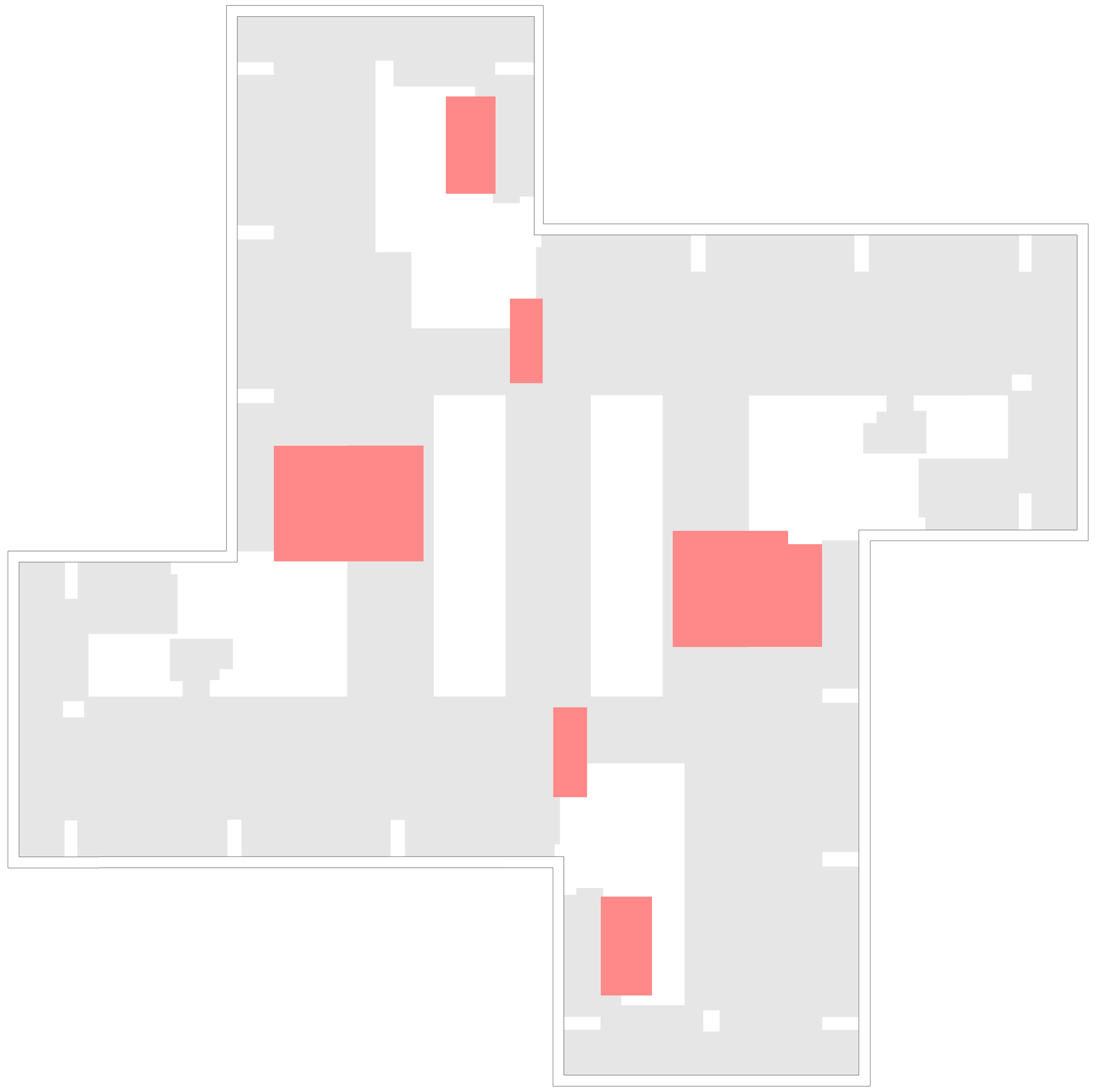
Offices_Mixed-Use_2AHUs

Impact on Existing Slabs



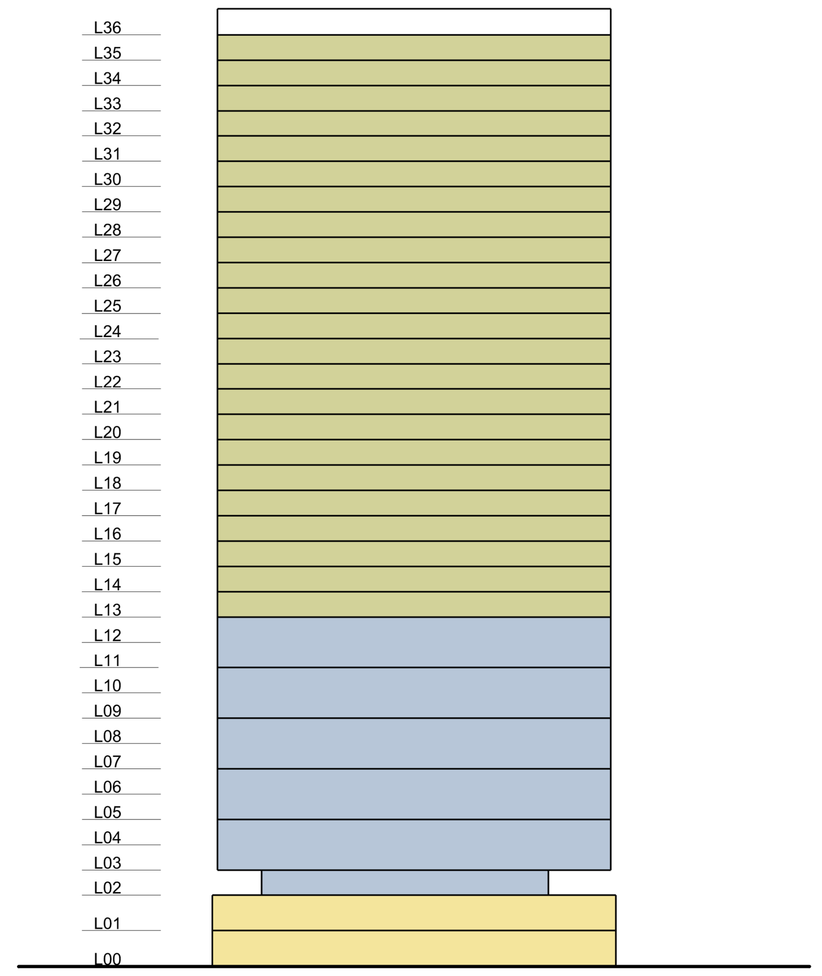
Offices_Mixed-Use_2AHUs

Slab Areas to be Demolished



Offices_Mixed-Use_2AHUs

Resultant Slab Areas Retained



Euston Tower

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Revisions:

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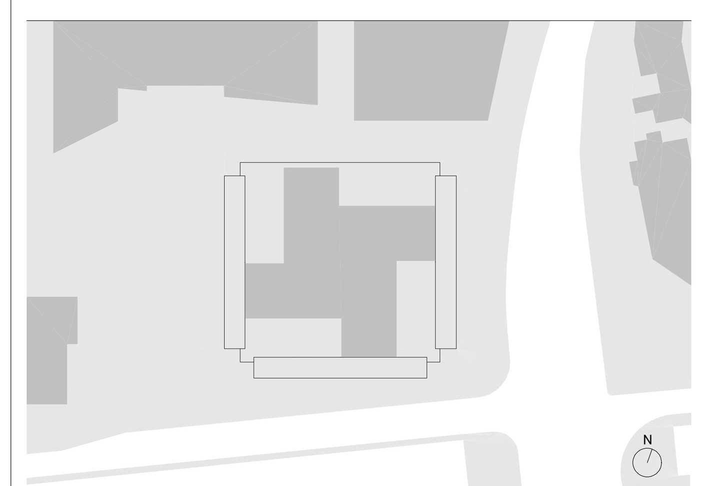
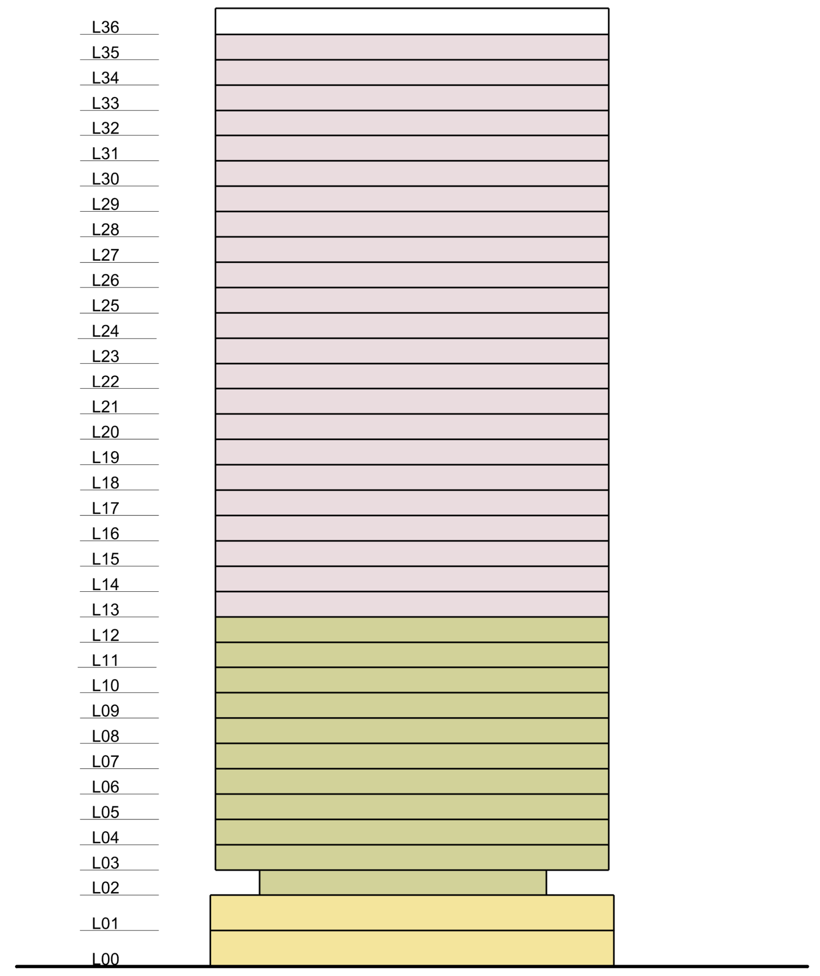
PROJECT NAME	EUSTON TOWER
AUTHOR PROJECT NUMBER	1312
PROJECT PHASE	**PLANNING APPLICATION**
CLIENT	
	British Land Property Management Limited
	York House 45, Seymour Street, London. W1H 7LX
	info@britishland.com / Tel: +44 20 7486 4466



GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Office Test Fit-Out - 4AHUs Mixed-Use Option - Upper Tower
DRAWING NUMBER	N/A

Key
Residential
Student Housing
Hotel
Offices
Labs
Retail



Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

Euston Tower

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AUTHOR PROJECT NUMBER	1312
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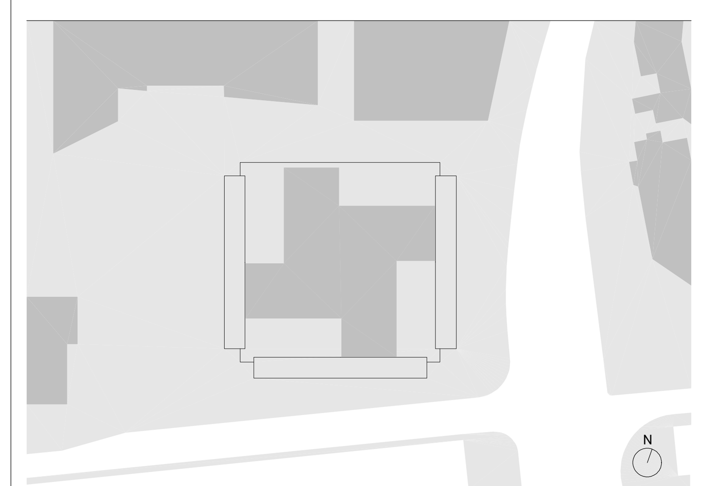
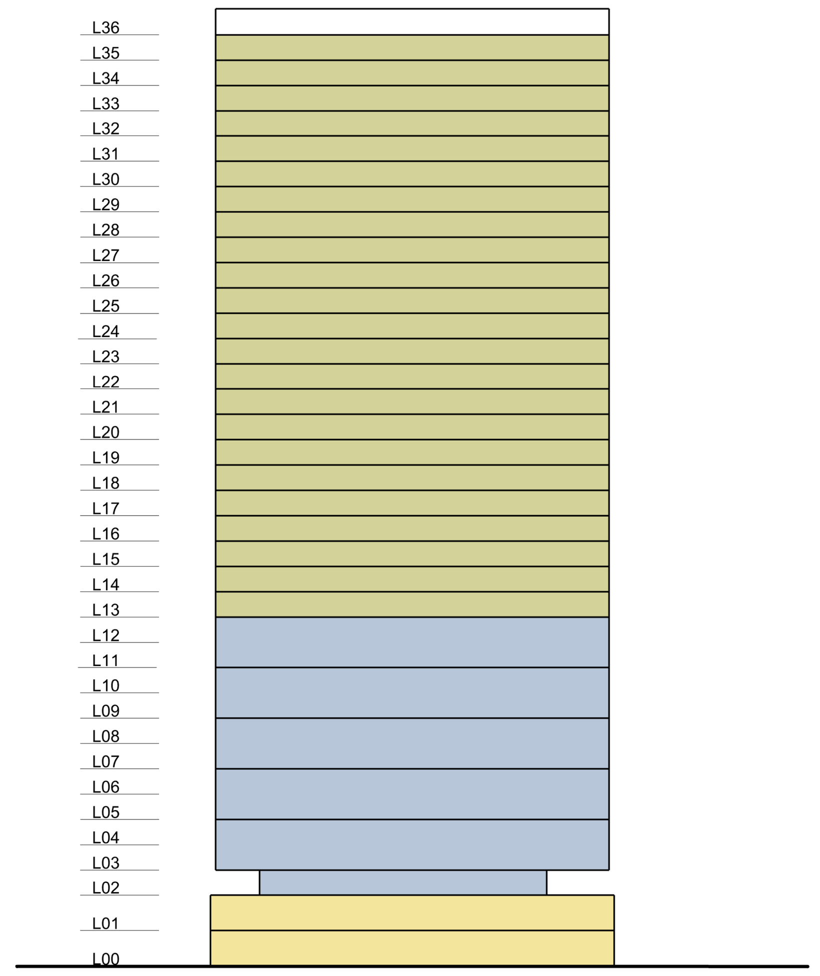
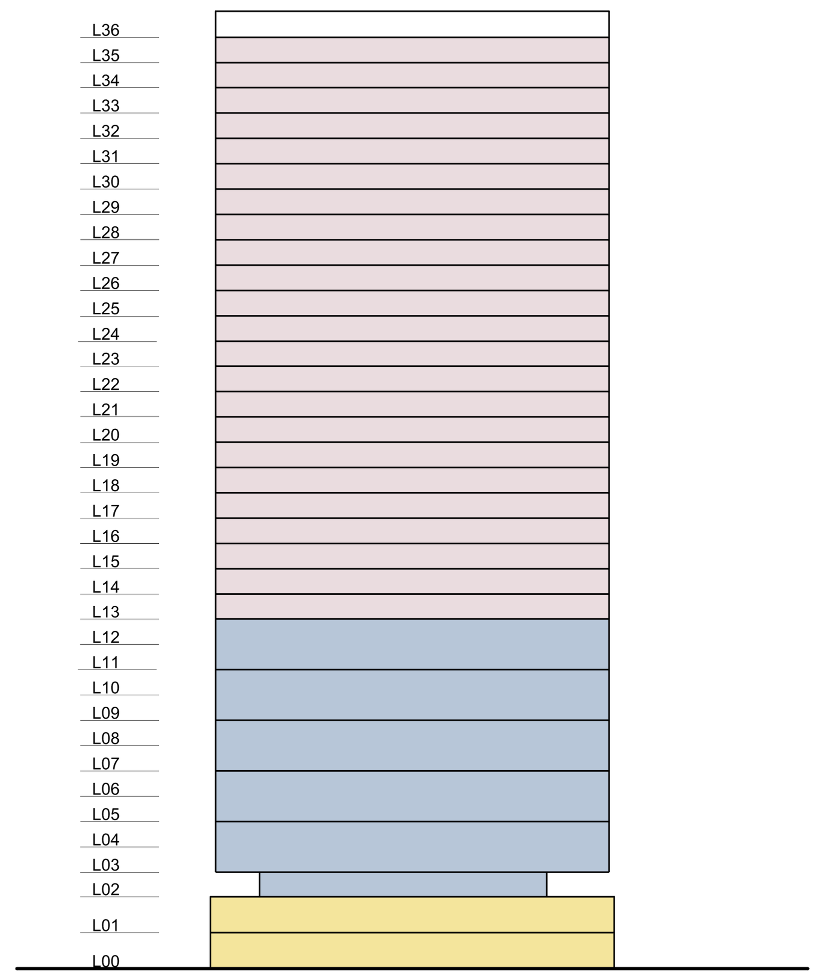


GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Office Test Fit-Out - 4AHUs Mixed-Use Option - Lower Tower
DRAWING NUMBER	N/A

Euston Tower





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Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

PROJECT NAME	EUSTON TOWER
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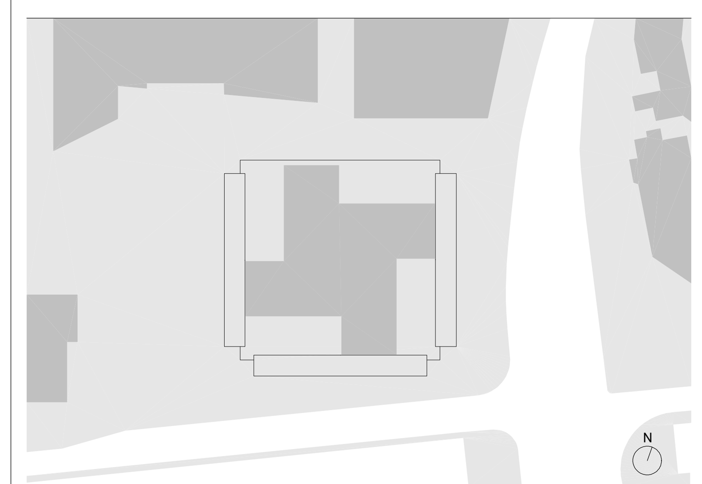
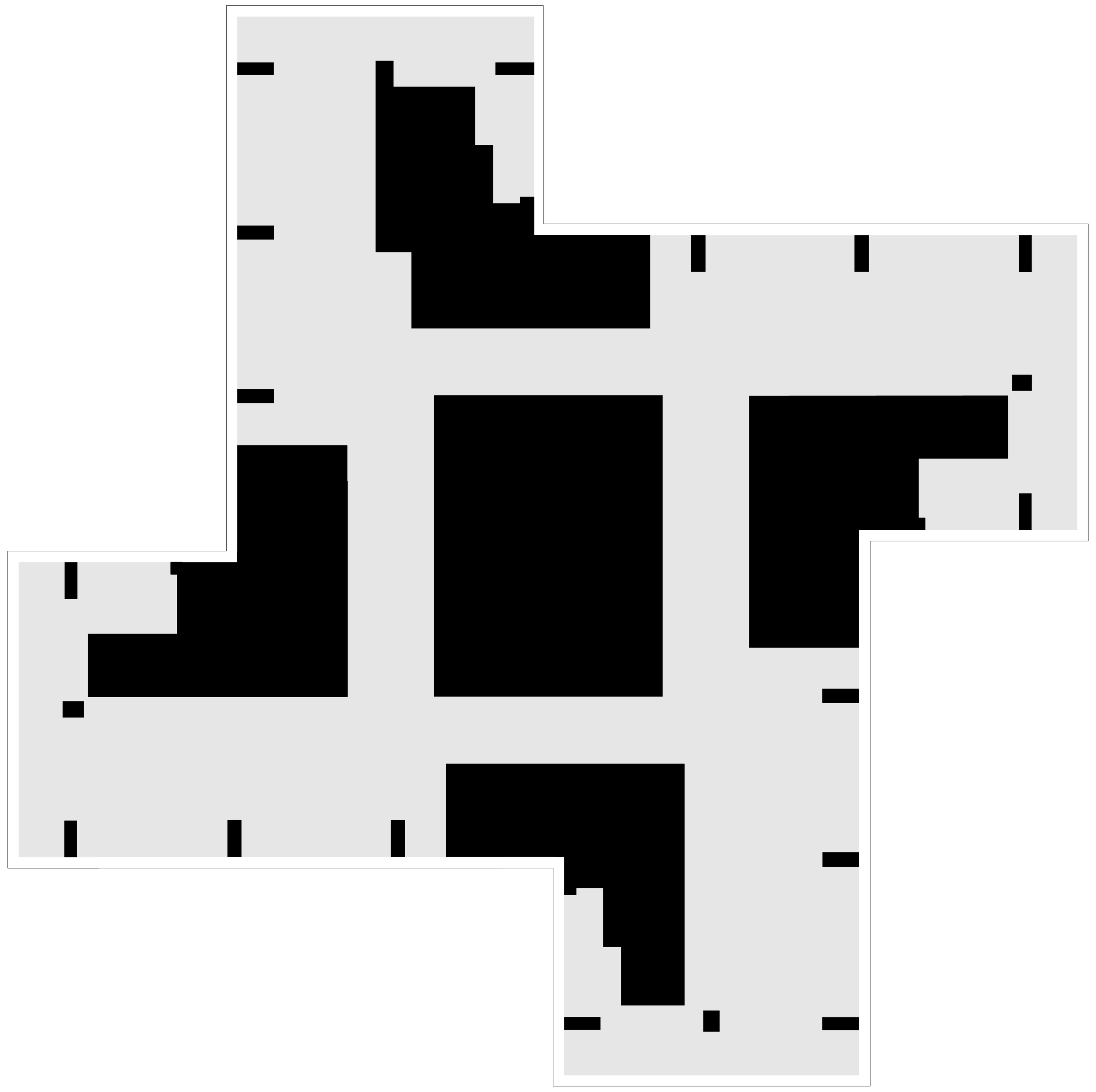


GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Labs Test Fit-Out - 4AHUs Mixed-Use Option - Lower Tower
DRAWING NUMBER	N/A

Offices_Mixed-Use_4AHUs

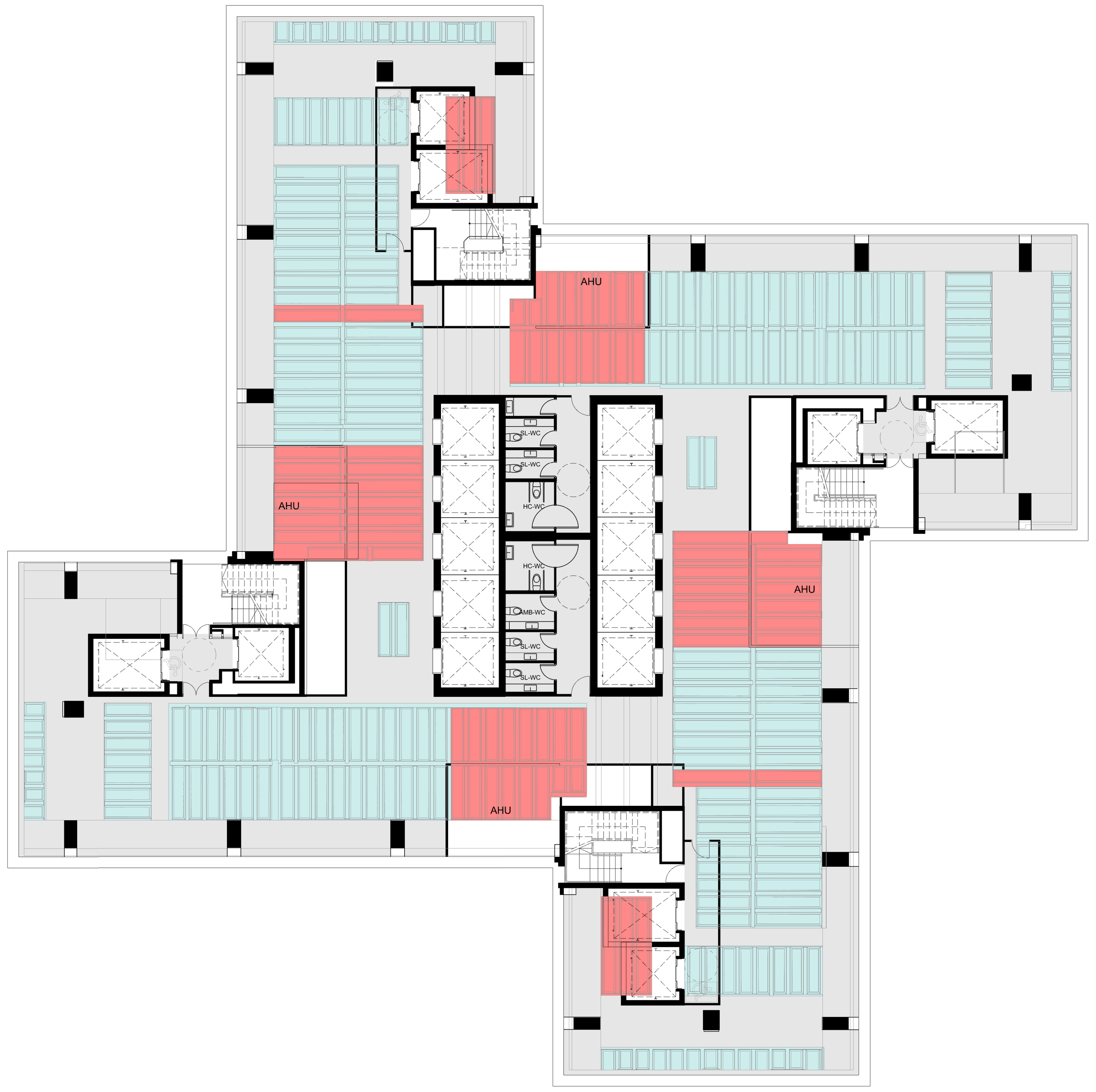
Floorplate Figure Ground



NIA:GIA Efficiency 62,3%

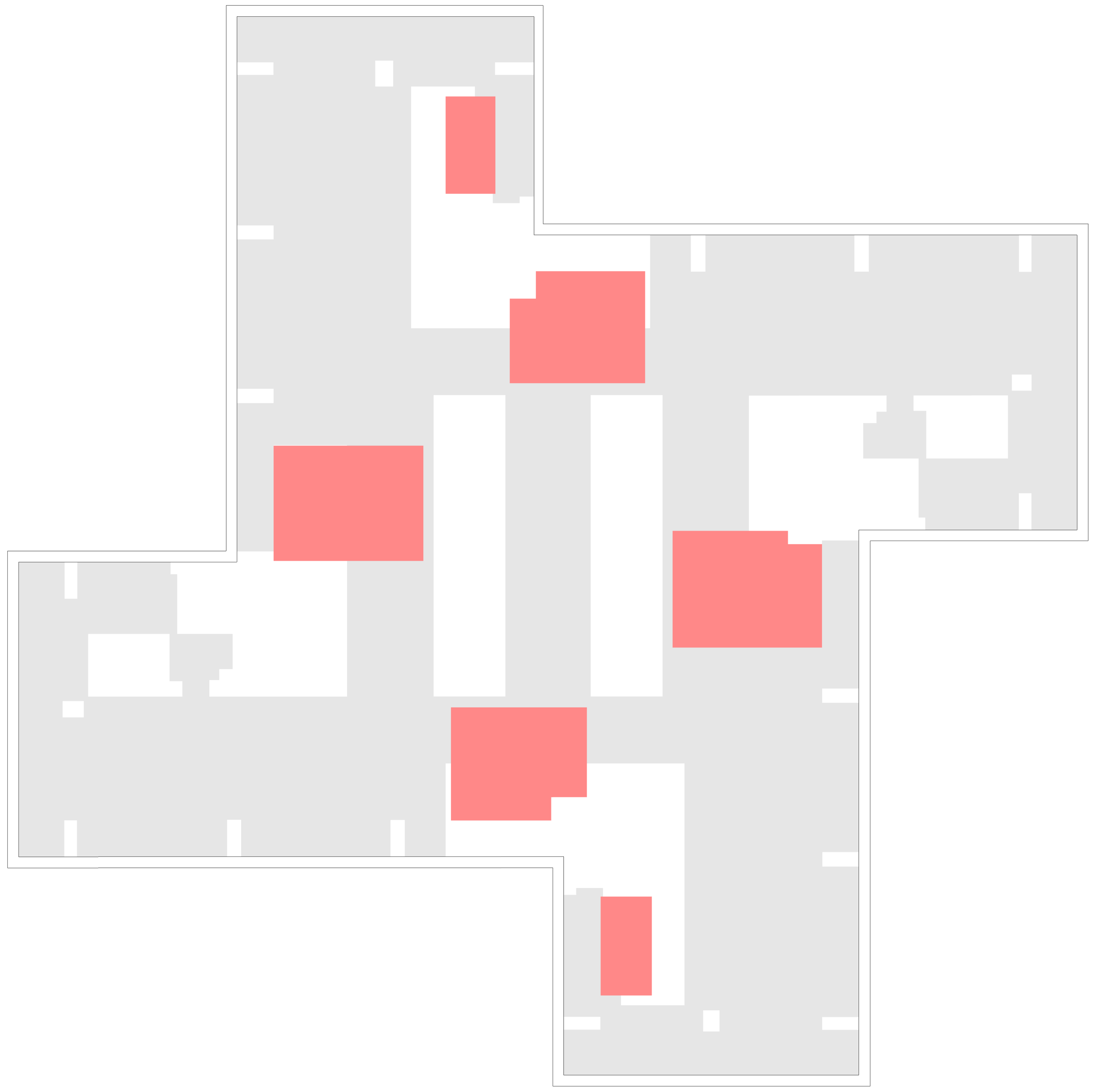
Offices_Mixed-Use_4AHUs

Impact on Existing Slabs



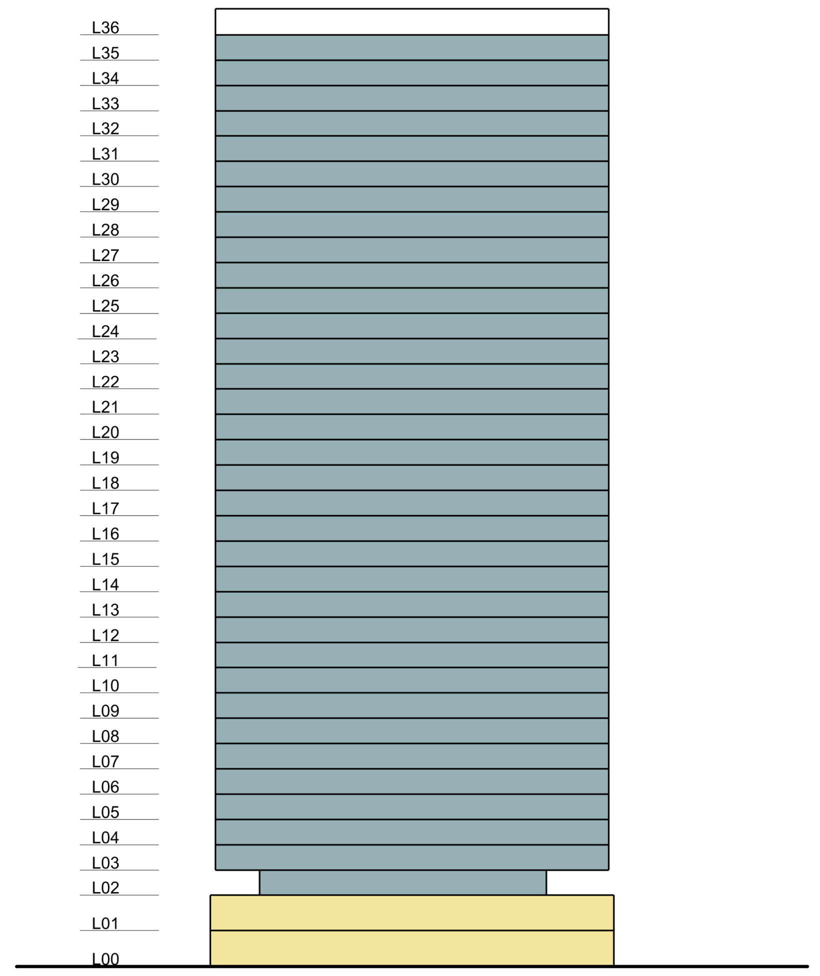
Offices_Mixed-Use_4AHUs

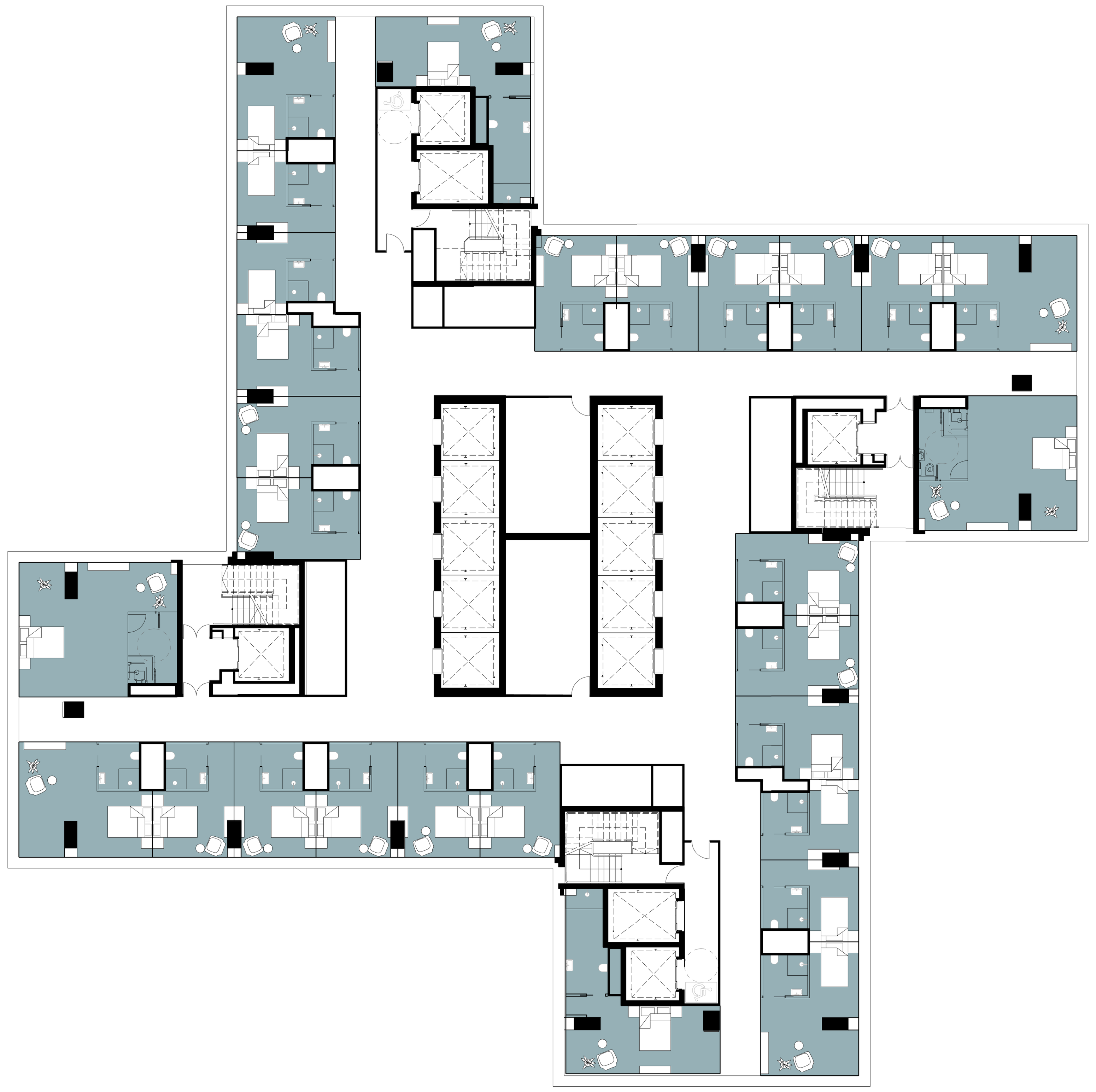
Slab Areas to be Demolished



Offices_Mixed-Use_4AHUs

Resultant Slab Areas Retained





Key

Residential
Student Housing
Hotel
Offices
Labs
Retail

Euston Tower

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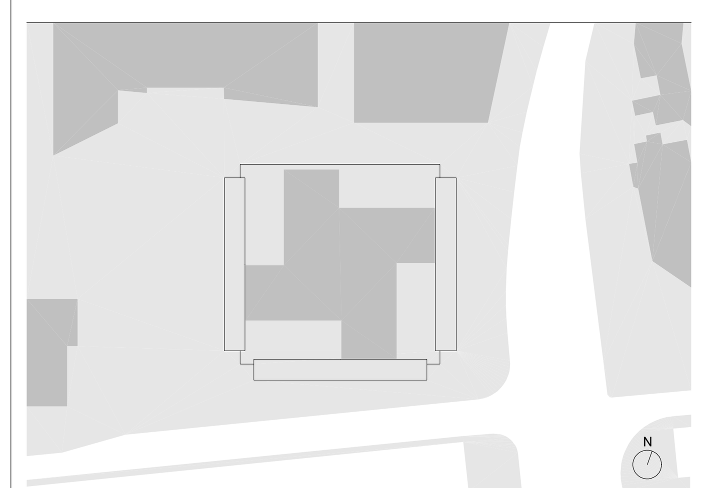
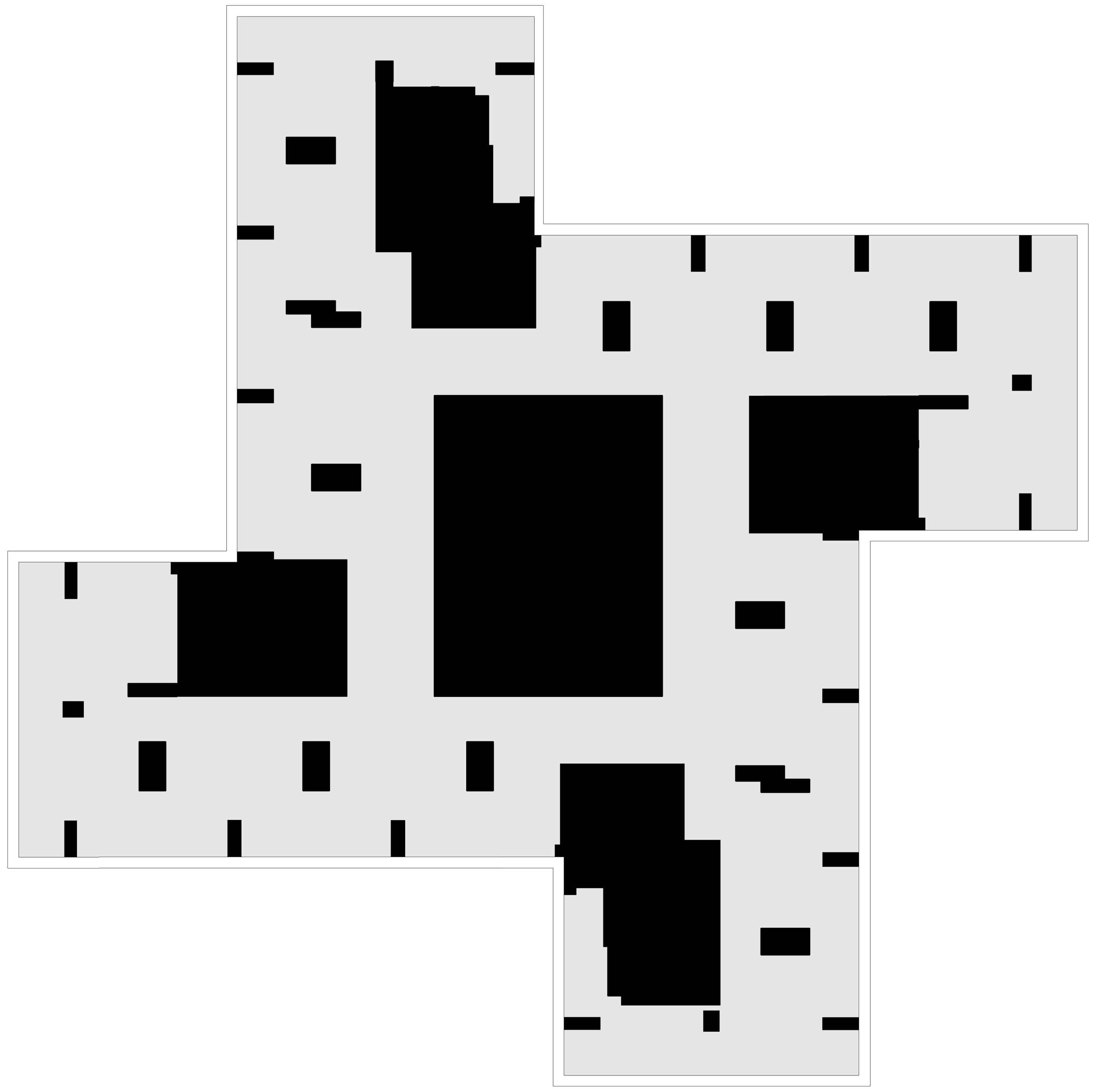
PROJECT NAME	EUSTON TOWER
AUTHOR PROJECT NUMBER	1312
PROJECT PHASE	**PLANNING APPLICATION**
CLIENT	
	British Land Property Management Limited
	York House 45, Seymour Street, London. W1H 7LX
	info@britishland.com / Tel: +44 20 7486 4466



GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Hotel Test Fit-Out Single-Use Option
DRAWING NUMBER	N/A

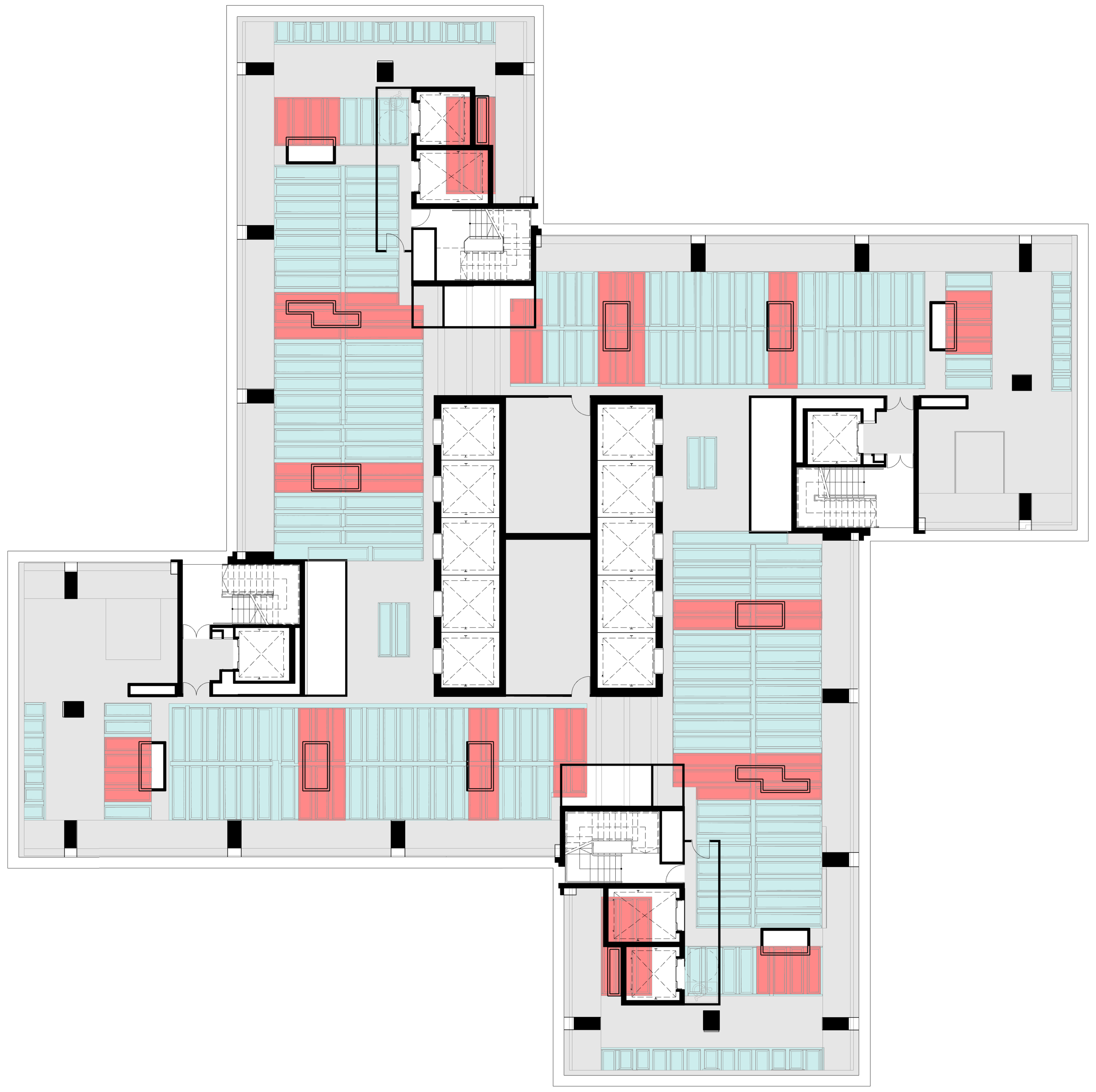
Hotel_Single-Use

Floorplate Figure Ground



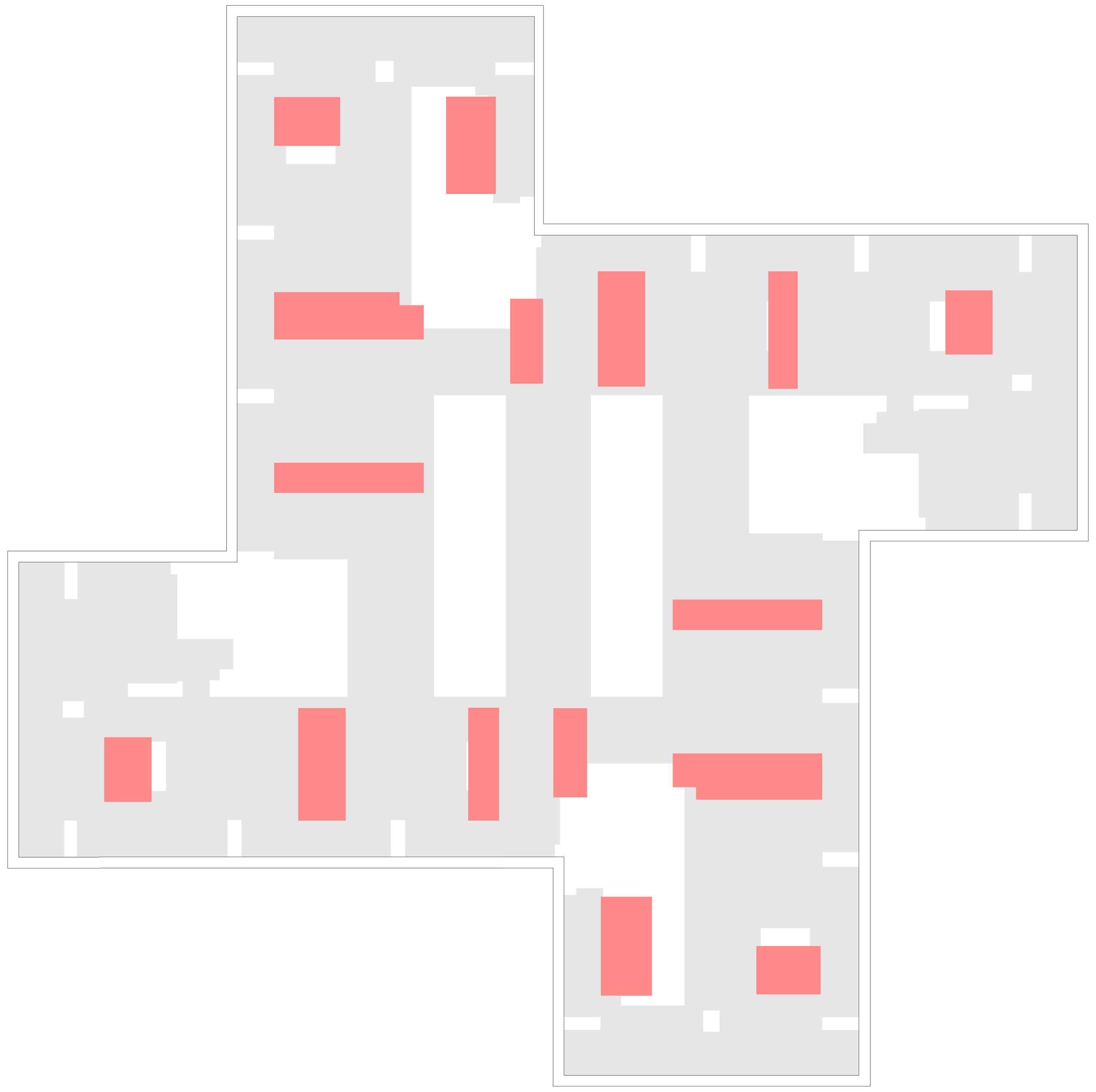
Hotel_Single-Use

Impact on Existing Slabs



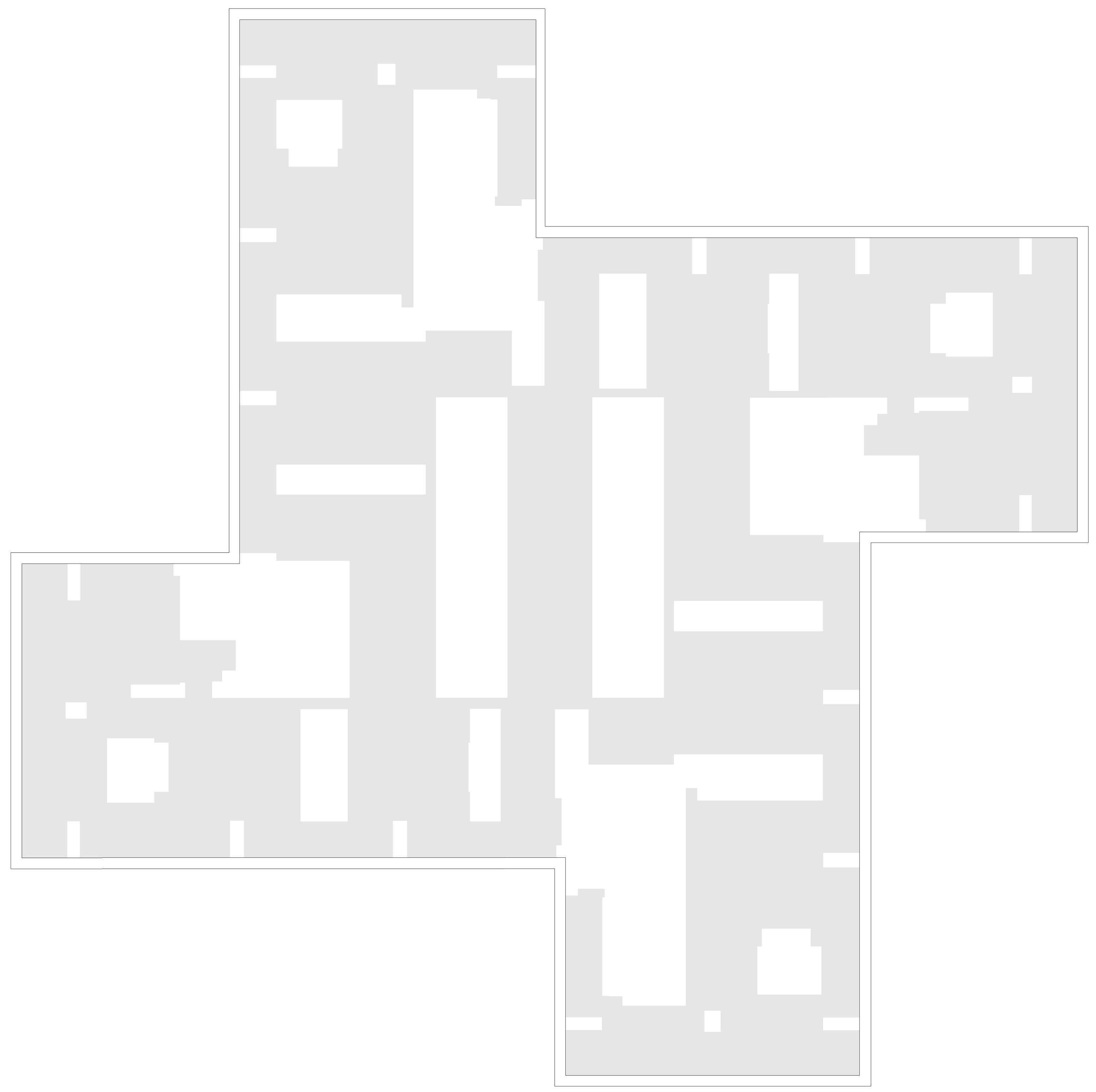
Hotel_Single-Use

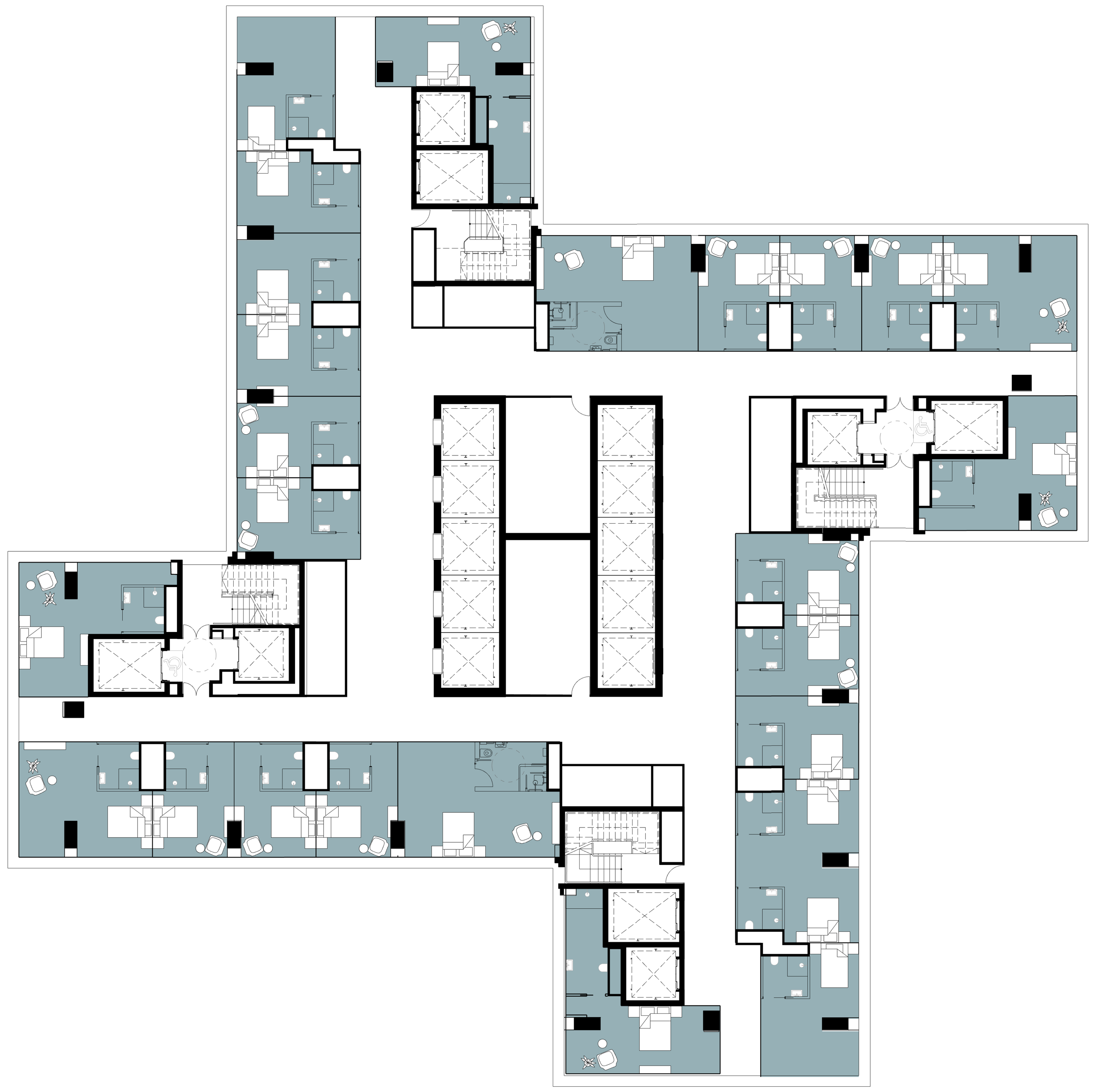
Slab Areas to be Demolished

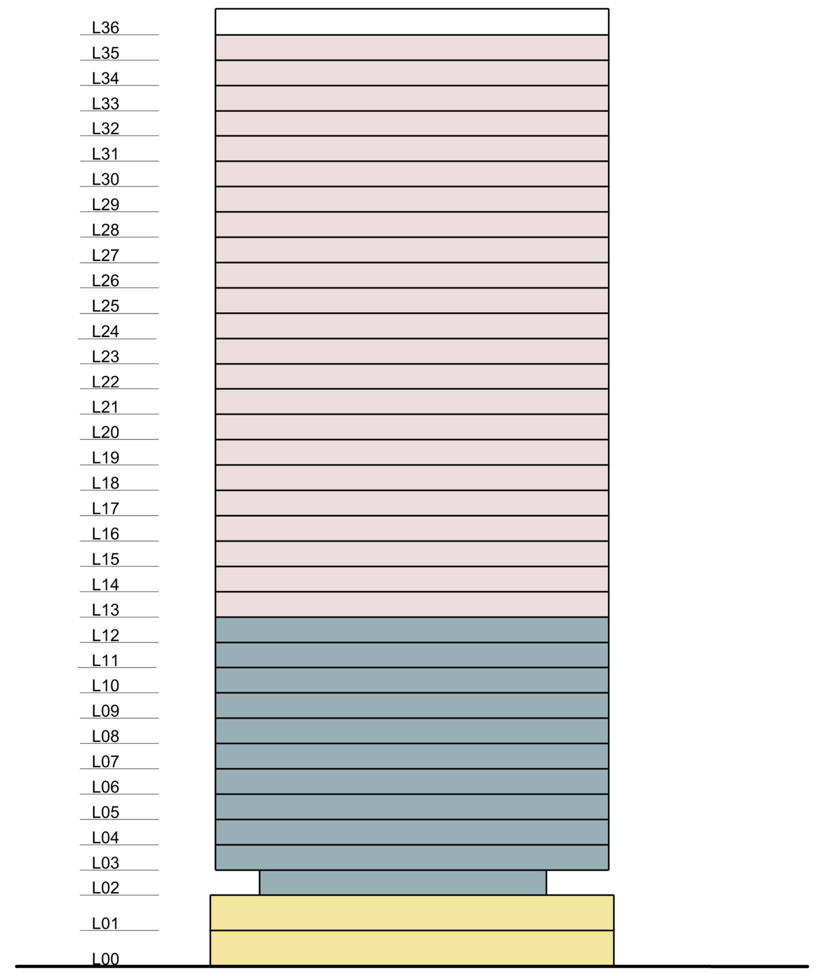


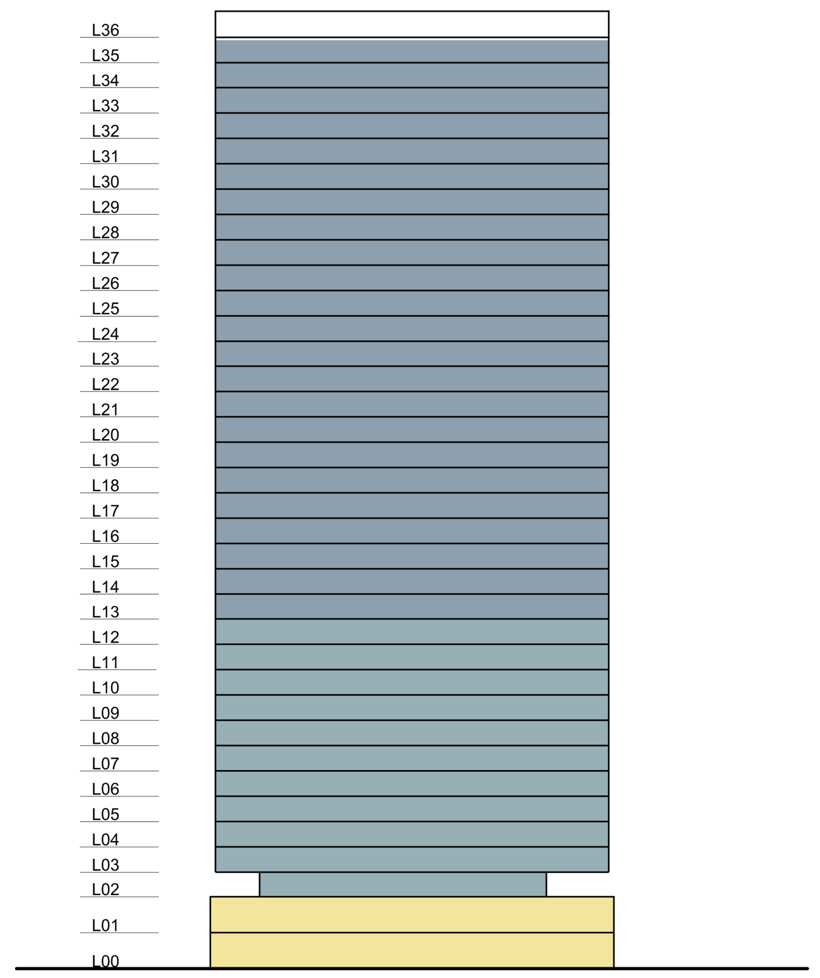
Hotel_Single-Use

Resultant Slab Areas Retained









Key

Residential
Student Housing
Hotel
Offices
Labs
Retail

Euston Tower

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AUTHOR PROJECT NUMBER	1312
PROJECT PHASE	**PLANNING APPLICATION**
CLIENT	
	British Land Property Management Limited
	York House 45, Seymour Street, London. W1H 7LX
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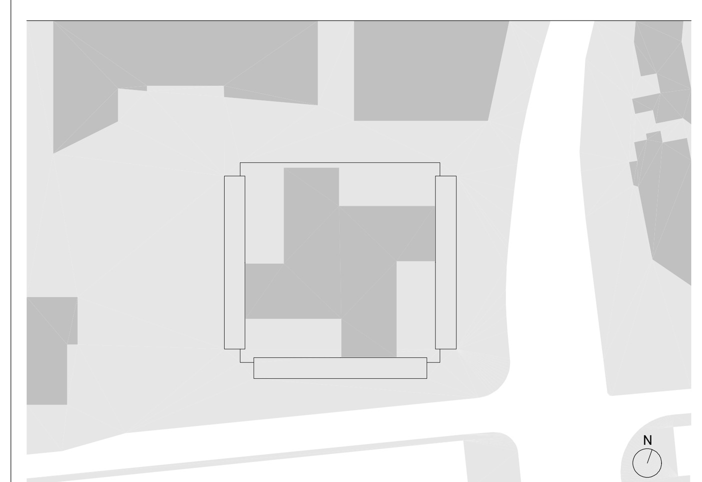
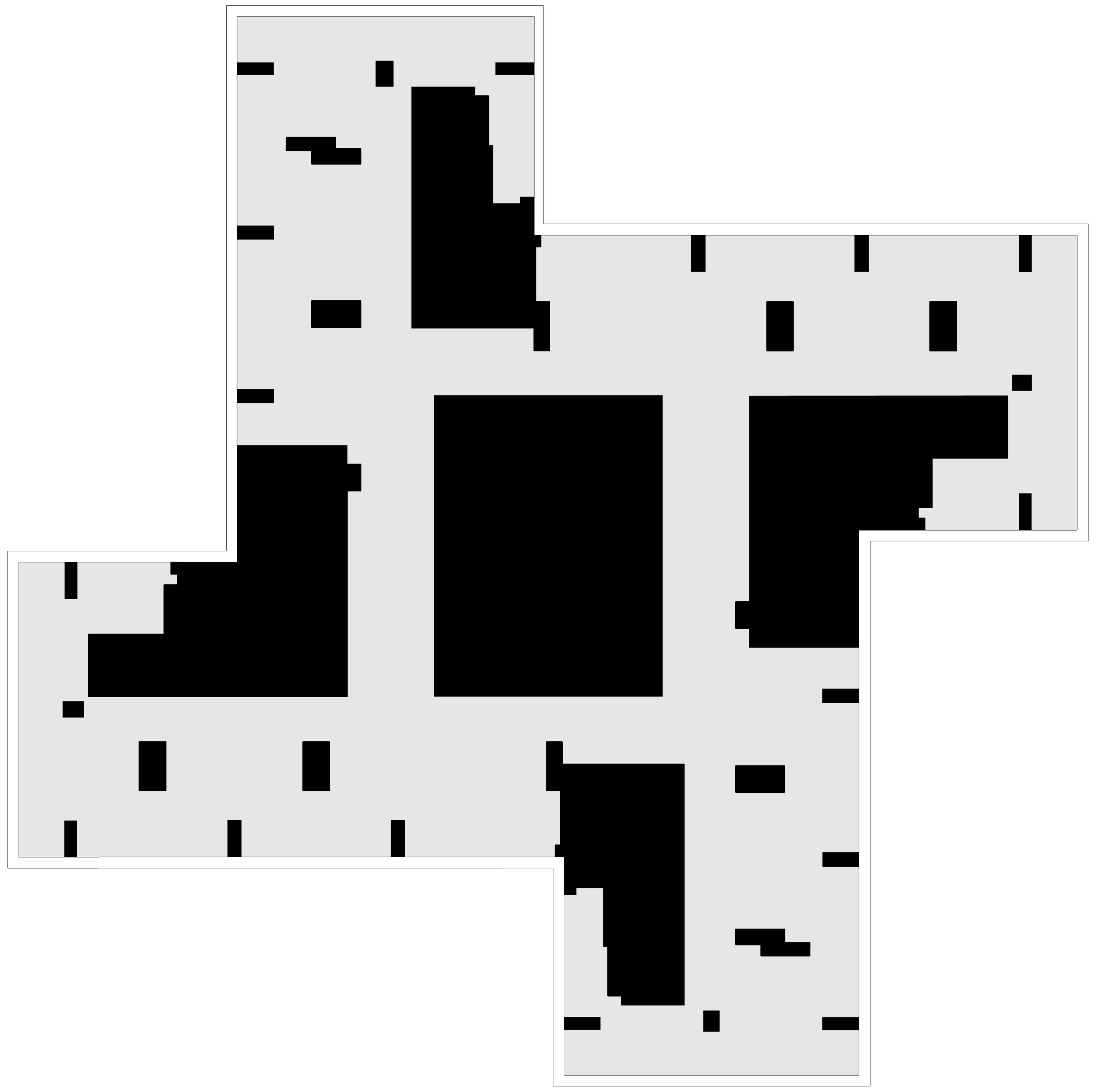


GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Hotel Test Fit-Out Mixed-Use Option
DRAWING NUMBER	N/A

Hotel_Mixed-Use

Floorplate Figure Ground

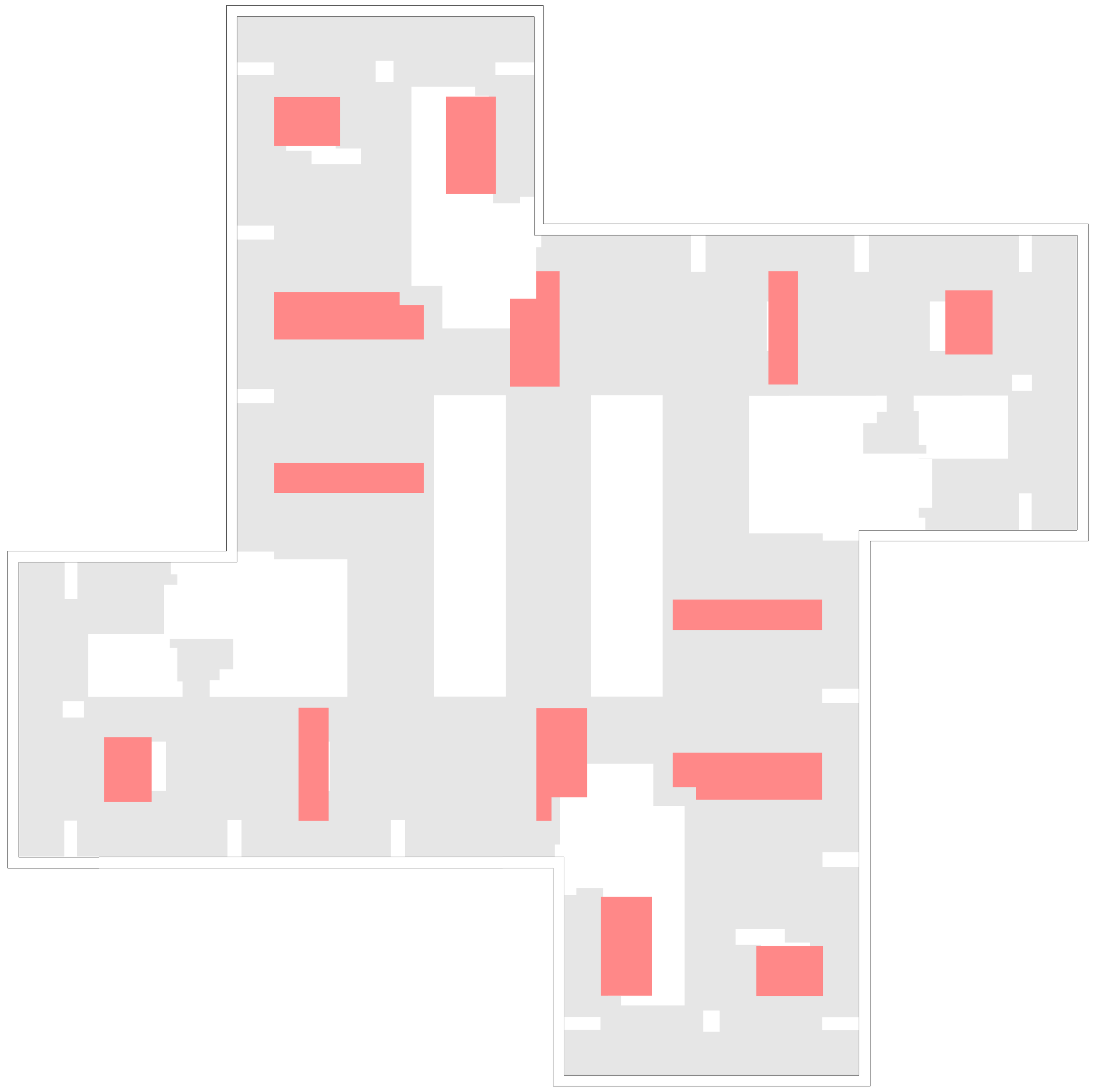


Hotel_Mixed-Use

Impact on Existing Slabs

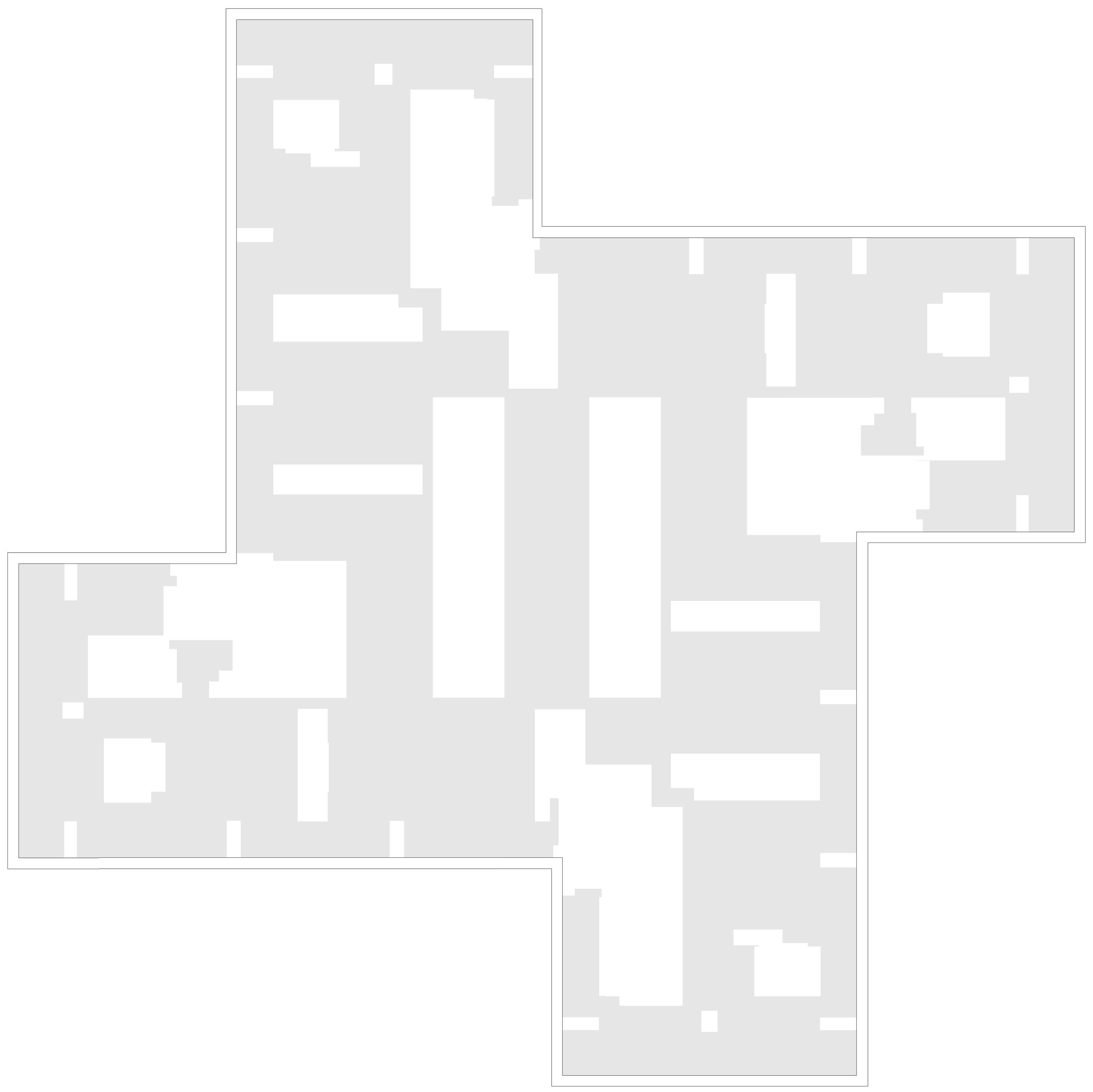
Hotel_Mixed-Use

Slab Areas to be Demolished

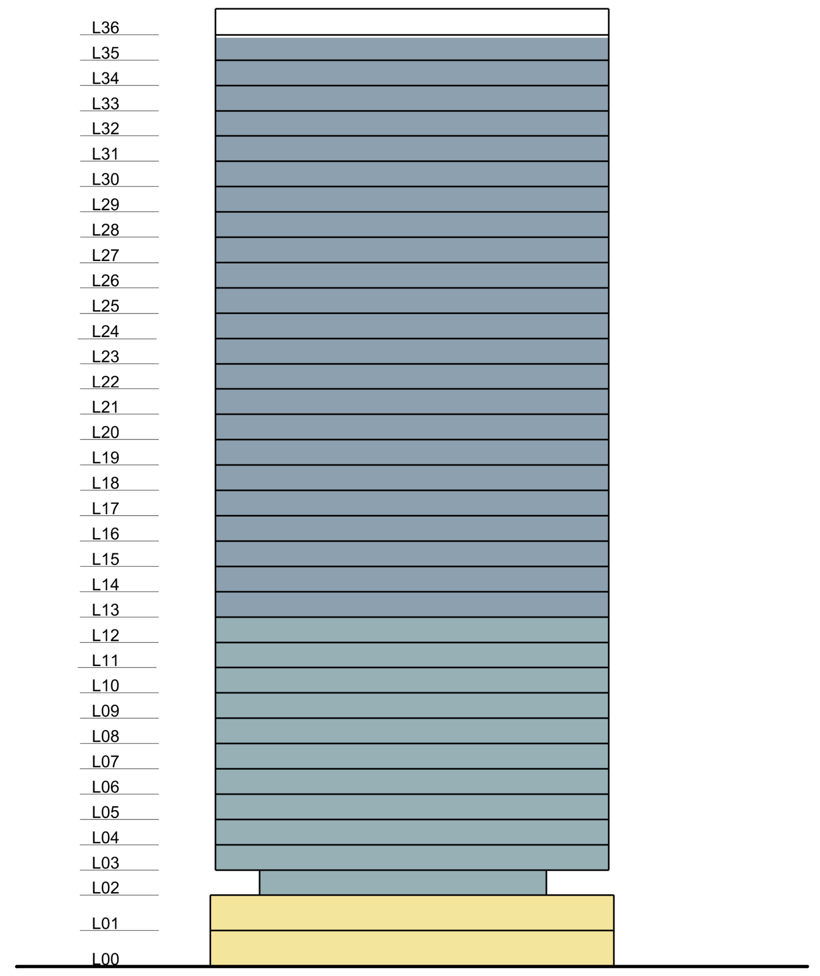


Hotel_Mixed-Use

Resultant Slab Areas Retained



Euston Tower



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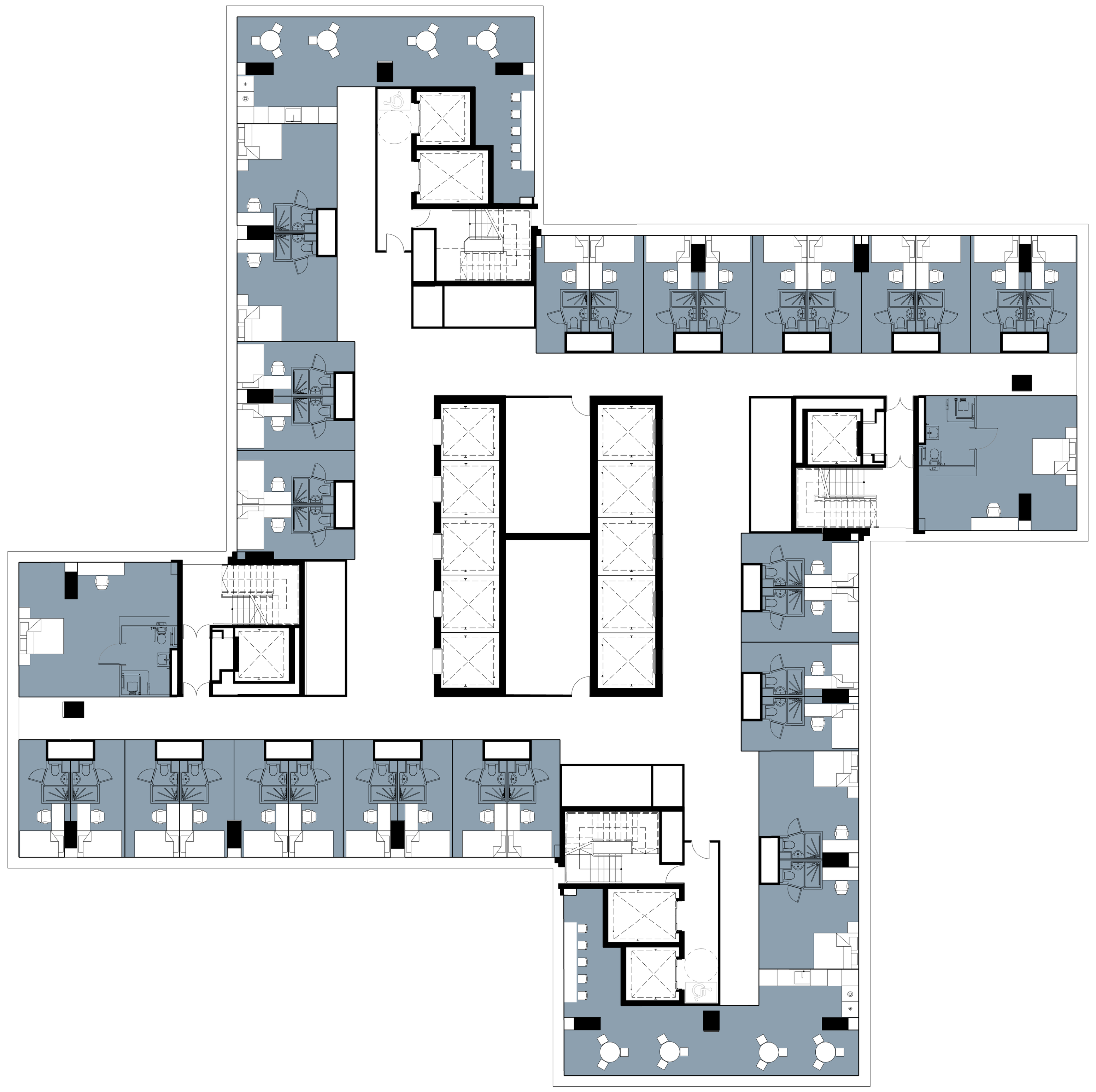

3xn

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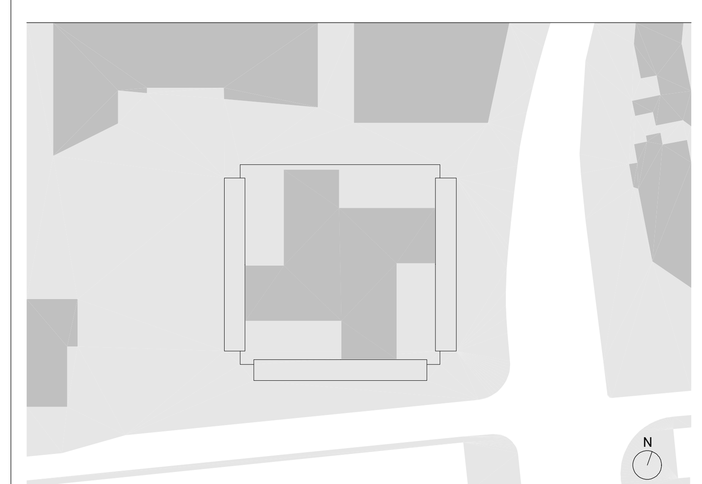
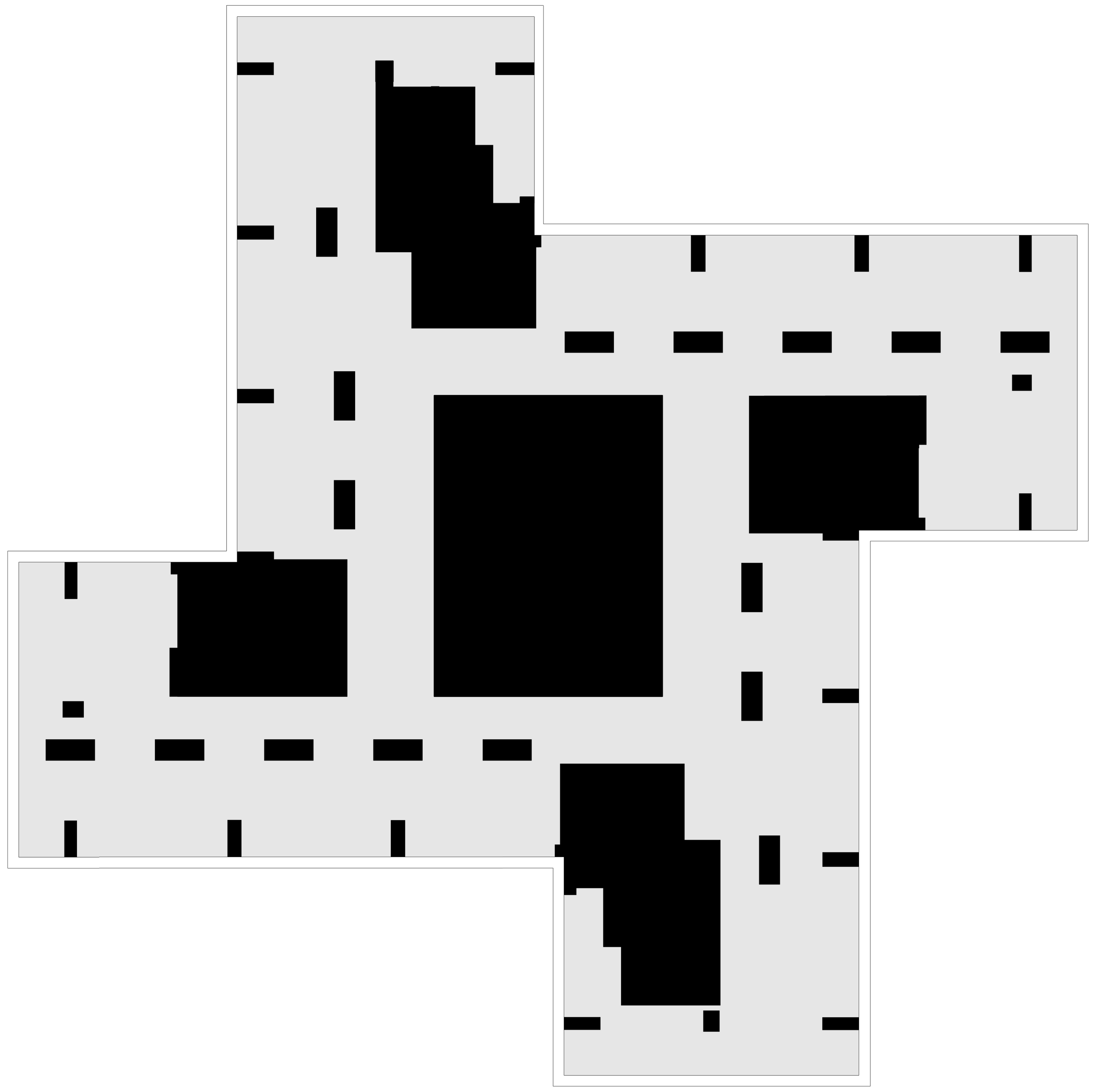


GRAPHIC SCALE	0 2M 4M 10M
SCALE	1 : 200 (A1)
AUTHOR	3XN
REVISION	-.
ISSUE DATE	N/A
DRAWING TITLE	**Plan - Typical Tower Level** Student Residential Test Fit-Out Mixed-Use Option
DRAWING NUMBER	N/A

Key
Residential
Student Housing
Hotel
Offices
Labs
Retail

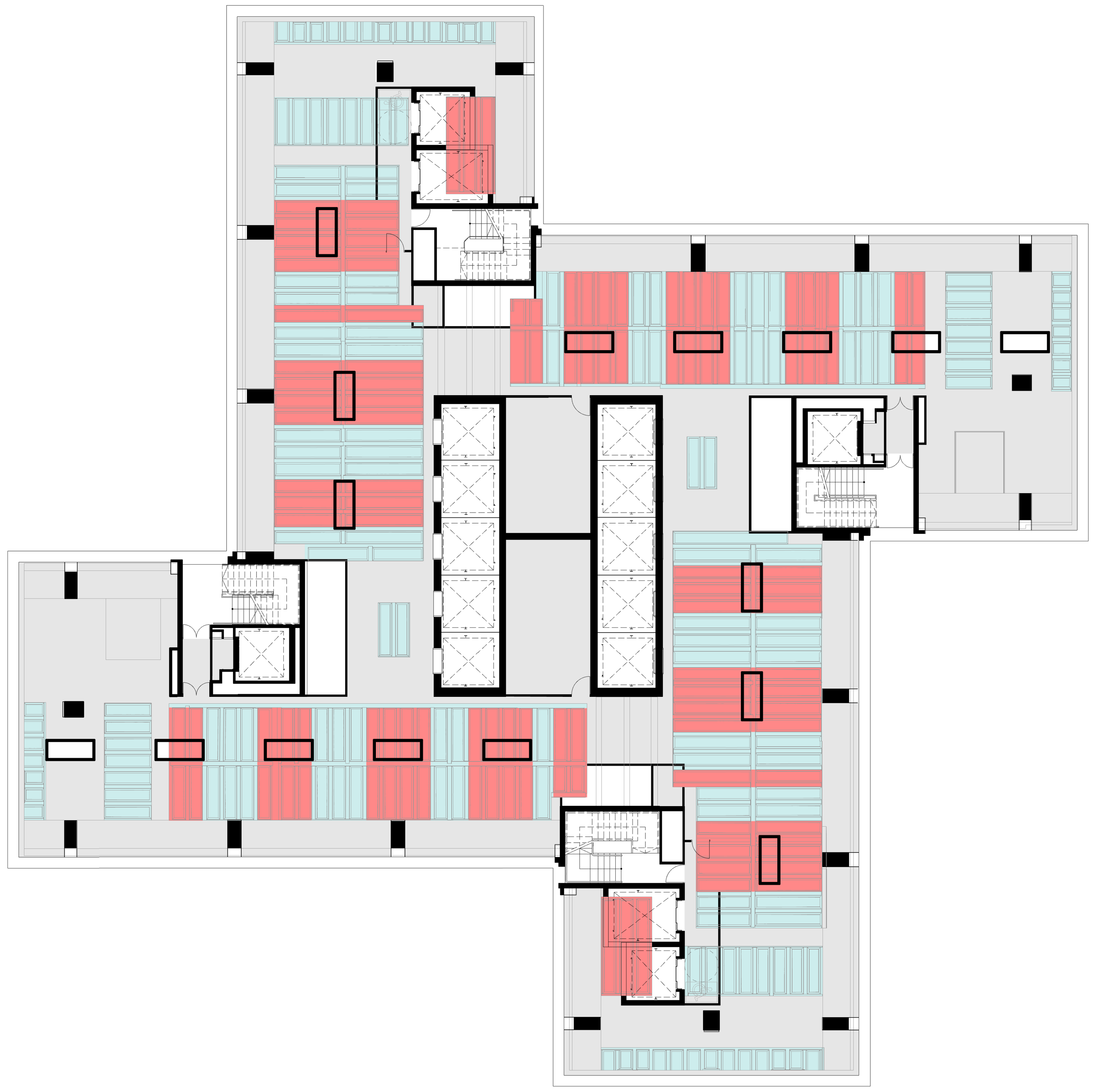
Student Housing_Mixed-Use

Floorplate Figure Ground



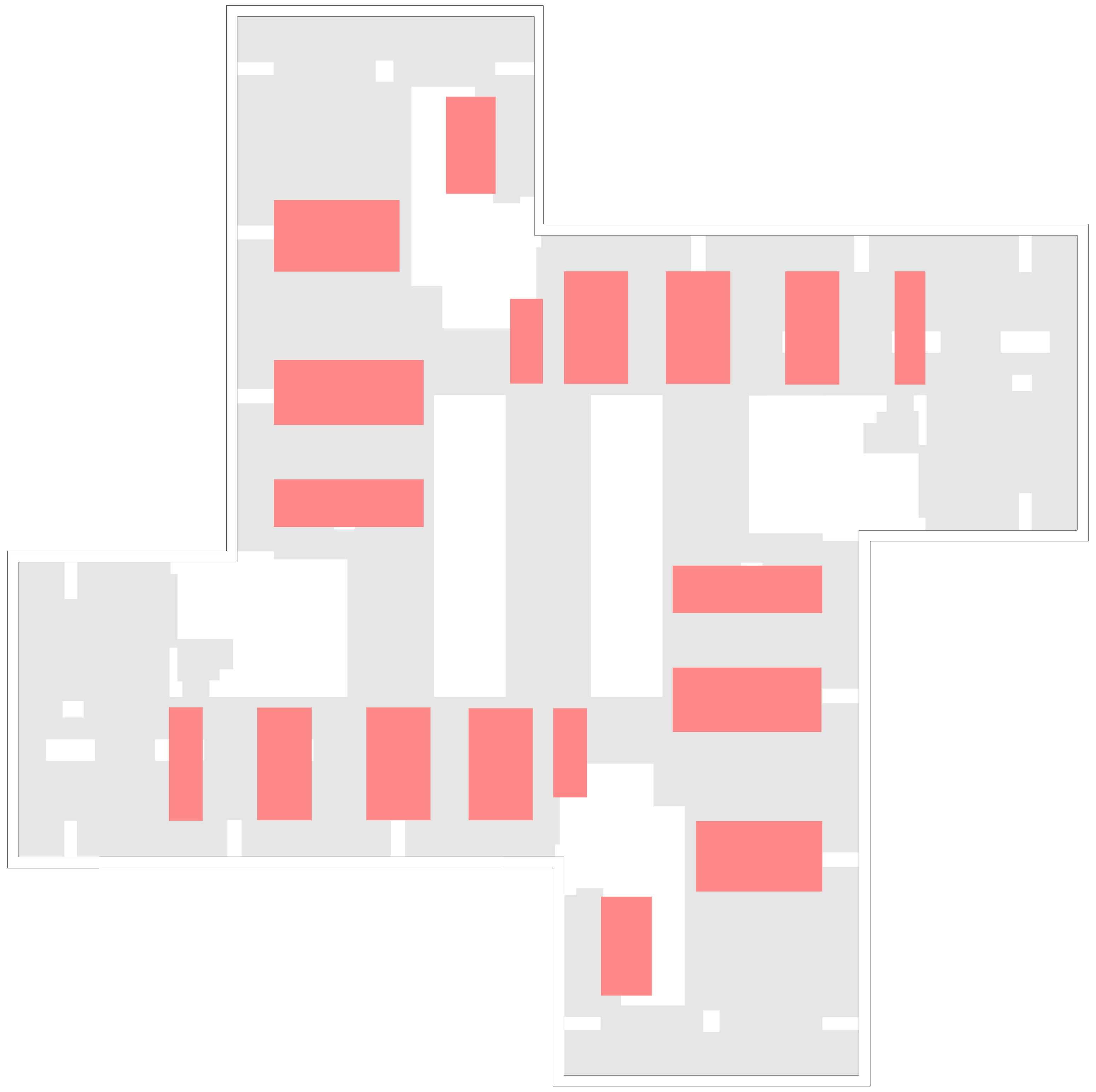
Student Housing_Mixed-Use

Impact on Existing Slabs



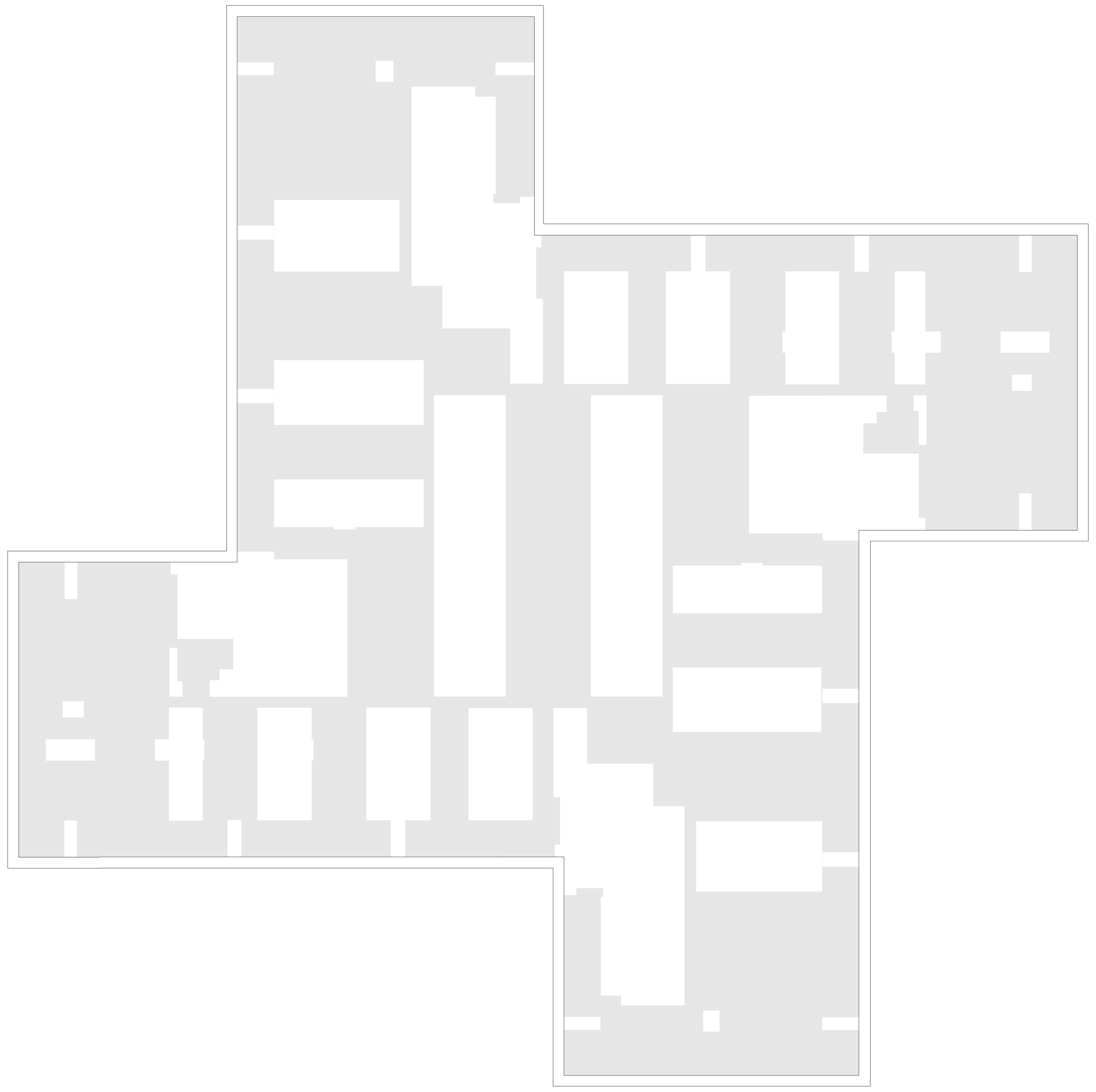
Student Housing_Mixed-Use

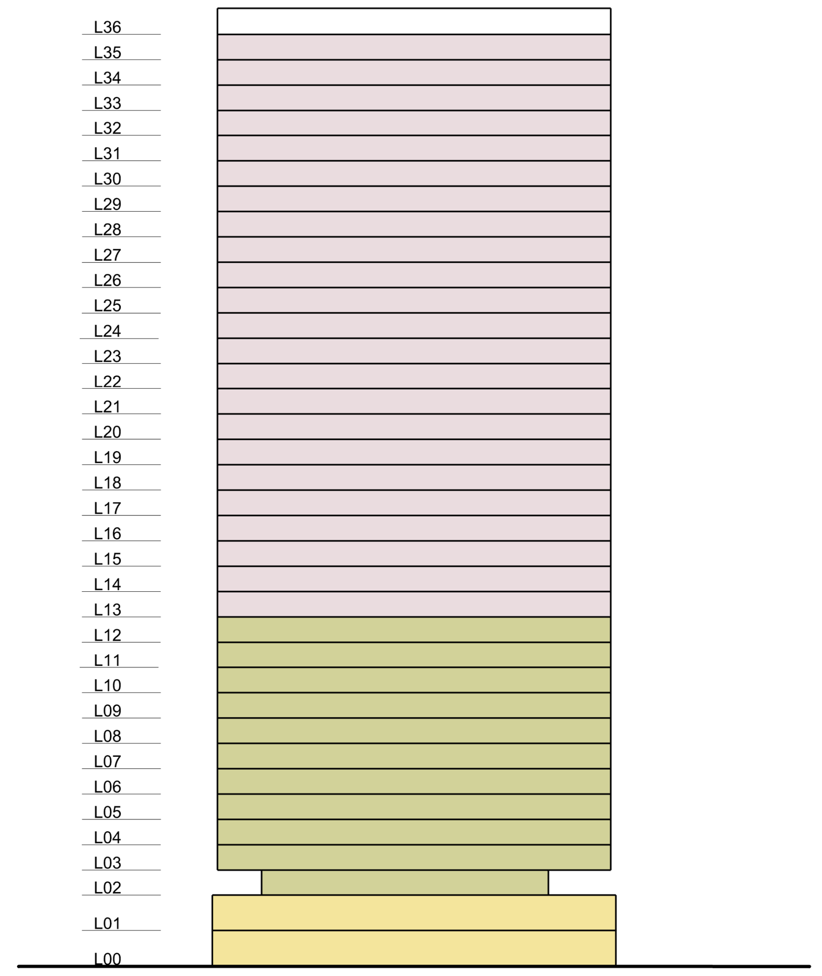
Slab Areas to be Demolished

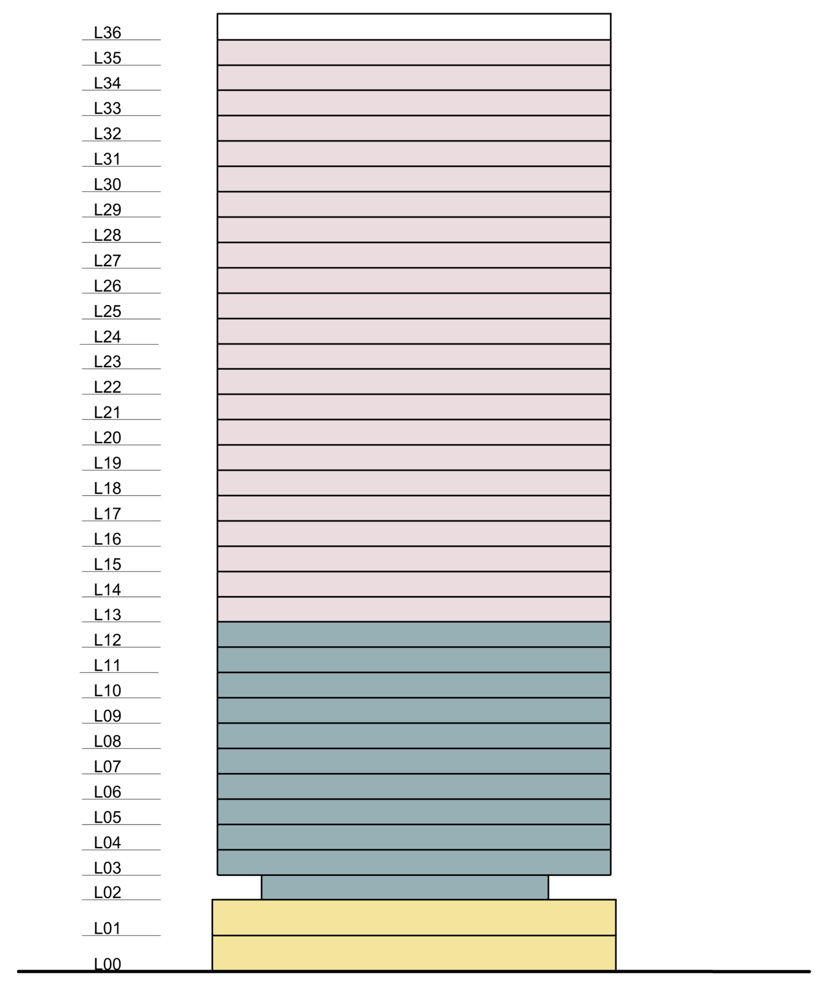


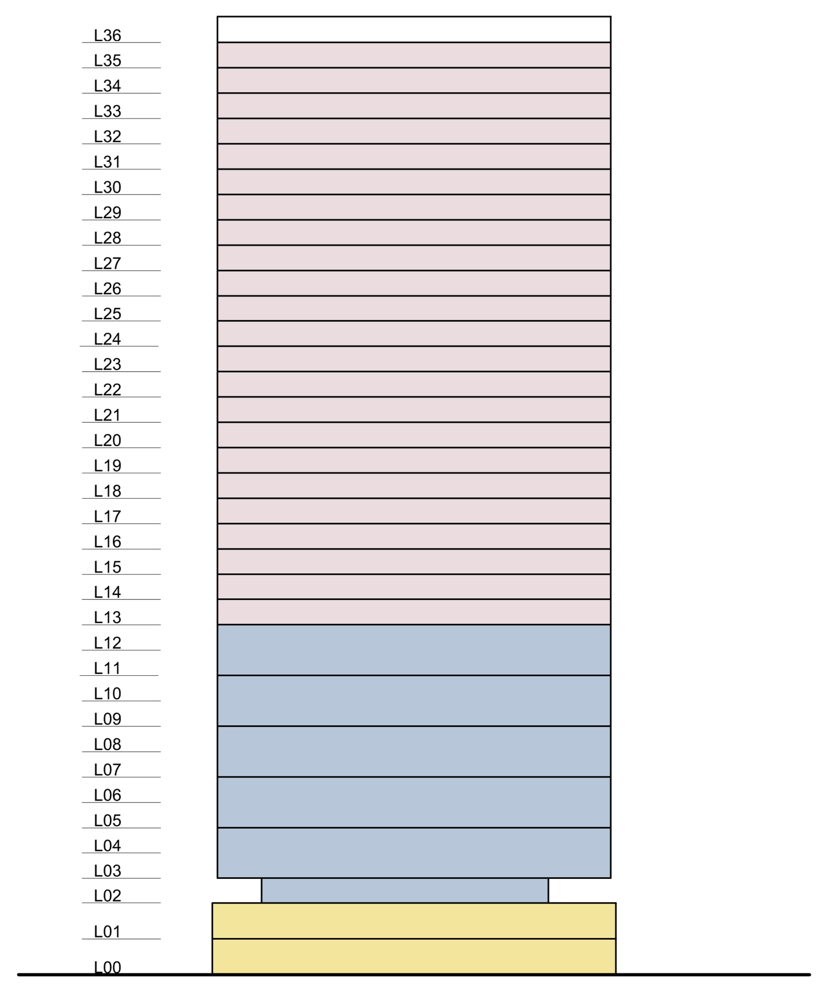
Student Housing_Mixed-Use

Resultant Slab Areas Retained









Key
- Residential
- Student Housing
- Hotel
- Offices
- Labs
- Retail

Euston Tower

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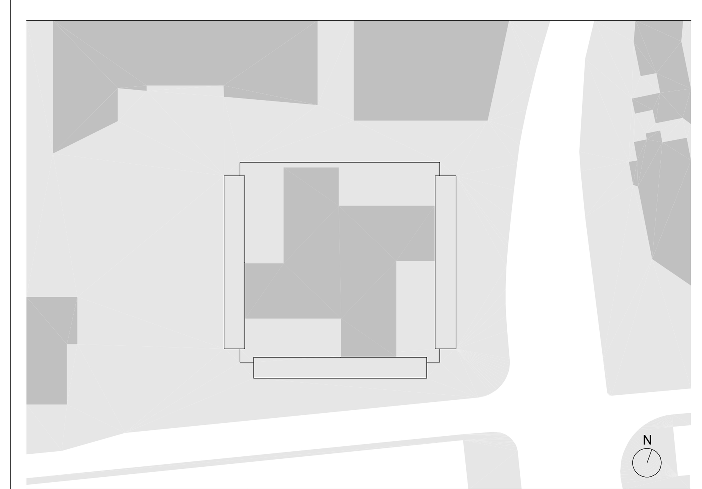
	York House 45, Seymour Street, London. W1H 7LX
	info@britishland.com / Tel: +44 20 7486 4466



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REVISION	-
ISSUE DATE	N/A
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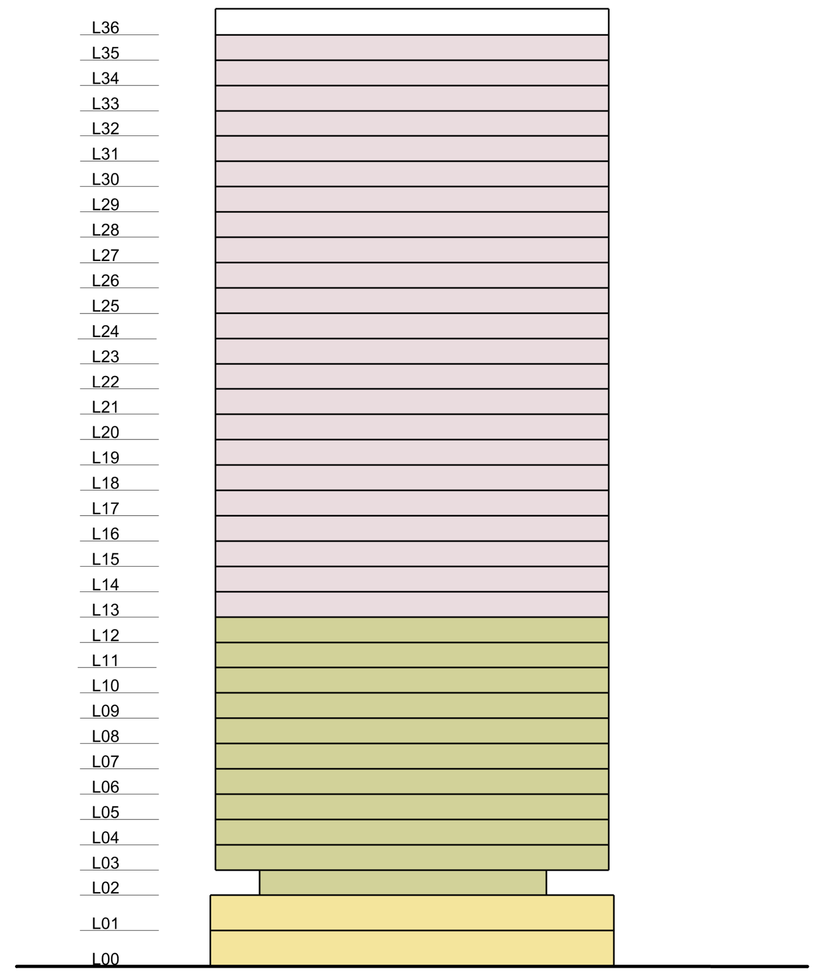
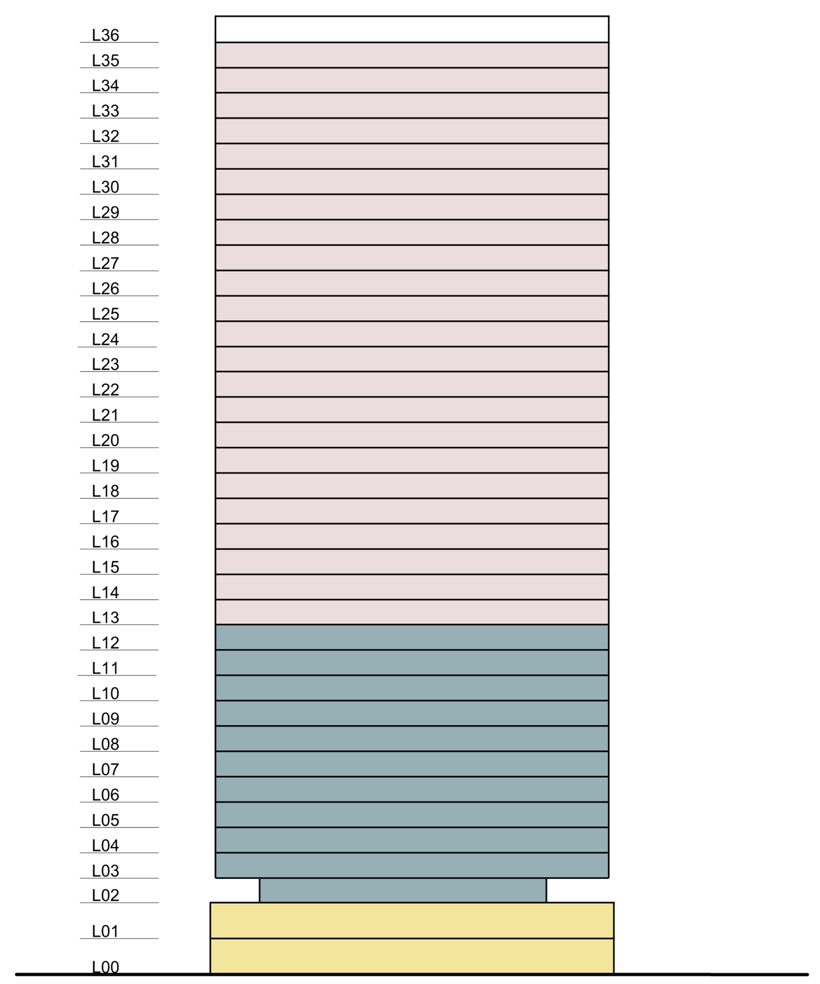
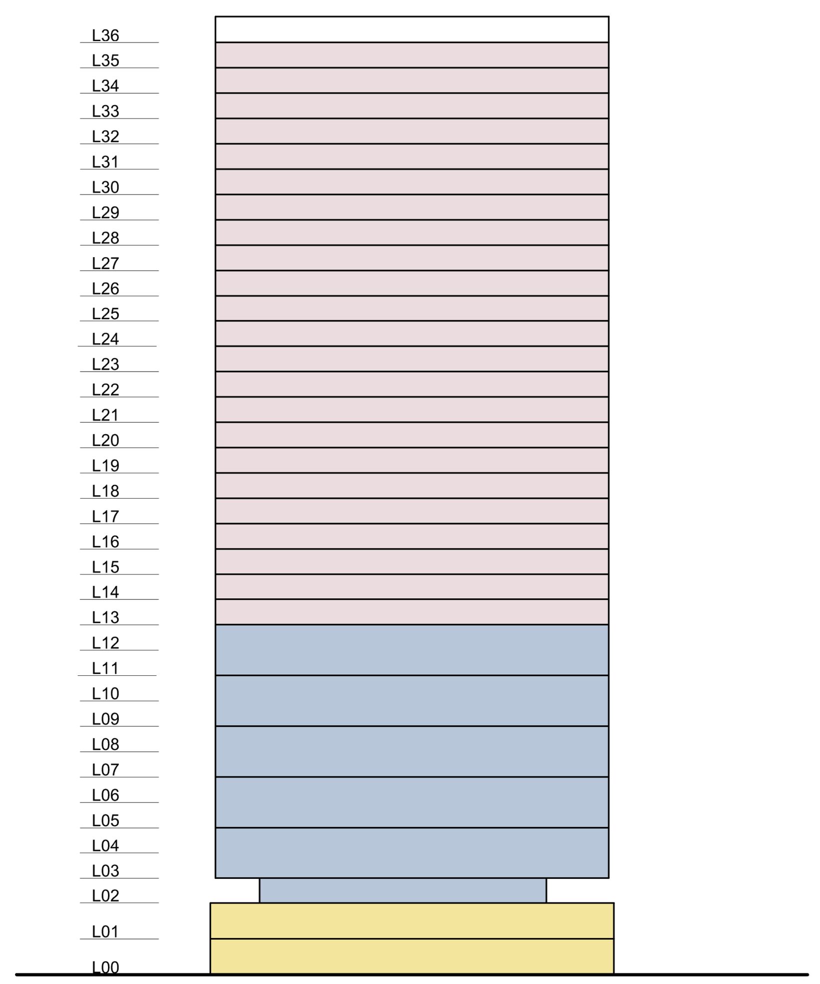
DRAWING NUMBER	N/A







Key
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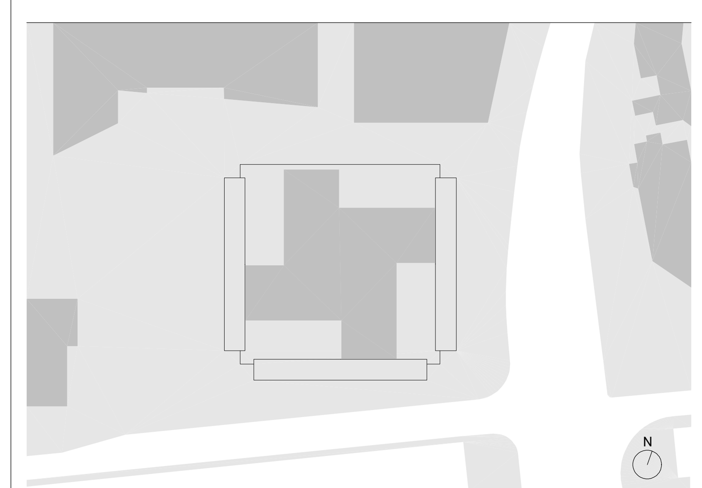

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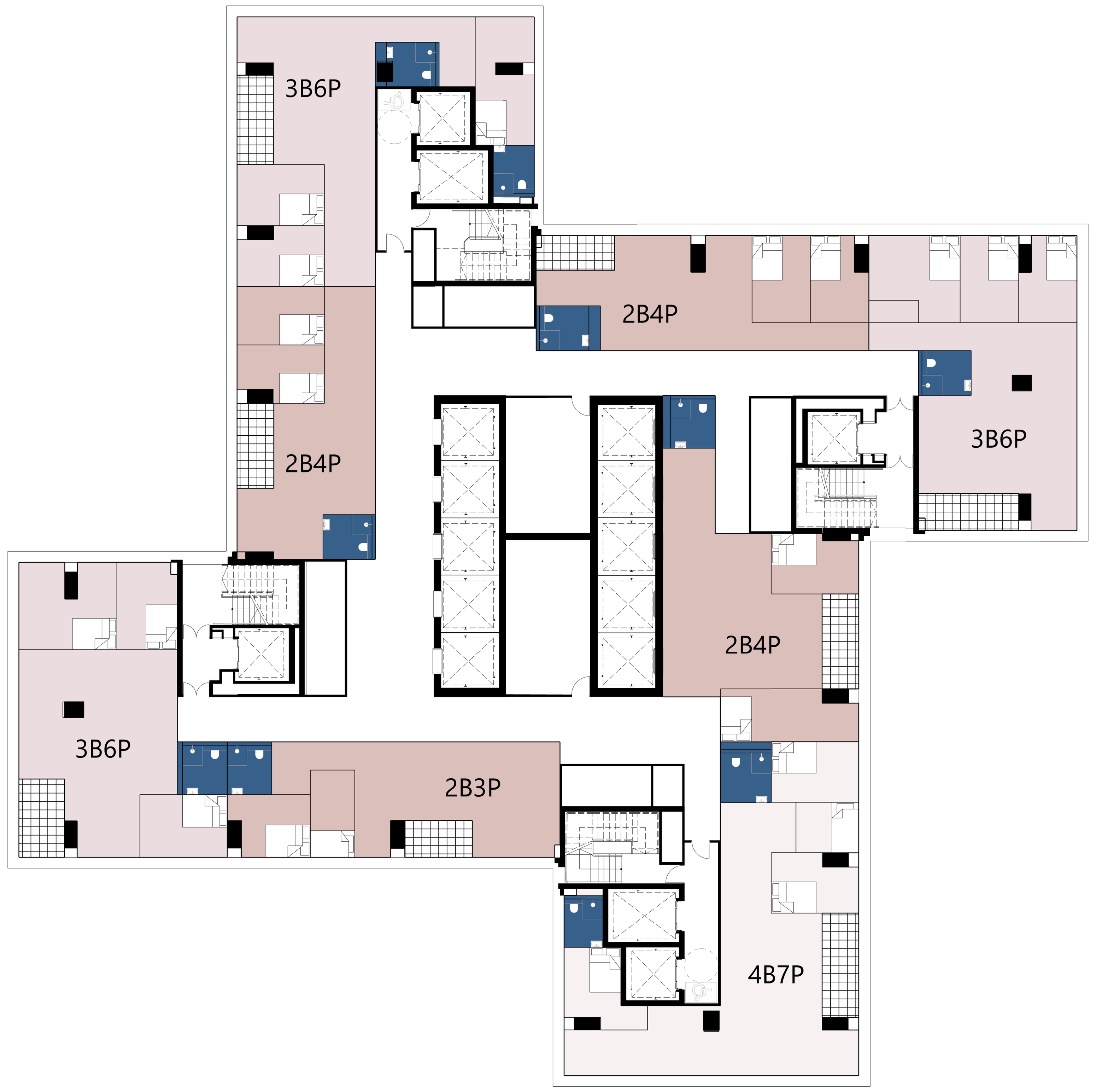

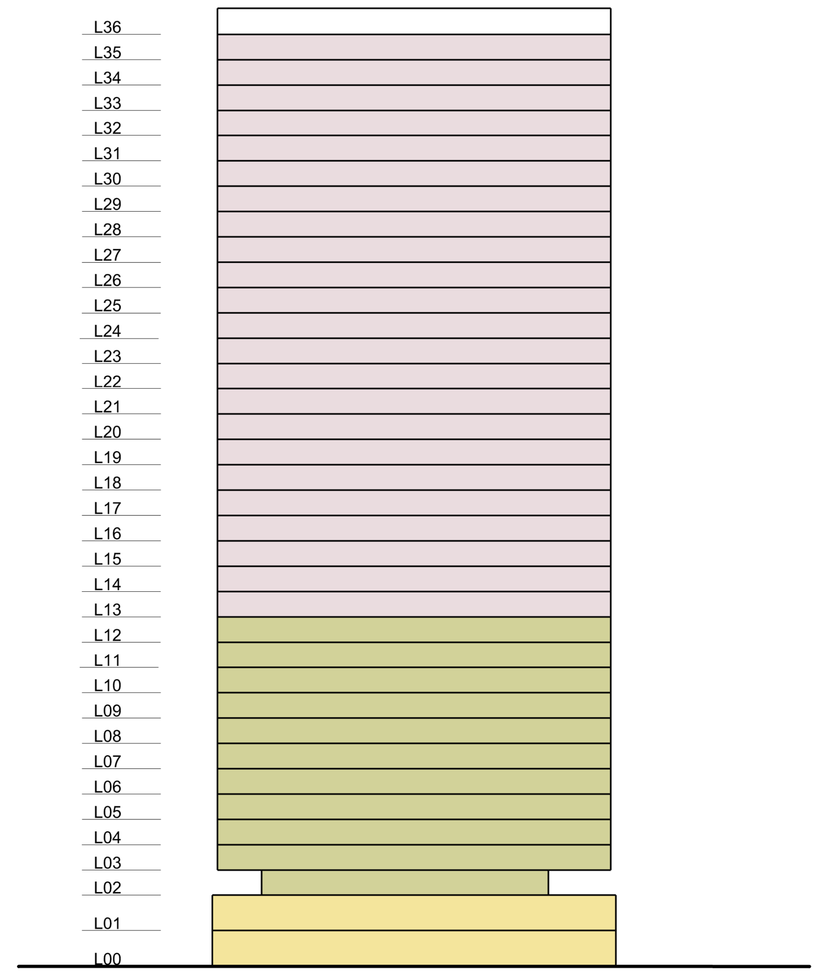

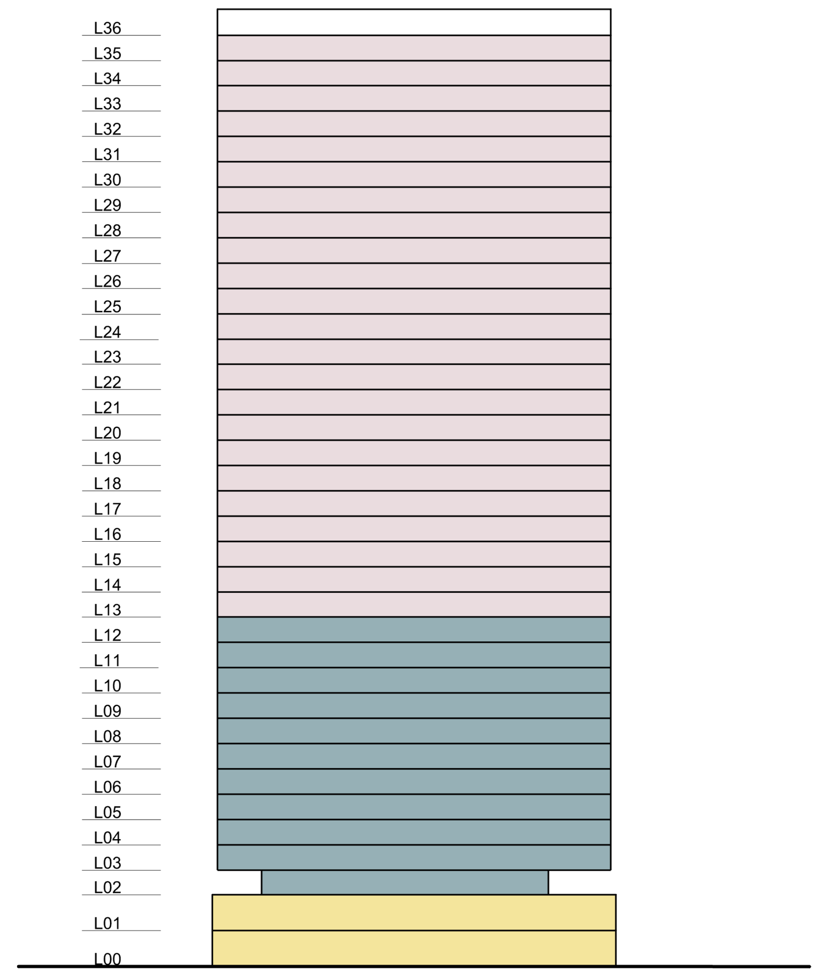

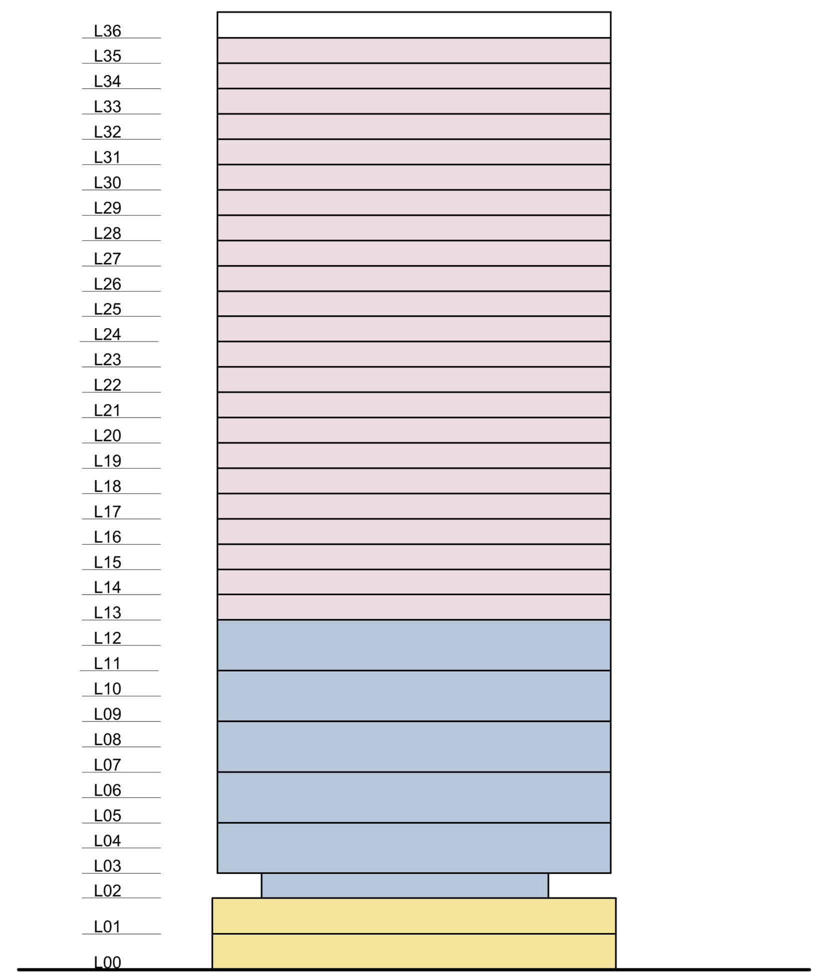

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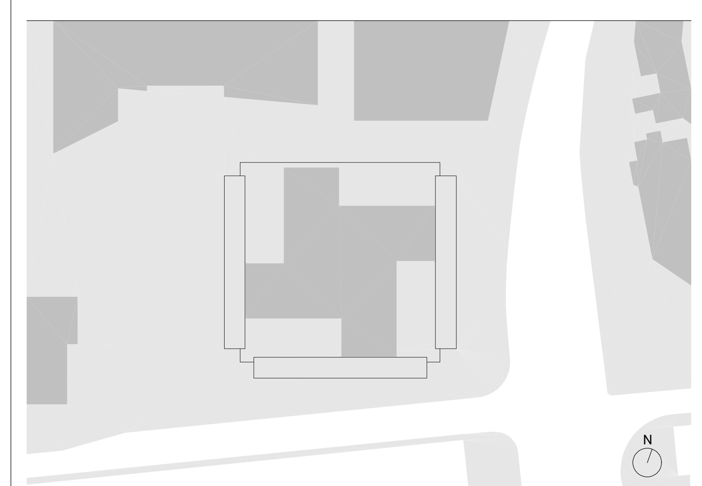

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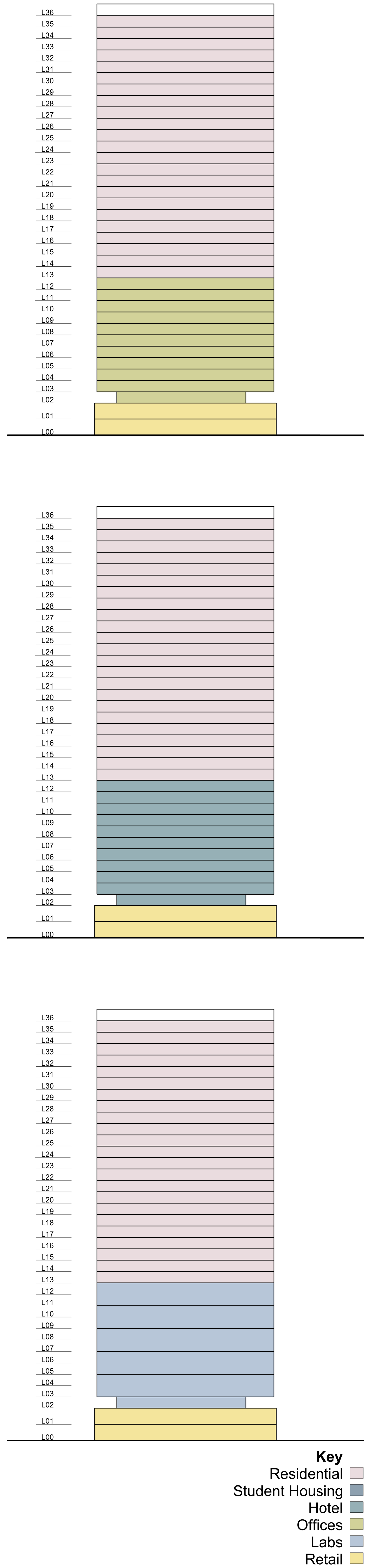

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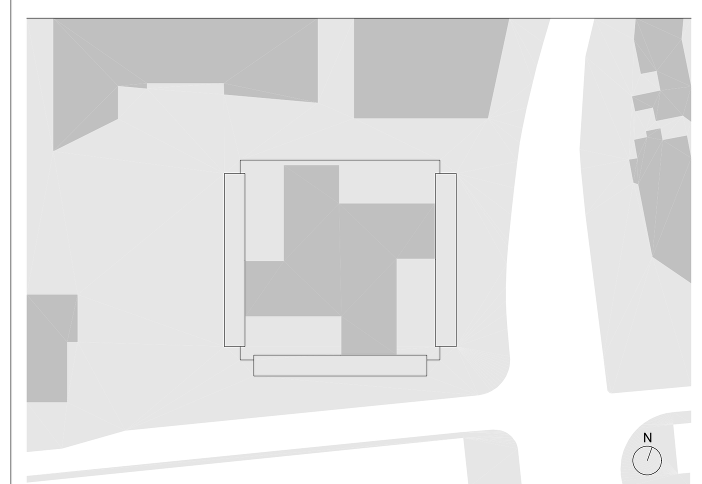

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Residential_Mixed-Use

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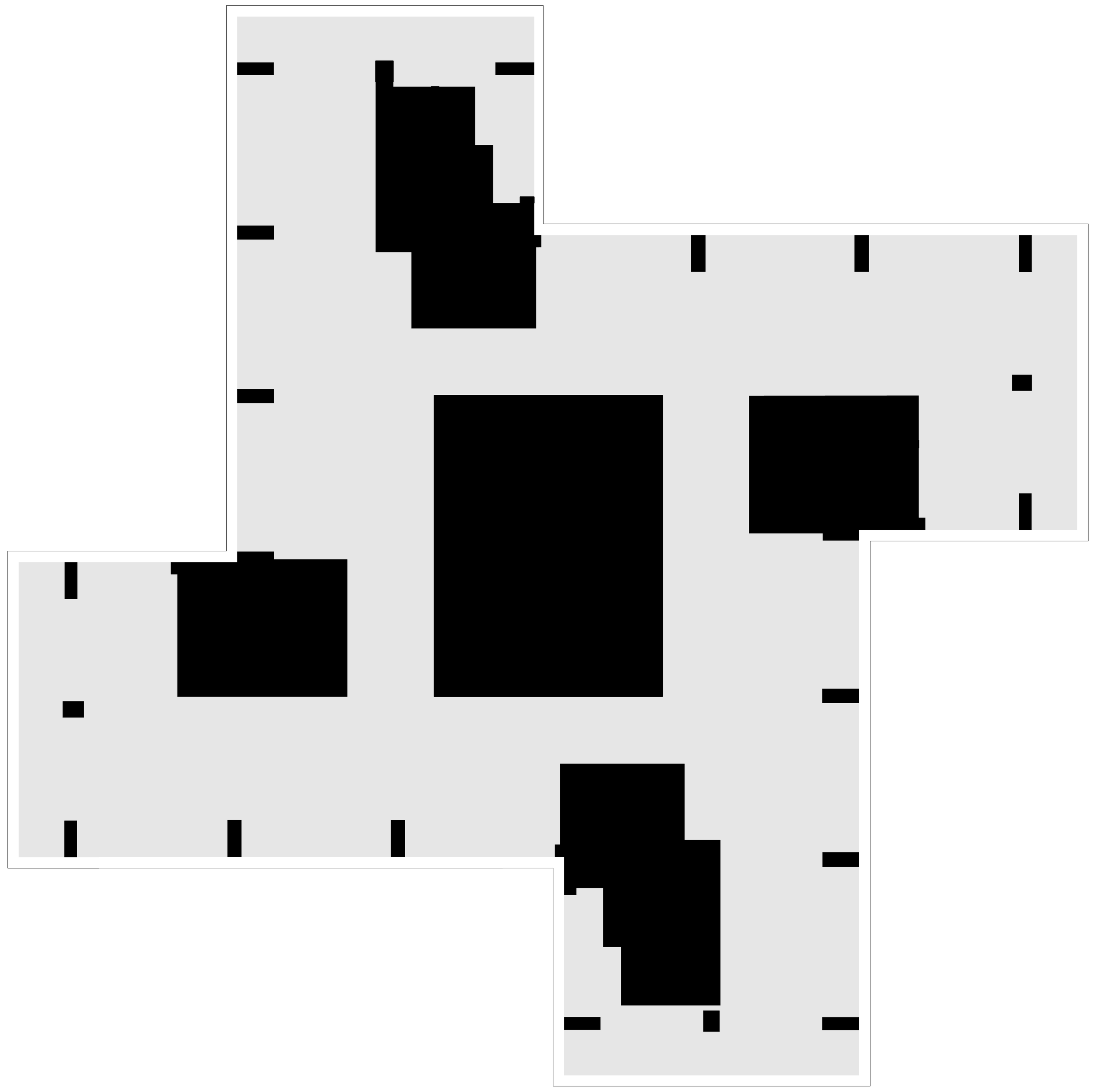

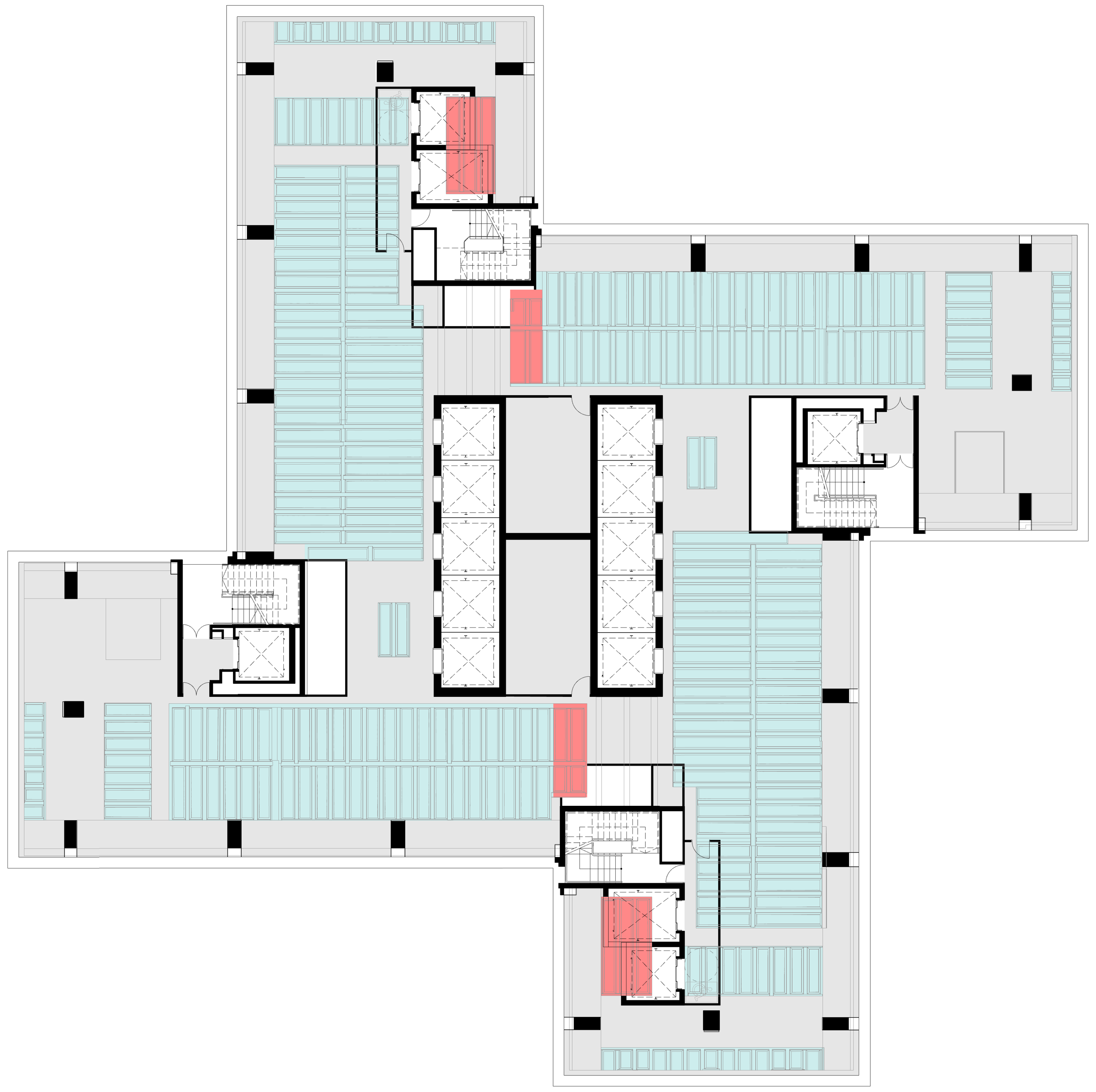

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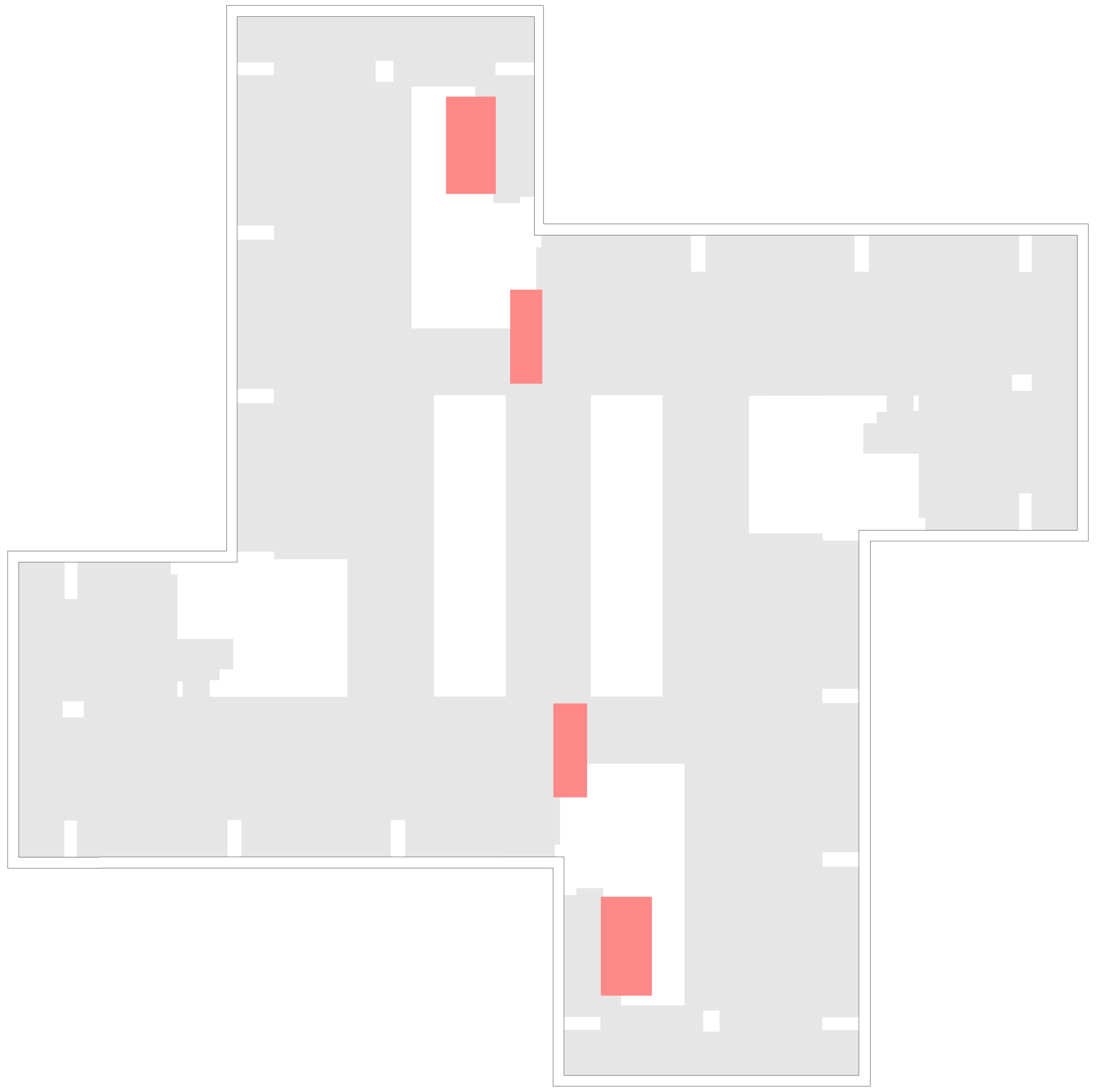
Slab Areas to be Demolished



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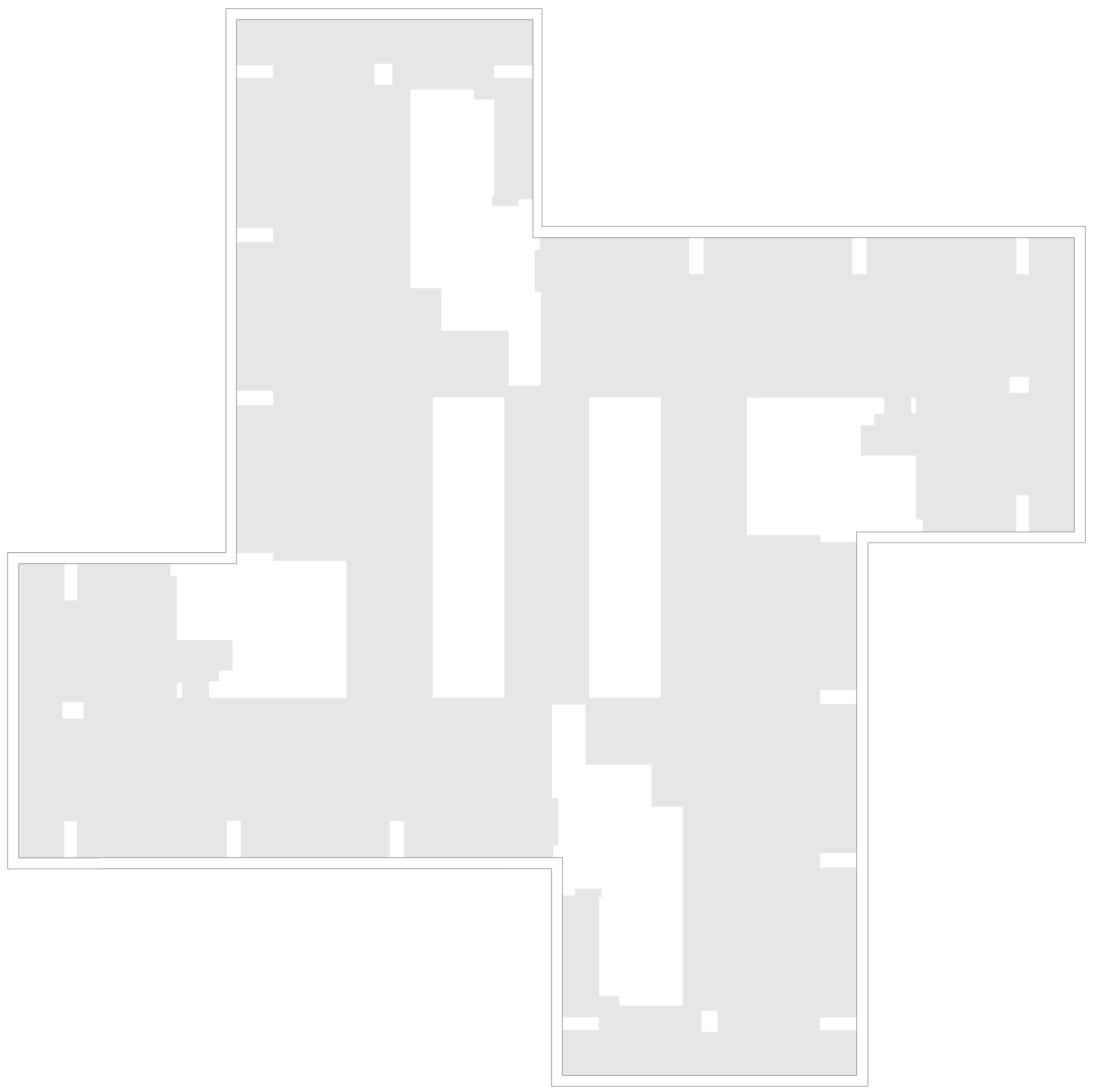
Resultant Slab Areas Retained



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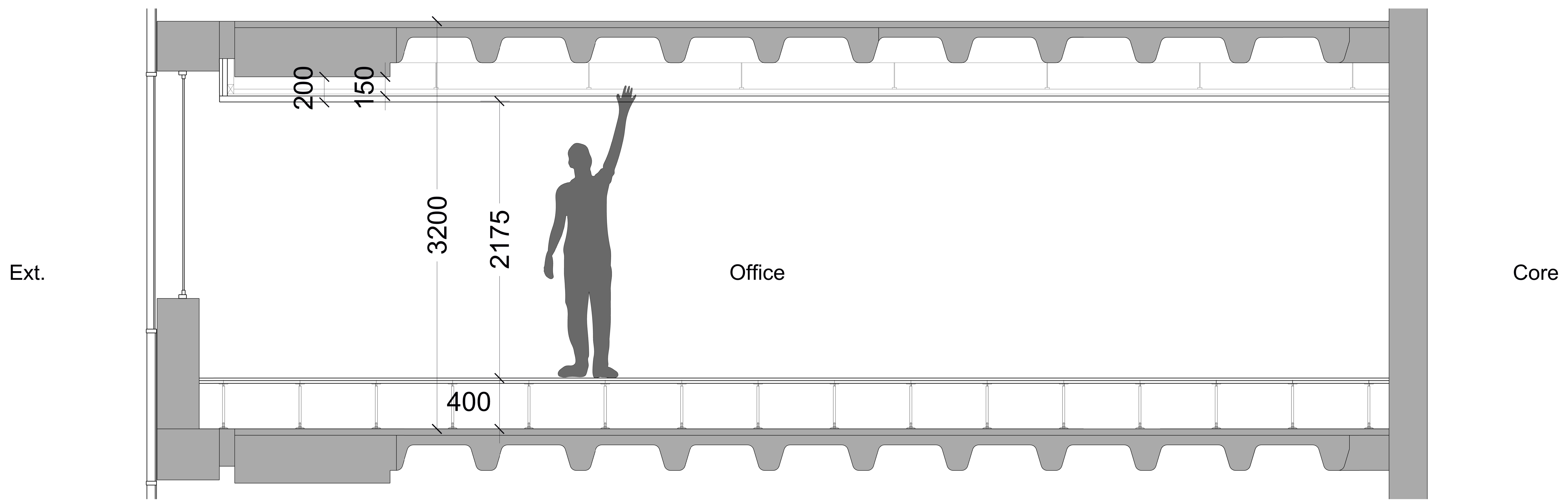

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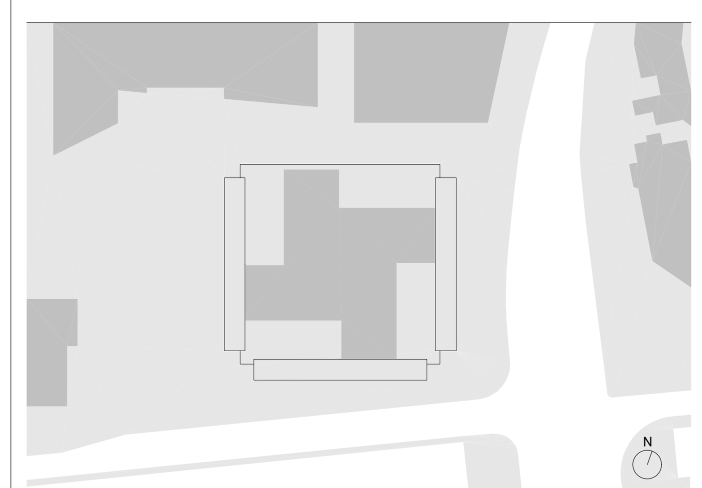

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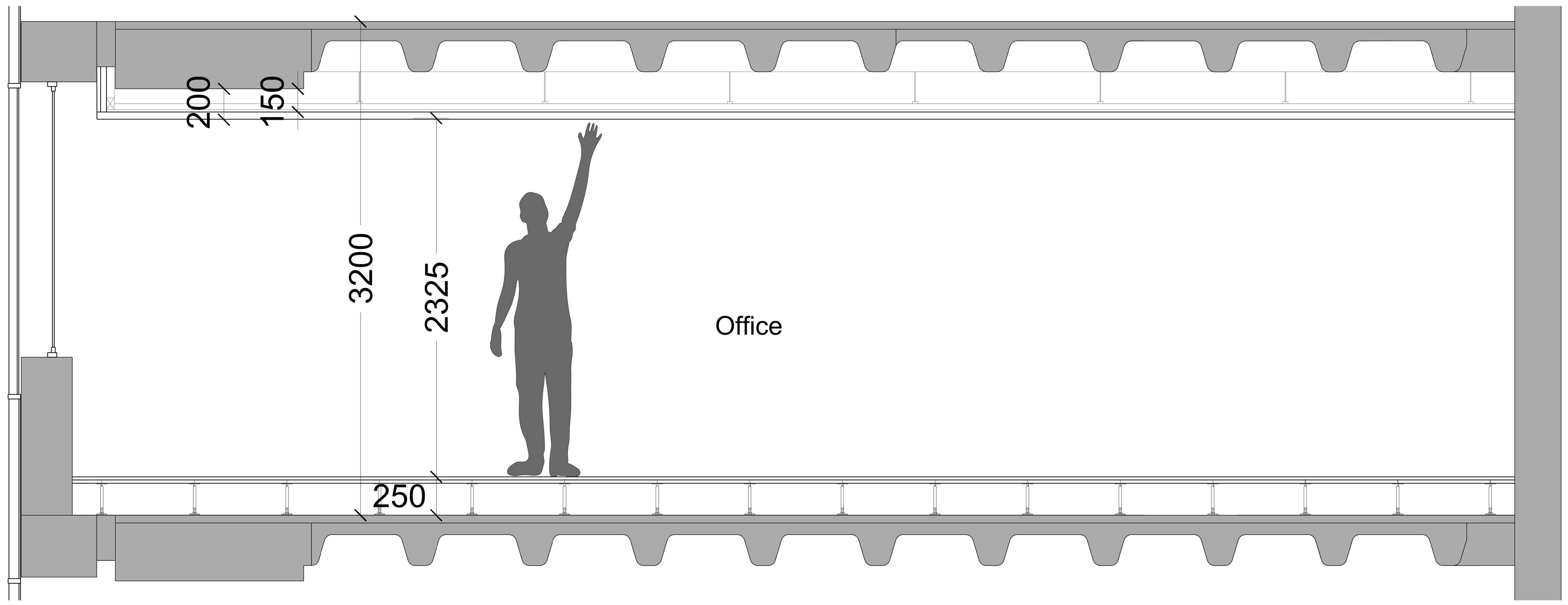
DRAWING TITLE	**Section - Typical Tower Level** Offices - 2AHUs Option
DRAWING NUMBER	N/A



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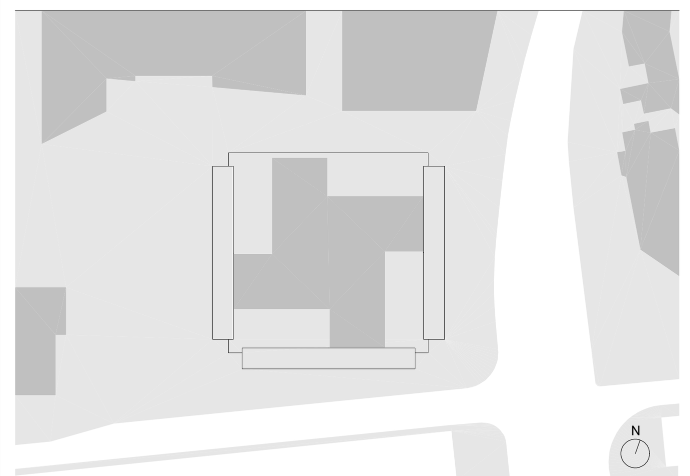

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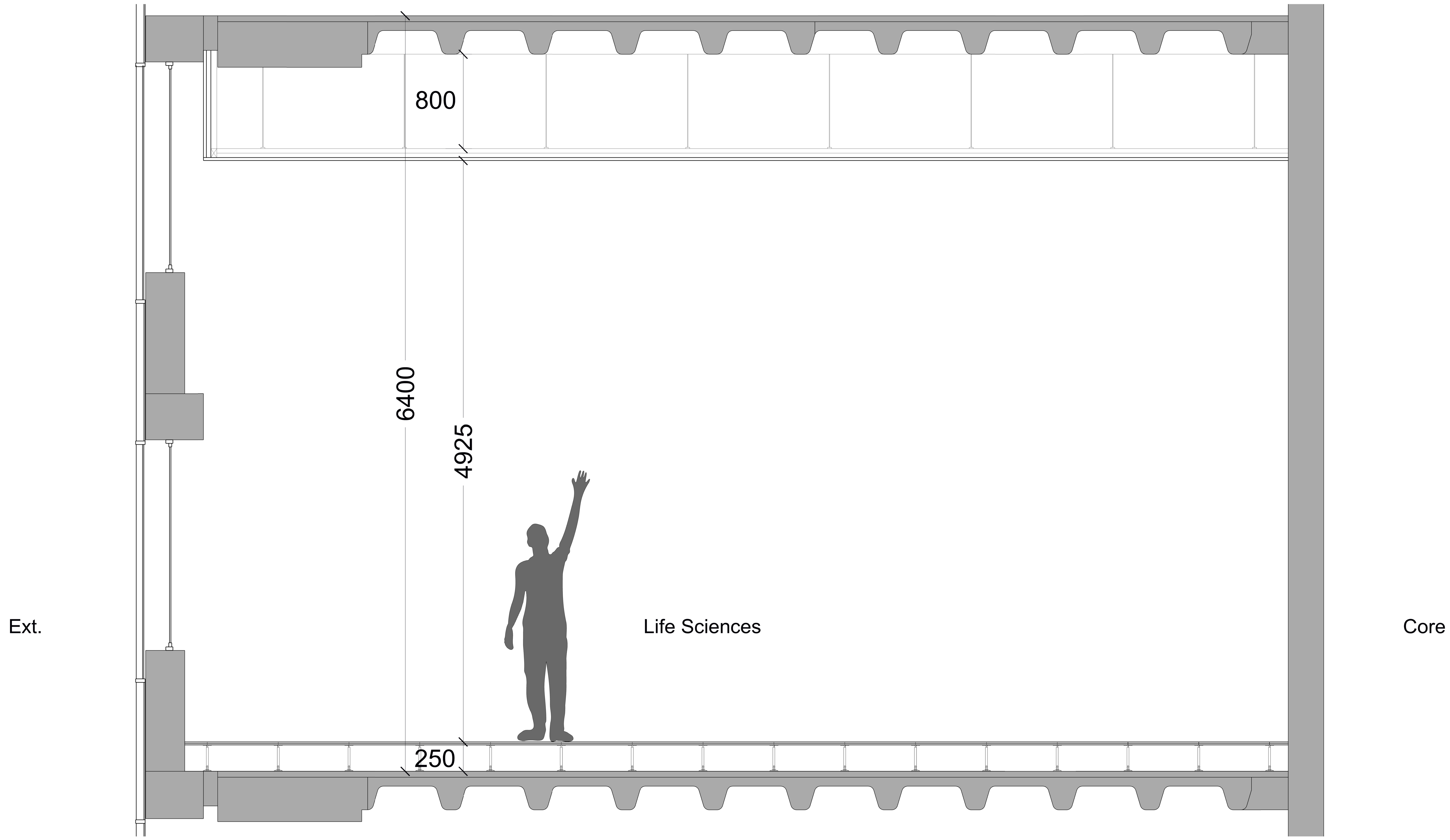

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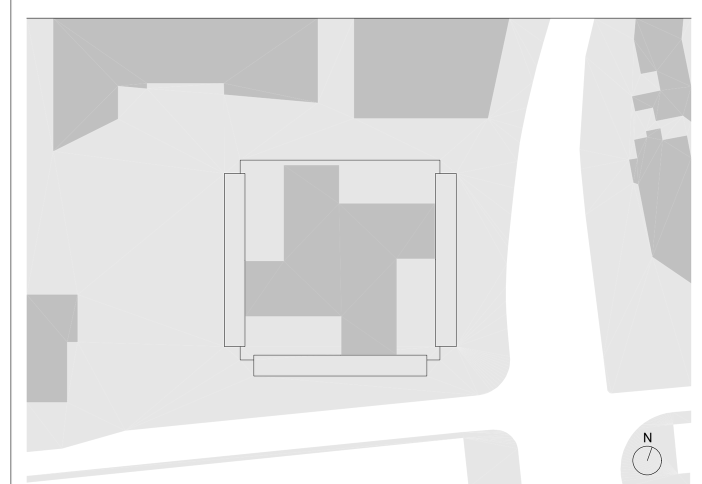

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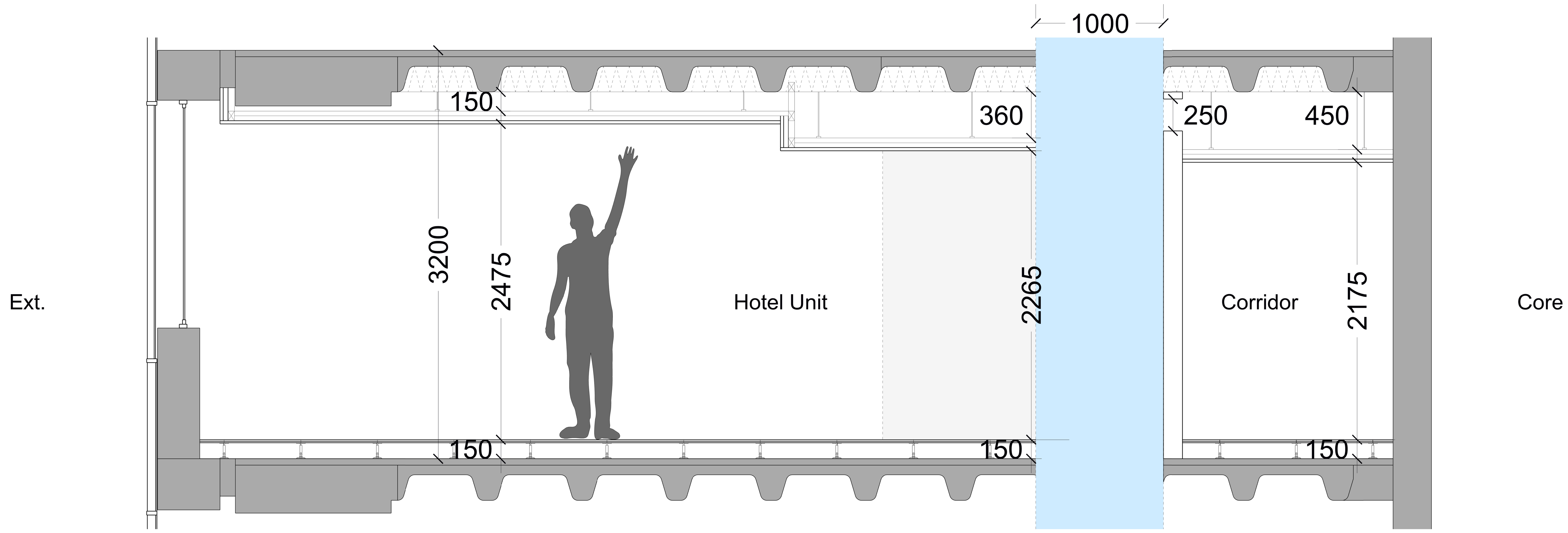

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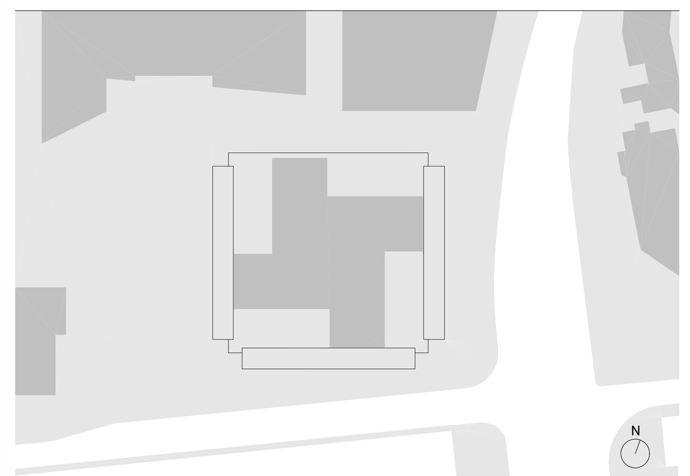

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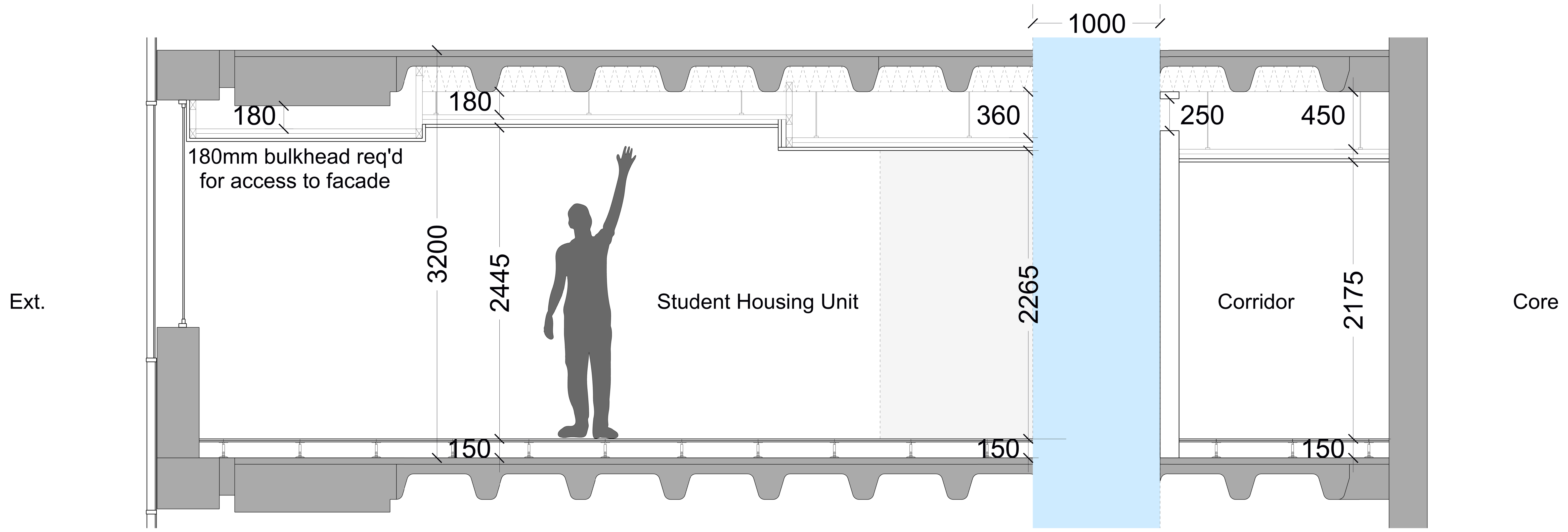

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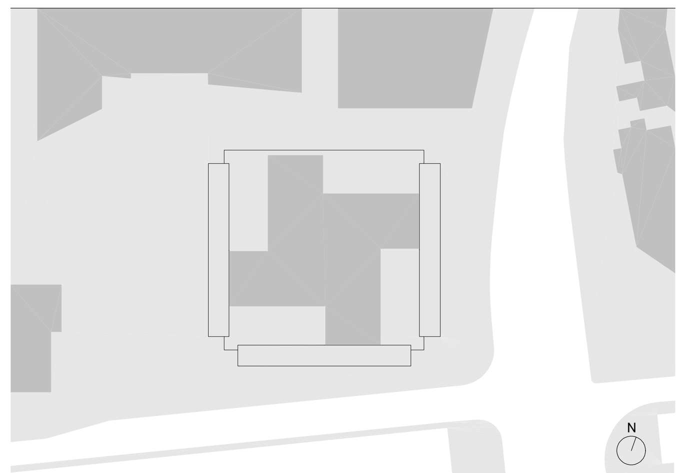

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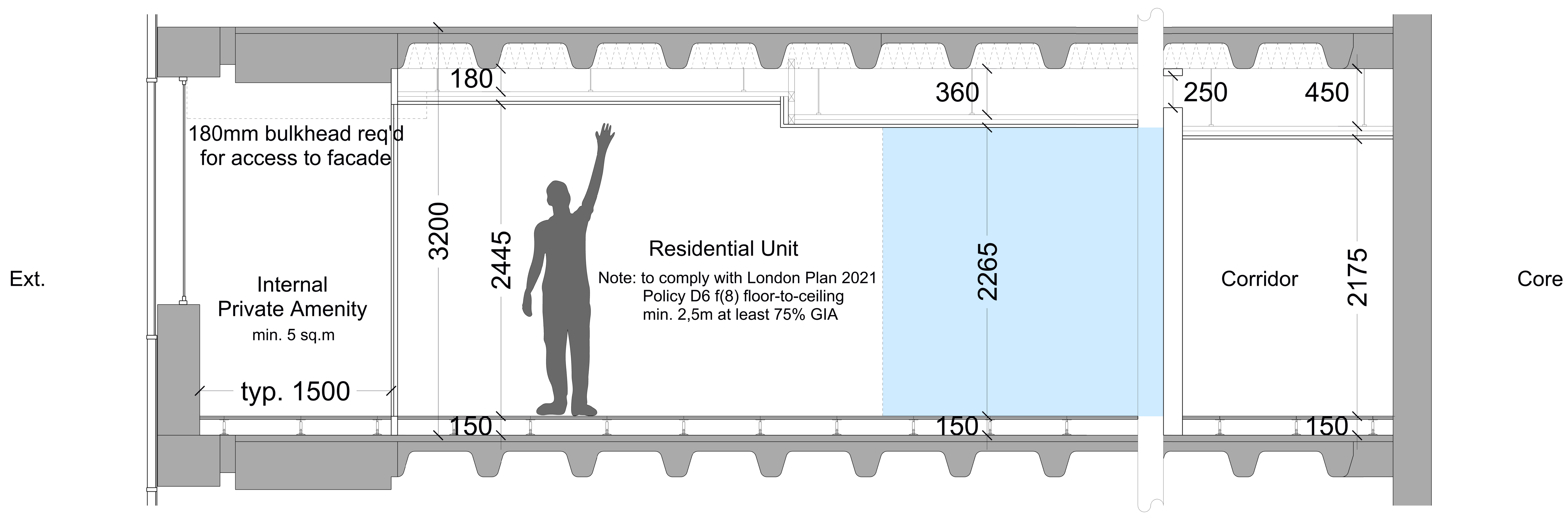

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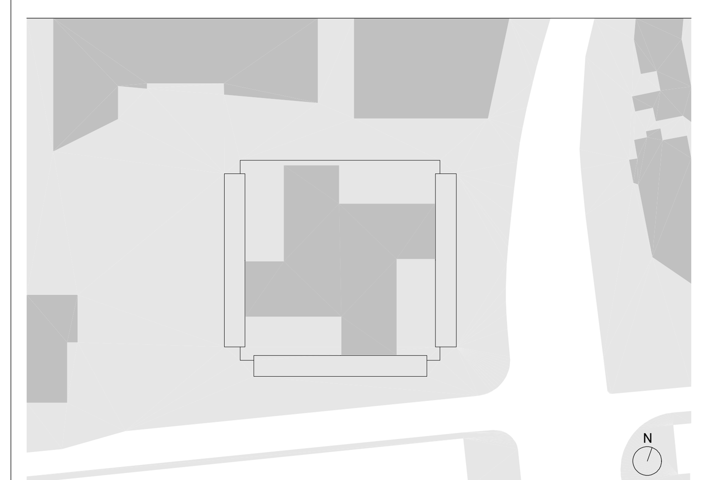

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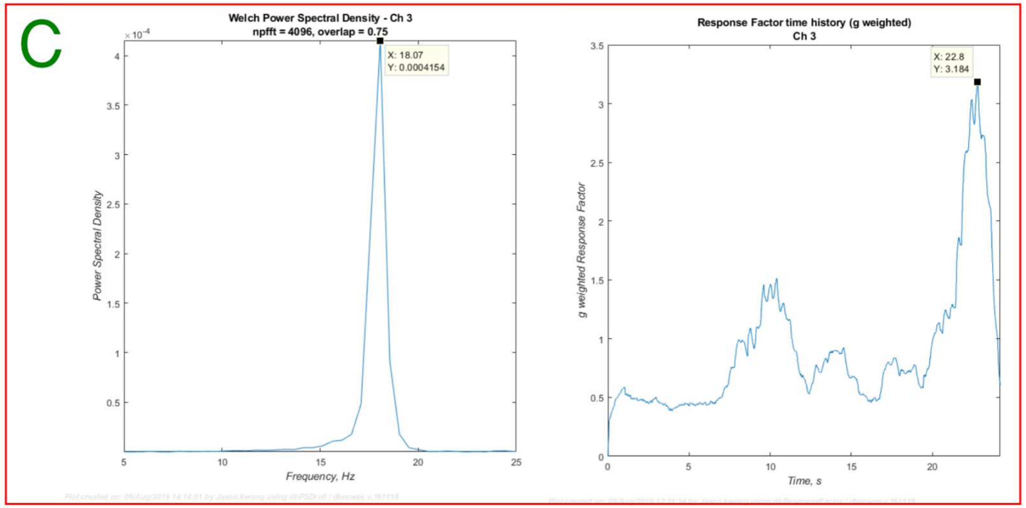
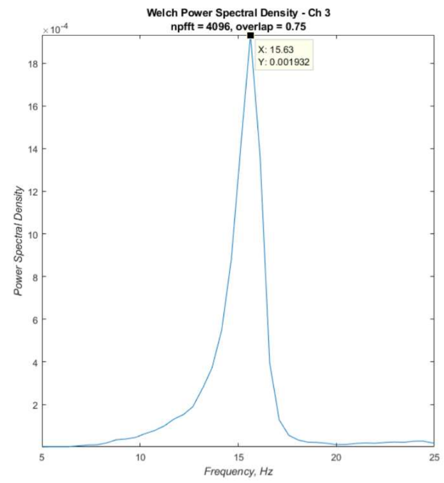


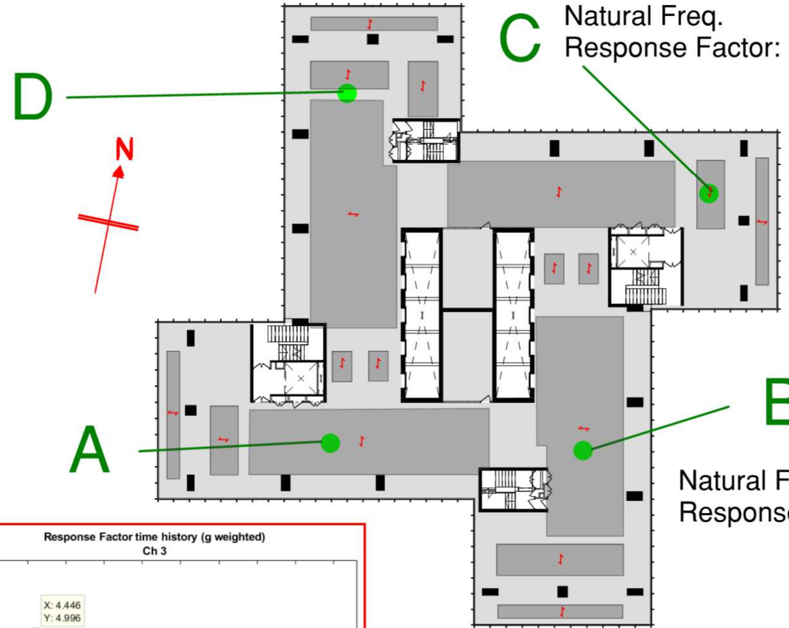


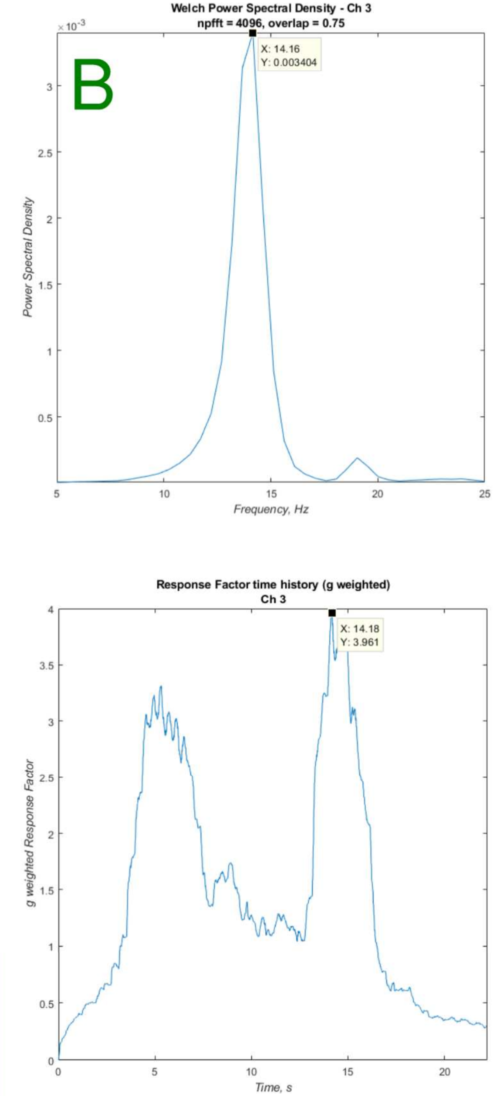
D

Natural Freq. 15.6 Hz
Response Factor: Not tested

C

Natural Freq. 18.1 Hz
Response Factor: 1.0 to 3.2



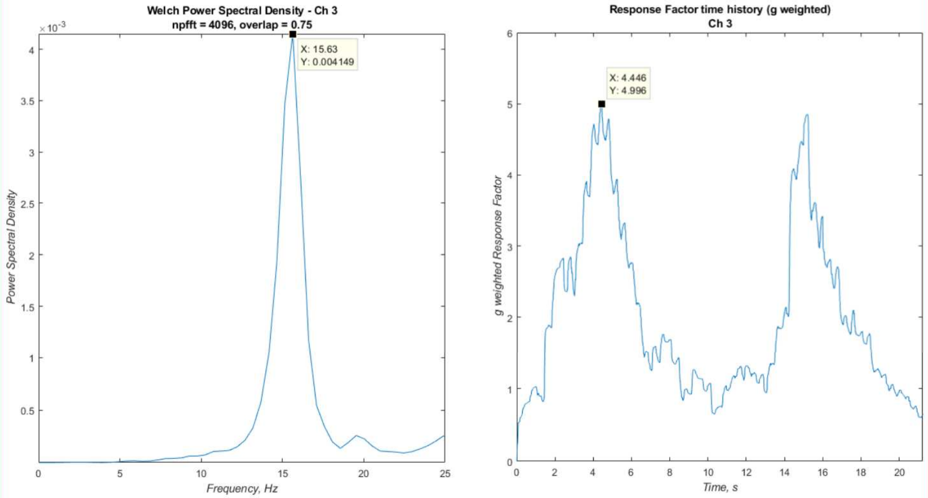


A

Natural Freq. 15.6 Hz
Response Factor: 3.3 to 5.0

B

Natural Freq. 14.2 Hz
Response Factor: 1.5 to 4.0



Accelerometers were set-up at 4 locations: A to D.

Natural frequencies were determined by Power Spectral Densities of heel drops.

Response factors were calculated with walk-bys at 4 frequencies:
1.8, 2.0, 2.2, and 2.5 Hz.

British Land

Euston Tower

Air quality monitoring report

REP/01

Draft 1 | 30 March 2020

Draft

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 274365-99

Ove Arup & Partners Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

ARUP

Document verification

ARUP

Job title		Euston Tower		**Job number** 274365-99	
Document title		Air quality monitoring report		**File reference**	
Document ref		REP/01			
Revision	**Date**	**Filename**	Euston Tower Analysis Report.docx		
Draft 1	30 Mar 2020	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Rosie Davies Angie Chan	Emma Gibbons	Michael Bull
		Signature	[signature]	[signature]	[signature]
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
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			Prepared by	Checked by	Approved by
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		Name			
		Signature			

Issue Document verification with document ✓

Draft

Contents

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1 Introduction

Ove Arup and Partners Limited (Arup) has been commissioned by British Land to undertake an air quality monitoring survey to inform the refurbishment of Euston Tower at Euston Road in the London Brough of Camden (LBC). It is hereafter referred as the 'Development' to describe the proposal or the 'Site' to describe the site boundary.

The Site is bordered by the A501 (Euston Road) to the south and A400 (Hampstead Road) to the east. The location of the Site is shown in Figure 1.

The existing building is currently operational and entirely mechanically ventilated. There are air-handling plants at level 12 and roof level. Openable windows are installed in the existing building to provide emergency ventilation when the air-conditioning plant on-site is out of service.

The Development is currently at RIBA Stage 1 and is seeking the feasibility of implementing natural ventilation within the building. The air quality around the Site is of concern for natural ventilation, and therefore monitoring has been carried out to determine concentrations of nitrogen dioxide (NO_2), the main pollutant of concern in the area. The monitoring survey covers areas in and around the Site as well as different heights from ground to roof level at Euston Tower.

The monitoring survey commenced in September 2019 and concentrations of NO_2 have been measured on a monthly basis. This report provides the analysis of the monitoring data for the 6-month survey from September 2019 to February 2020.

This report is structured as follows:

- Section 2: an overview of the relevant air quality standards, to which the monitoring concentrations are compared;
- Section 3: information on the baseline conditions of the study area;
- Section 4: information on the 6-month survey;
- Section 5: results of the monitoring survey; and
- Section 6: summary of report.

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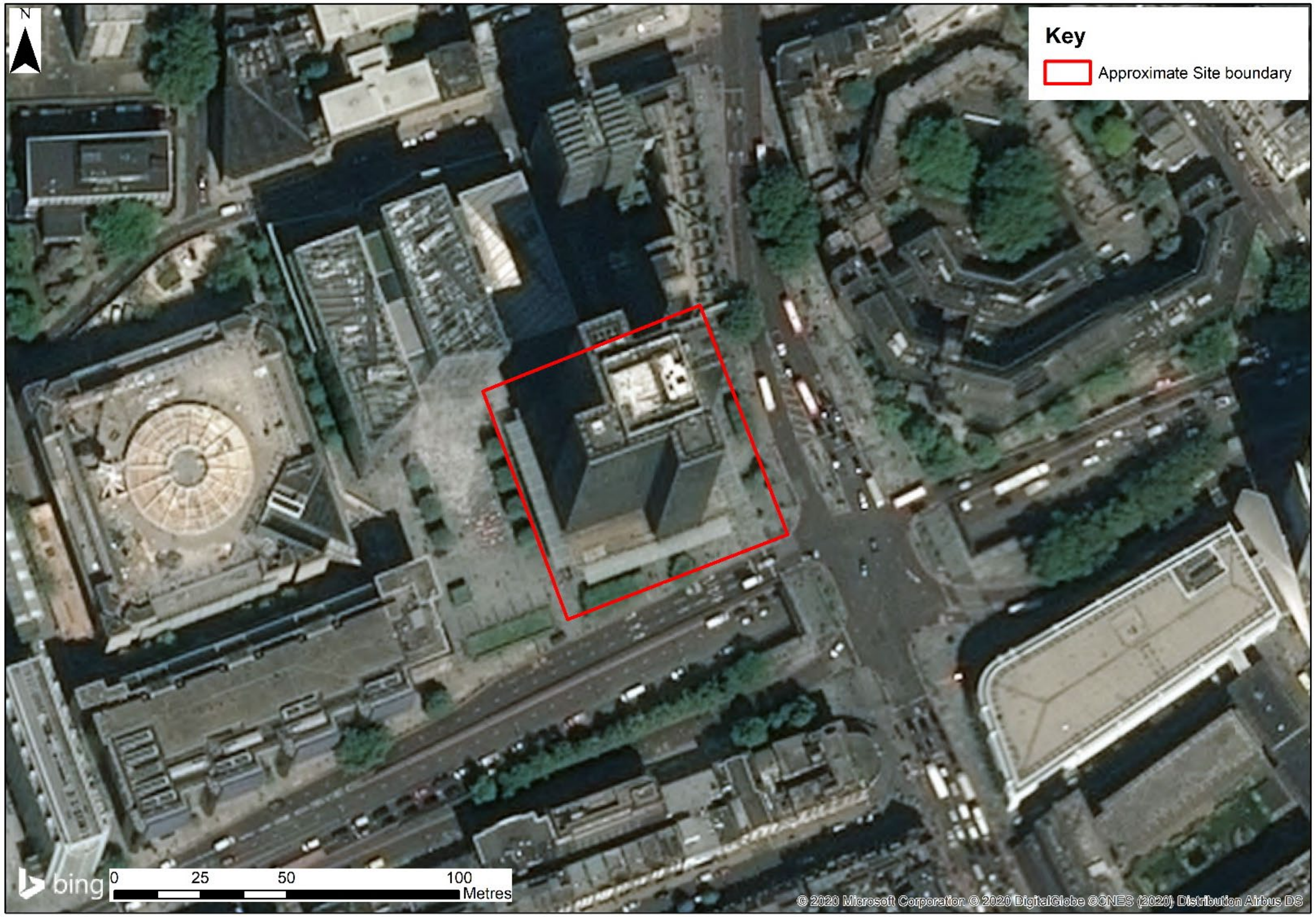
Figure 1: Location of the Site



2 Air quality standards

2.1 Pollutants of concern

The main pollutants of concern at the Site relate to those from road traffic emissions and are NO_2 and particulate matter (PM_{10}).

This report focusses on NO_2 since this is the pollutant most likely to cause exceedances of the air quality standards (described in section 2.2) due to main roads in the vicinity of the Development. The local air quality is mainly influenced by vehicle emissions associated with heavily trafficked A501 (Euston Road) to the south and A400 (Hampstead Road) to the east.

2.2 Air quality standards

In 1996, the European Commission published the Air Quality Framework Directive on ambient air quality assessment and management (96/62/EC)[1], which defined the policy framework for 12 air pollutants known to have harmful effects on human health and the environment. Limit values (pollutant concentrations not to be exceeded by a certain date) for each pollutant were set through a series of Daughter Directives, including Directive 1999/30/EC (the 1st Daughter Directive)[2] which sets limit values for NO_2 (amongst other pollutants) in ambient air.

In May 2008, the Directive 2008/50/EC[3] on ambient air quality and cleaner air for Europe came into force. This Directive consolidates the above (apart from the 4th Daughter Directive), provides a new regulatory framework for $PM_{2.5}$ and makes provision for extended compliance deadlines for NO_2 and PM_{10}. The Directive has been transposed into national legislation in England by the Air Quality Standards Regulations 2010[4] (amended in 2016[5]).

The World Health Organisation (WHO) has set non-statutory standards in the form of 'guidelines', which are based on various epidemiological studies. These guidelines are taken into consideration when forming new legislation. In relation to NO_2, the studies have identified that high concentrations and long-term exposure may cause inflammation of the airways, lung dysfunction and an enhanced response to allergens, especially for sensitive receptors.

The air quality limit values set by the European legislation and transposed into national law (UK objectives) are based on the recommended guideline values from the WHO.

[1] Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management.

[2] Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air.

[3] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

[4] The Air Quality Standards Regulations 2010, SI 2010/1001.

[5] The Air Quality Standards Regulations 2016, SI 2016/1184.

Table 1 sets out the air quality standards for the pollutant relevant to this study (NO_2 and PM_{10}).

Table 1: Air quality standards

Pollutant	**Averaging period**	**Air quality standard**
Nitrogen Dioxide (NO_2)	Annual mean	40µg/m^3
	1-hour mean	200µg/m^3 not to be exceeded more than 18 times a year (99.8th percentile)
Fine Particulate Matter (PM_{10})	Annual mean	40µg/m^3
	24-hour mean	50µg/m^3 not to be exceeded more than 35 times a year (90.4th percentile)

3 Baseline conditions

This section presents information on the baseline air quality conditions around the Site.

3.1 Air quality management areas

LBC declared the whole borough an Air Quality Management Area (AQMA) in September 2002 due to exceedances of annual mean NO_2 objectives and 24-hour mean PM_{10} objectives[6]. Therefore the Development is within an AQMA.

3.2 Local monitoring

LBC undertake automatic and diffusion tube monitoring in the borough. The latest Local Air Quality Management (LAQM) report[7] shows there are two automatic monitors and seven diffusion tube monitoring locations within 2km of the Site. The latest published years of monitoring data have been presented.

3.2.1 Automatic monitoring

Automatic monitoring involves drawing air through an analyser continuously to obtain near real-time pollutant concentration data. Details of the two automatic monitors are included in Table 2 and their locations are shown in Figure 2. Table 3 shows the NO_2 monitoring results from 2014 to 2018. The NO_2 annual mean objective was exceeded at both automatic monitoring sites from 2014 to 2018, with the exception of the 2017 and 2018 concentrations recorded at London Bloomsbury. A downward trend can be observed in annual mean NO_2 concentrations over the past five years. In addition, the 1-hour mean NO_2 objective was breached at Euston Road from 2014 to 2017.

Table 4 shows the automatic monitoring results for PM_{10} from 2014 to 2018. No exceedances were recorded for both the PM_{10} annual mean and 24-hour mean objectives at the two continuous monitoring sites in the last five years.

Table 2: Details of the automatic monitoring sites within 2km of the Site

Site name	X	Y	Site type
LB: London Bloomsbury	530123	182014	Urban background
CD9: Euston Road	529878	182648	Roadside

[6] Defra, Air Quality Management Areas. Available at: https://uk-air.defra.gov.uk/aqma/details?aqma_ref=24 [Accessed March 2020].

[7] London Borough of Camden (2019), London Borough of Camden Air Quality Annual Status Report for 2018.

Table 3: Automatic monitoring results NO_2 concentrations (µg/m³)

Site name	NO_2 annual mean (µg/m³)					NO_2 1-hour mean exceedances				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
LB: London Bloomsbury	**45**	**48**	**42**	38	36	0	0	0	0	0
CD9: Euston Road	**98**	**90**	**88**	**83**	**82***	**221**	**54**	**39**	**25**	18
Objective	**40**					**200µg/m³ not to be exceeded more than 18 times a year**				
Note: Exceedances of the air quality objectives are highlighted in **bold.** *Annualised in accordance with LLAQM Technical Guidance.										

Table 4: Automatic monitoring results PM_{10} concentrations (µg/m³)

Site name	PM_{10} annual mean (µg/m³)					PM_{10} 24-hour mean exceedances				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
LB: London Bloomsbury	20	22	20	19	17	11	6	9	6	1
CD9: Euston Road	29	18	24	20	23	5	5	10	3	2
Objective	**40**					**50µg/m³ not to be exceeded more than 35 times a year**				

3.2.2 Diffusion tube monitoring

LBC operates seven diffusion tubes within 2km of the Site. The details are presented in Table 5 and their locations are shown in Figure 2.

Table 6 shows the monitoring results for annual mean NO_2 concentrations from 2014 to 2018. The monitoring results indicate that the annual mean NO_2 concentrations were above the objective at all roadside locations. Trend analysis indicates no clear pattern in annual mean NO_2 reduction for majority of the monitoring sites, however the lowest concentrations were recorded in 2018 compared to other years. Annual mean concentrations met the objective at the urban background locations, except for Tavistock Gardens in 2014 and 2015. In addition, the majority of NO_2 concentrations recorded at CA4, CA11, CA21 and CA23 were above 60µg/m³ in recent years, indicating breaches of the hourly mean objective were likely in accordance to the LAQM.TG(16) guidance**Error! Bookmark not defined.**.

Though LBC operates a comprehensive air quality monitoring network across the borough, the monitoring sites located in the vicinity of the Development are considered not to be representative of the Site. Therefore, a site-specific monitoring survey has been undertaken to measure the NO_2 concentrations at and around the Development. The survey results are presented in section 5.4.

Table 5: Details of the diffusion tube monitoring sites within 2km of the Site

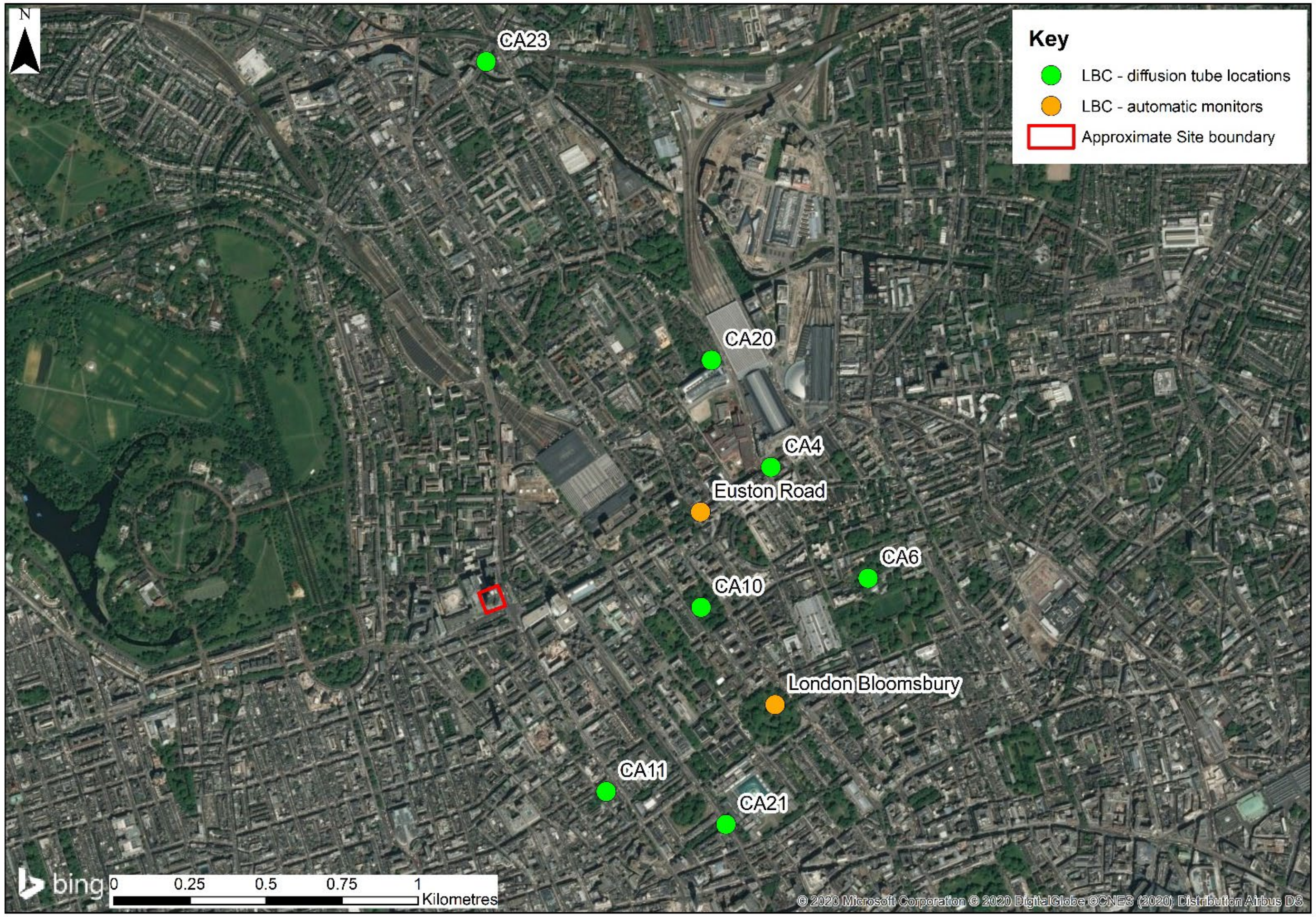
Site name	X	Y	Site type
CA4: Euston Road	530110	182795	Roadside
CA6: Wakefield Gardens	530430	182430	Urban background
CA10: Tavistock Garden	529880	182334	Urban background
CA11: Tottenham Court Road	529568	181728	Kerbside
CA20: Brill Place	529914	183147	Roadside
CA21: Bloomsbury Street	529962	181620	Roadside
CA23: Camden Road	529173	184127	Roadside

Table 6: Diffusion tube monitoring results NO_2 concentrations (µg/m^3)

Site name	NO_2 annual mean (µg/m^3)				
	2014	2015	2016 [a]	2017	2018
CA4: Euston Road	**<u>89.7</u>**	**<u>86.7</u>**	**<u>82.7</u>**	**<u>92.5</u>**	**<u>69.2</u>**
CA6: Wakefield Gardens	36.4	35.8	31.3	-	26.7
CA10: Tavistock Garden	**46.5**	**55.6**	39.7	-	35.4
CA11: Tottenham Court Road	**<u>86.8</u>**	**<u>85.6</u>**	**<u>83.6</u>**	-	**<u>65.7</u>**
CA20: Brill Place	**52.3**	**48.9**	**47.5**	**57.3**	**41.1**
CA21: Bloomsbury Street	**<u>80.8</u>**	**<u>71.4</u>**	**<u>72.2</u>**	**<u>80.7</u>**	**59.4**
CA23: Camden Road	**<u>72.2</u>**	**<u>63.3</u>**	**<u>61.7</u>**	**<u>75.4</u>**	**55.6**
Objective	**40**				

Note: Exceedance of the air quality objective are highlighted in **bold**.
NO_2 annual mean concentrations exceeding 60µg/m^3, indicating a potential exceedance of the hourly mean NO_2 objective are shown in **<u>bold and underlined</u>.**
'-' indicates no data for these sites for this year

Figure 2: Local monitoring within 2km of the Site



3.3 Background concentrations

Defra has produced background air pollution data for each 1x1km OS grid square for each local authority area[8]. Background maps are available for a base year of 2017 and projected for each year up to 2030.

Estimated background concentrations of oxides of nitrogen (NOx), NO_2, PM_{10} and $PM_{2.5}$ in the grid square in which the Site is located, and Defra's NOx breakdown of the different sources of emissions (e.g. roads, aviation, rail, etc) are presented in Table 7. This shows that the estimated NO_2 background concentration is close to the annual mean air quality standard of 40µg/m^3.

The source apportionment for NOx concentrations shows that the road contribution is 40% of the background at the Site. Domestic emissions are the second highest proportion (30%) with Other sources (including shipping, off-road sources and regional rural concentrations) and industrial sources contributing similar concentrations. The lowest concentrations are attributed to Other transport (including aircraft and rail).

The main source of background NOx concentrations at the Site is from road emissions. It is inferred from this that the distance of the diffusion tubes to the main roads in the vicinity of the Site (A501 Euston Road to the south and A400 Hampstead Road to the east) will be a contributory factor in the concentrations measured. It is predicted that those locations closest to the main roads will record the highest concentrations.

Table 7: Defra's background concentrations of NOx, NO_2, PM_{10} and $PM_{2.5}$ (µg/m^3) in 2019

Pollutant	Total	Roads	Industrial	Other transport	Domestic	Other
Site grid square (529500, 182500)						
NO_2	38.0	-	-	-	-	-
NOx	68.6	27.3	9.4	0.8	20.6	10.4
		(40%)	(14%)	(1%)	(30%)	(15%)
PM_{10}	19.2	19.2	1.1	2.4	0.0	0.9
		(6%)	(13%)	(0%)	(5%)	(76%)
$PM_{2.5}$	12.7	0.7	1.1	0.0	0.9	9.9
		(6%)	(9%)	(0%)	(7%)	(78%)

[8] Defra, 2017-based background maps. Available at: https://uk-air.defra.gov.uk/data/laqm-background-home [Accessed March 2020].

4 Monitoring locations

The on-site monitoring locations are shown in Figure 3 and details are provided in Table 8.

Measurements of NO_2 were undertaken at a total of 10 sites at three heights, ground level and two heights on Euston Tower, as follows:

- Ground Level: Brock Street, courtyard facing Triton Square, Euston Road;
- Second Level: façades facing Hampstead Road, Triton Square, Euston Road; and
- Roof Level: façades facing Brock Street, Hampstead Road, Triton Square, Euston Road .

Monitoring of NO_2 was carried out using Palmes diffusion tubes (Figure 4), which consist of a small plastic tube containing a chemical reagent which absorbs the pollutant to be measured (in this case NO_2) directly from the air. Diffusion tubes were attached to street furniture, lamp posts, drain pipes, and building structures at the second and roof level. Tubes were set up in locations of interest and those modelled in the air quality assessment[9]. Each site was measured in triplicate (containing three diffusion tubes).

The monitoring survey commenced on 4th September 2019 and finished on 6th March 2020. Concentrations of NO_2 were measured on a monthly basis for a duration of 6 months. A travel blank was also used every month to identify any possible contamination of the diffusion tubes while in transit and storage.

[9] Arup (2019) Euston Tower Air Quality Report.

Figure 3: Arup diffusion tube monitoring locations

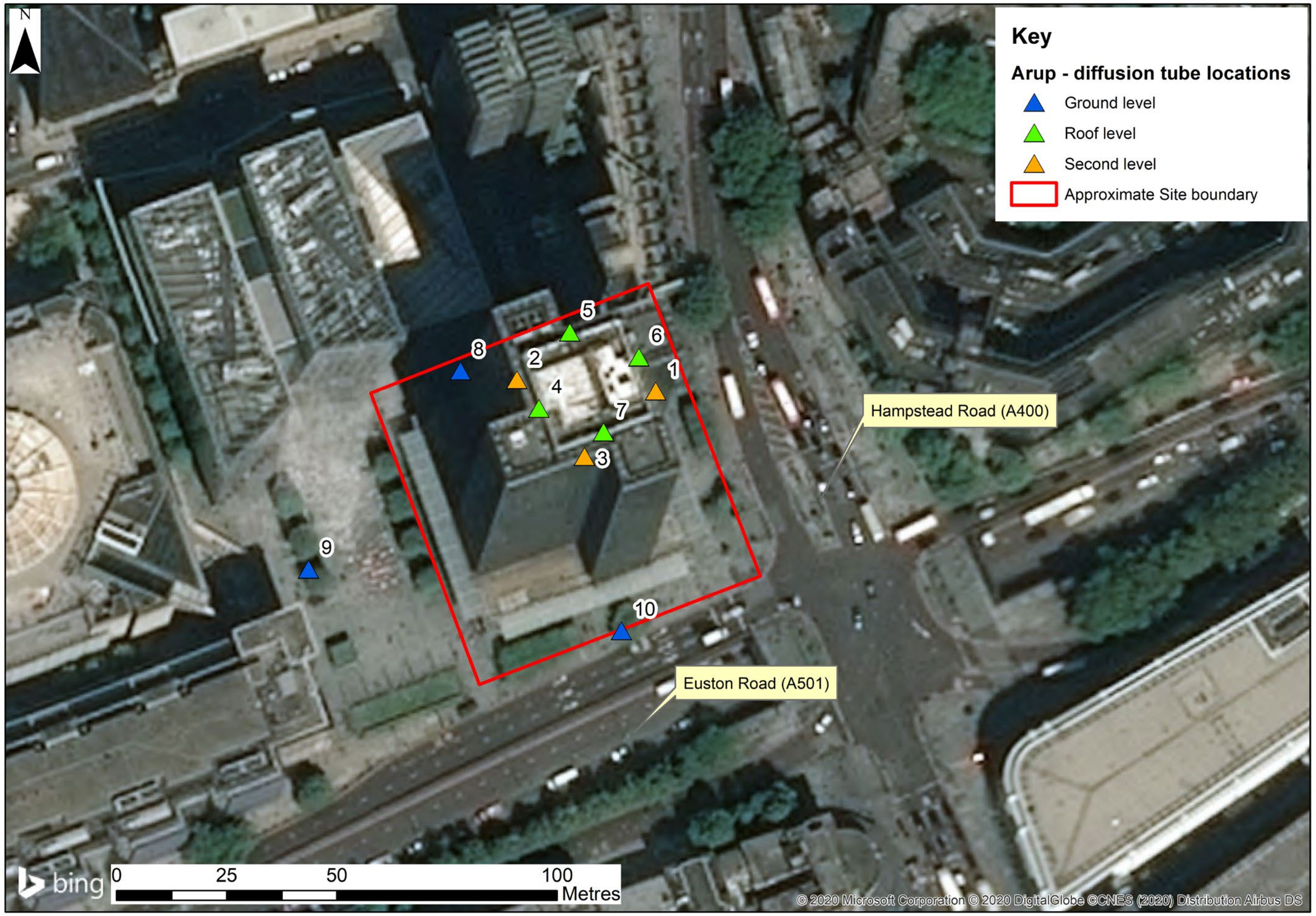


Figure 4: Palmes diffusion tubes for measuring NO_2 concentrations

Table 8: Details of monitoring sites

Site ID	Location description	X	Y	Height (m)	Cardinal direction*
1	Second Level (facing Hampstead Rd)	529206	182358	9.4	East
2	Second Level (facing Triton Square)	529173	182358	9.4	West
3	Second Level (facing Euston Road)	529188	182343	9.4	South
4	Roof Level (facing Triton Square)	529178	182356	120.0	West
5	Roof Level (facing Brock Street)	529184	182369	120.0	North
6	Roof Level (facing Hampstead Road)	529199	182363	120.0	East
7	Roof Level (facing Euston Road)	529192	182351	120.0	South
8	Ground Level (facing Brock Street)	529183	182388	2.0	North
9	Ground Level (facing Triton Square)	529134	182341	2.0	West
10	Ground Level (facing Euston Road)	529205	182327	2.0	South

5 Data analysis

The diffusion tubes were exposed on site every month and then sent to Gradko International Limited[10], a UKAS accredited laboratory, for analysis. The exposure dates for each month along with a comparison against the recommended exposure times by Defra are presented in Table A1. 1.

The performance of the laboratory is a factor that needs to be taken into consideration, since different laboratories may systematically over or under-estimate concentrations. This is mainly due to the procedures of preparing and analysing the tubes at each individual laboratory. The preparation method for the diffusion tubes at Gradko was 20% triethanolamine (TEA) in water.

The monthly average and raw data from the laboratory are presented in Table A1. 2 and Table A1. 3 respectively.

5.1 Annualisation

Annualisation is the process of estimating an annual average of monitored concentrations, where monitoring has been completed for less than 75% of the year. The minimum number of monitoring months for annualisation is three months.

This survey lasted 6 months (50%) therefore all results have been annualised, following the method described in the Defra TG16 guidance[11].

As there were no relevant local urban background continuous monitors to co-locate with around the Site. The nearest relevant continuous urban background monitoring location, London Bloomsbury located in Russell Square[12] has been used for annualisation. This urban background monitoring site is located approximately 1km south-east of the Development .

The annual and period means of the London Bloomsbury continuous monitoring site were compared against the diffusion tube period means for which measurements were available (Table 9), in order to derive an annualisation factor. The data from the continuous monitor for period 6th March 2019 to 6th March 2020 (inclusive) was 57% verified with data capture well above 90% in for the same period (98%). One site (site 9) had a lower data capture (42%) than all the rest due to missing tubes in December (period 4). As such, only the relevant monitoring data have been accounted for calculating the period mean, therefore a different annualisation factor has been used for site 9.

Table 10 presents the annualisation factor for site 9 and the other sites.

[10] Gradko, Available at: https://www.gradko.com/.

[11] Defra (2016), Local Air Quality Management Technical Guidance (TG16).

[12] Defra UK AIR Air Information Resource, Avaiable at: https://uk-air.defra.gov.uk/networks/site-info?uka_id=UKA00211 [Accessed March 2020].

Table 9: Comparison of annual and period means of the continuous monitoring site

Continuous monitor site	Annual mean*	Period mean	Available measurement periods
London Bloomsbury	30.7	34.7 (Sites 1 to 8 and 10)	1 to 6
		35.1 (Site 9)	1 to 3, 5 and 6
*6th March 2019 to 6th March 2020 (inclusive)			

Table 10: Annualisation factors for all sites and site 9 individually

Site ID	Data capture	Annualisation factor	Available measurements
Rest of the sites	42%	0.876	Periods 1 to 6
Site 9 – Ground Level (Santander building)	50%	0.884	Periods 1 to 3, 5, 6

5.2 Precision

Precision refers to the ability to consistently reproduce a measurement, i.e. how similar the results of the triplicate tubes are to each other. The precision is calculated using the coefficient of variation (CV) and is categorised as 'good' or 'poor'.

For this monitoring survey, the precision of the diffusion tubes over the survey period was **good** for all monitoring sites.

5.3 Bias

Bias refers to the possibility of the diffusion tubes systematically over or under-reading the concentrations. To correct for this bias, Defra recommends that an adjustment factor is applied to the measured concentrations. As such, a bias adjustment factor is derived from either co-location locally with a continuous monitor or from the national database on co-location studies available from Defra[13] for each laboratory in the UK.

As noted in 5.1 there were no local continuous monitors for co-location; therefore, the national factor for the latest year available (2018) was used for this survey analysis. There are very minor changes to the bias adjustment factor from one year to the next for this laboratory (Gradko) and, therefore, the 2018 factor is considered representative of the 2019/20 period of monitoring for this study. The national bias adjustment factor for 2018 was 0.92; the annual concentrations for all sites were therefore adjusted by multiplying by this factor.

[13] Defra, The National Diffusion Tube Bias Spreadsheet, Available at: http://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html [Accessed March 2020].

5.4 Processed data

The annual mean NO_2 concentrations recorded (bias adjusted and annualised) for the survey period (2019 to 2020) are presented in Table 11. It can be observed that NO_2 concentrations are below the annual mean air quality objective (40μg/m^3) at all but one monitoring site (Site 1) in the study area.

Measured NO_2 concentrations at the second level of the Development ranged between 30.0μg/m^3 and 44.6μg/m^3. The highest measured NO_2 concentration (44.6μg/m^3) was observed at this level at Site 1 on Hampstead Road (A400), which is heavily trafficked. This location also has the largest range between measured concentrations (14.6μg/m^3).

Measured NO_2 concentrations at roof level were below the air quality standard ranging from 33.0μg/m^3 to 38.4μg/m^3. The highest measured NO_2 concentration (38.4μg/m^3) was observed at Site 6 facing Hampstead Road (A400). It is understood that operational boilers are located at the roof level and their associated emissions were likely to contribute to these measurements.

Measured NO_2 concentrations at ground level were below the air quality standard ranging from 28.8μg/m^3 to 39.6μg/m^3. Sites 8 and 9 recorded lower concentrations as they are set back from the main roads. The highest measured NO_2 concentration at ground level (39.6μg/m^3) was observed at Site 10 which is adjacent to Euston Road (A501).

The Defra TG16 guidance**Error! Bookmark not defined.** states that the hourly mean NO_2 standard is only likely to be exceeded if the annual mean concentration is greater than 60μg/m^3. As the annual mean concentrations recorded at all sites are below 60μg/m^3 it is unlikely that there are exceedances of hourly mean NO_2 standard at any of the monitoring locations.

On the basis of the result of the monitoring survey, air quality is not a constraint to the installation of natural ventilation at the Development, however it is recommended that lower levels floors on the eastern façade (facing Hampstead Road) have closed windows at lower level.

Table 11: Bias-adjusted and annualised mean NO_2 concentrations (μg/m^3)

Site ID	Location description	Annual mean NO_2 concentration (μg/m^3)	Data capture after annualisation
1	Second Level (facing Hampstead Road)	**44.6**	100%
2	Second Level (facing Triton Square)	30.9	100%
3	Second Level (facing Euston Road)	30.0	100%
4	Roof Level (facing Triton Square)	33.4	100%
5	Roof Level (facing Brock Street)	33.5	100%
6	Roof Level (facing Hampstead Road)	38.4	100%
7	Roof Level (facing Euston Road)	33.0	100%
8	Ground Level (facing Brock Street)	31.6	100%

Site ID	Location description	Annual mean NO_2 concentration ($\mu g/m^3$)	Data capture after annualisation
9	Ground Level (Triton Square courtyard)	28.8	91.7%
10	Ground Level (Euston Road)	39.6	100%

5.5 Comparison with modelling

Dispersion modelling undertaken by Arup[9] predicted high concentrations at locations in close proximity to the highly trafficked Euston Road (A501) and Hampstead Road (A400). Conversely, lower concentrations were predicted at receptors facing Brock Street and Triton Square, as these receptors are set back from the road sources and faced internal areas. The findings of the dispersion modelling were that some floors (ground to 8th floors) might not be suitable for natural ventilation due to potential exceedances of the annual mean NO_2 standard and this should be confirmed by the site-specific monitoring. As such, the recommendation for the natural ventilation arrangement should follow the information detailed in section 5.4.

6 Conclusion

This report presented the analysis of the monitoring survey around the Development for the refurbishment of Euston Tower at Euston Road for the period September 2019 to February 2020. The analysis includes bias adjusted and annualised measurements across all three height levels surveyed.

Ten monitoring sites were installed across three study areas:

- Ground Level: three sites with triplicate tubes
- Second Level: three sites with triplicate tubes; and
- Roof Level: four sites with triplicate tubes.

Measurements of NO_2 concentrations were obtained on a monthly basis for six months, and the results have been annualised to compare against the annual mean air quality objective of 40µg/m^3.

Measured NO_2 concentrations were below the annual mean air quality standard of 40µg/m^3 at all sites, except one site in the study area. The recorded exceedance is on the second floor level of Euston Tower overlooking heavily trafficked Hampstead Road. No exceedances were measured at any ground or roof level locations, or any other locations on the second floor. Exceedances of the hourly mean NO_2 standard are unlikely as the measured NO_2 concentrations were all below 60µg/m^3.

Comparison of the previous dispersion modelling undertaken was compared with the measured concentrations. Both findings agree that high concentrations were found in road facing locations and lower concentrations were observed to the north and west, away from main roads.

On the basis of the results of the monitoring survey and the dispersion modelling carried out, air quality is not considered to be a constraint to the installation of natural ventilation at the Development, however it is recommended that lower levels floors on the eastern façade (facing Hampstead Road) have closed windows at lower level.

Appendix A

Raw monitoring results

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A1 Exposure dates

Table A1. 1: Exposure times and dates for monitoring survey

Period	Month	From	To	Exposure days	Defra recommended exposure days
1	September	04/09/2019	03/10/2019	29	28
2	October	03/10/2019	07/11/2019	35	35
3	November	07/11/2019	04/12/2019	27	28
4	December	04/12/2019	08/01/2020	35	35
5	January	08/01/2020	05/02/2020	28	28
6	February	05/02/2020	06/03/2020	30	28

Table A1. 2: Monthly NO_2 ($\mu g/m^3$) concentrations for survey period 2019 to 2020

Site ID	Location description	Sep	Oct	Nov	Dec	Jan	Feb
1	Second Level (Hampstead Rd)	46.7	48.0	59.2	59.2	58.3	57.3
2	Second Level (Santander building)	32.3	38.3	44.6	39.9	38.9	33.8
3	Second Level (Euston Road)	35.5	33.4	40.2	37.7	38.7	35.9
4	Roof Level (Santander building)	29.2	37.8	47.9	46.3	41.9	43.5
5	Roof Level (Brock Street)	30.4	40.5	36.5	51.7	38.5	49.0
6	Roof Level (Hampstead Road)	30.8	43.4	44.0	59.7	50.3	55.4
7	Roof Level (Euston Road)	30.3	34.7	52.3	44.2	41.9	39.8
8	Ground Level (Brock Street)	32.2	38.6	46.0	41.0	39.3	35.6
9	Ground Level (Santander building)	31.3	36.5	43.2	*N/A*	34.8	32.9
10	Ground Level (Euston Road)	36.9	37.0	64.2	45.0	55.1	54.0
N/A: tubes missing at collection							

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Table A1. 3: Raw monitoring data (NO_2 ($\mu g/m^3$))

Site	September	October	November	December	January	February
1	41.7	52.3	66.6	72.0	70.2	48.0
	43.9	49.0	58.8	53.8	53.0	55.7
	54.5	42.9	52.1	52.0	51.7	68.1
2	32.3	38.3	45.4	39.2	38.4	33.1
	33.2	38.4	43.5	41.0	34.8	33.1
	31.2	38.2	45.0	39.6	43.6	35.4
3	37.1	36.1	39.2	36.1	39.8	39.5
	36.9	33.6	40.4	38.5	37.4	33.0
	32.7	30.4	40.9	38.6	38.8	35.2
4	26.4	35.7	46.8	44.0	41.2	43.8
	30.1	35.8	46.8	49.7	46.9	43.3
	31.0	41.9	49.9	45.1	37.5	43.2
5	30.7	42.1	46.6	51.7	43.1	48.5
	30.8	40.3	17.6	48.1	43.2	49.5
	29.7	39.1	45.3	53.6	38.5	49.1
6	30.1	44.8	41.2	54.9	51.8	57.3
	31.8	42.5	44.2	62.1	42.0	50.0
	30.5	42.9	46.4	62.0	57.0	58.9
7	32.9	35.2	54.4	48.7	39.3	41.3
	32.0	36.1	52.6	47.2	41.3	42.5
	26.0	32.8	49.8	36.6	45.1	35.6
8	30.1	38.3	48.5	41.0	41.4	34.7
	32.1	36.7	46.6	40.4	38.8	36.1
	34.5	40.9	42.9	44.5	37.7	36.0
9	33.1	*N/A*	40.8	*N/A*	34.4	32.8
	29.9	*N/A*	43.4	*N/A*	32.6	32.8
	30.8	36.5	45.3	*N/A*	37.4	33.2
10	38.3	40.2	*N/A*	46.3	51.6	54.7
	38.6	34.8	68.8	54.9	60.8	53.0
	33.7	36.1	59.7	33.7	52.8	54.3
Blank	0.2	0.1	0.1	0.1	0.1	0.3
N/A: tubes missing at collection						

British Land

Euston Tower

Air Quality Assessment

266427-30

Draft 2 | 11 November 2019

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It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Document verification

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Contents

Tables

Draft

Figures

Appendices

Draft

1 Introduction

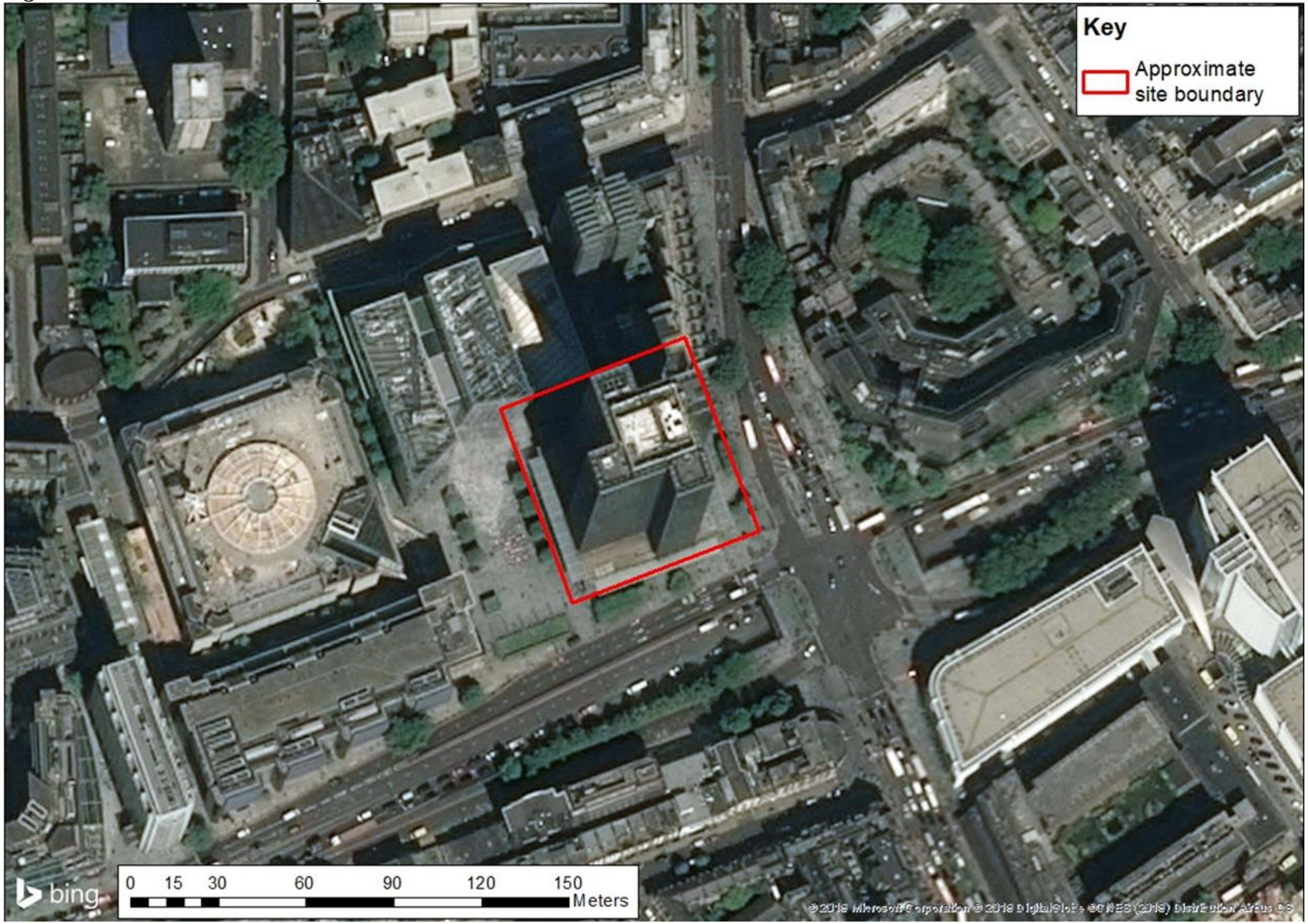
Ove Arup and Partners (Arup) Limited has been commissioned to undertake an air quality assessment of the refurbishment for Euston Tower at Euston Road in the London Brough of Camden (LBC), hereafter referred as the 'Development' to describe the proposals or the 'Site' to describe the site boundary.

The Site is bordered by the A501 Euston Road to the south and A400 Hampstead Road to east. The location of the Site is shown in Figure 1. The existing building is currently operational, and it is entirely mechanically ventilated. The air-handling plants at level 12 serve lower to mid-levels of the tower and the plant at the roof level server the top third. Openable windows are installed in the existing building, but they only provide emergency ventilation when the air-conditioning plant on-site is out of service.

The Development is currently at RIBA Stage 1 and is seeking the feasibility of implementing natural ventilation within the building. The proposals are to refurbish the existing building and the Development will remain as commercial use with 39 storeys. The proposed refurbishment includes extending the current building facades from the ground to third floors, providing larger building footprints on the lower floors.

This air quality assessment reviews the existing air quality baseline conditions and determines the suitability of the Development for natural ventilation at various heights.

Figure 1: Location of the Development



2 Air Quality Standards and Guidelines

2.1 European Air Quality Management

In 1996 the European Commission published the Air Quality Framework Directive on ambient air quality assessment and management (96/62/EC)[1]. This Directive defined the policy framework for 12 air pollutants known to have harmful effects on human health and the environment. Limit values (pollutant concentrations not to be exceeded by a certain date) for each specified pollutant were set through a series of Daughter Directives, including Directive 1999/30/EC (the 1st Daughter Directive)[2] which sets limit values for sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x), particulate matter (PM_{10}) and lead in ambient air.

In May 2008, the Directive 2008/50/EC[3] on ambient air quality and cleaner air for Europe came into force. This Directive consolidates the previous Directives (apart from the 4th Daughter Directive) and provides a new regulatory framework for $PM_{2.5}$ and makes provision for extended compliance deadlines for NO_2 and PM_{10}.

The Directives were transposed into national legislation in England by the Air Quality Standards Regulations 2010[4]. The Secretary of State for the Environment has the duty of ensuring compliance with the air quality limit values.

2.2 Environment Act 1995

Part IV of the Environment Act 1995 places a duty on the Secretary of State for the Environment to develop, implement and maintain an Air Quality Strategy with the aim of reducing atmospheric emissions and improving air quality[5]. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[6] provides the framework for ensuring compliance with the air quality limit values based on a combination of international, national and local measures to reduce emissions and improve air quality. This includes the statutory duty, also under Part IV of the Environment Act 1995, for local authorities to undergo a process of local air quality management and declare Air Quality Management Areas (AQMA) where necessary.

2.3 Air Quality Objectives and Limit Values

Air quality limit values and objectives are quality standards for clean air. Some pollutants have standards expressed as annual average concentrations (long-term)

[1] Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management
[2] Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air
[3] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe
[4] The Air Quality Standards Regulations 2010, SI 2010/1001
[5] Environment Act 1995, Chapter 25, Part IV Air Quality
[6] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Volume 1, July 2007

due to the chronic way in which they affect health or the natural environment (i.e. effects occur after a prolonged period of exposure to elevated concentrations) and others have standards expressed as 24-hour, 1-hour or 15-minute average concentrations (short-term) due to the acute way in which they affect health or the natural environment (i.e. after a relatively short period of exposure). Some pollutants have standards expressed in terms of both long-term and short-term concentrations. Table 1 sets out these EU air quality limit values and national air quality objectives for the pollutants relevant to this study (NO_2 and particulate matter).

In the majority of cases the air quality limit values and air quality objectives have the same pollutant concentration threshold and date for compliance. The key difference is that the Secretary of State for the Environment is required under European Law to ensure compliance with the air quality limit values whereas local authorities are only obliged under national legislation to undertake best efforts to comply with the air quality objectives. To assist local authorities in demonstrating best efforts, the Environment Act 1995 requires that when carrying out their local air quality management functions, local authorities shall have regard to guidance issued by the Secretary of State.

Table 1: Air quality standards

Pollutant	**Averaging period**	**Limit value / objective**
Nitrogen Dioxide (NO_2)	Annual mean	40µg/m^3
	1-hour mean	200µg/m^3 not to be exceeded more than 18 times a year (99.8th percentile)
Fine Particulate Matter (PM_{10})	Annual mean	40µg/m^3
	24-hour mean	50µg/m^3 not to be exceeded more than 35 times a year (90.4th percentile)
Very Fine Particulate Matter ($PM_{2.5}$)	Annual mean	25µg/m^3

2.4 Clean Air Strategy

Defra published an updated Clean Air Strategy in 2019[7], and this is aimed out tackling all sources of air pollution, making air healthier to breathe, protecting nature and boosting the economy. The strategy also sits alongside three other UK government strategies: our Industrial Strategy, our Clean Growth Strategy and our 25 Year Environment Plan.

The strategy proposes tough new goals to cut public exposure to particulate matter pollution, as per the recommendation by the World Health Organisation. Comprehensive action is required from all parts of government and society to participate in order to meet these goals. In particular, the Clean Air Strategy states:

"New legislation will create a stronger and a more coherent framework for action to tackle air pollution. This will be underpinned by new England-wide powers to control major sources of air pollution, in line with the risk they pose to public health and the environment, plus new local powers to take action in areas with an air pollution problem. These will support the creation of Clean Air Zones to lower emissions from all sources of air pollution, backed up with clear enforcement mechanism."

[7] Defra (2019). Clean Air Strategy 2019.

3 Planning Policy and Guidance

3.1 National Policy and Guidance

The land-use planning process is a key means of improving air quality, particularly in the long term, through the strategic location and design of new developments. Any air quality consideration that relates to land-use and its development can be a material planning consideration in the determination of planning applications, dependent upon the details of the proposed development.

3.1.1 National Planning Policy Framework (2019)

The National Planning Policy Framework (NPPF) was published in February 2019[8] with the purpose of planning to achieve sustainable development. Paragraph 181 of the NPPF on air quality states that:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

In addition, paragraph 103 states that:

"The planning system should actively manage patterns of growth in support of these objectives. Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help to reduce congestion and emissions, and improve air quality and public health. However, opportunities to maximise sustainable transport solutions will vary between urban and rural areas, and this should be taken into account in both plan-making and decision-making."

Paragraph 170 discusses how planning policies and decisions should contribute to and enhance the natural and local environment. In relation to air quality, NPPF notes that this can be achieved by:

"e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of

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[8] Secretary of State for Ministry of Housing, Communities and Local Government, 2018. National Planning Policy Framework. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf. [Accessed: September 2019].

soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans"

3.1.2 Planning Practice Guidance (2014)

As part of the NPPF, planning practice guidance on various topics was recently published[9], including air quality, to supplement the NPPF. However, the PPG in relation to air quality has not yet been updated to reflect the changes in the latest NPPF published in July 2018 as outlined above. The current version of the guidance refers to the significance of air quality assessments to determine the impacts of proposed developments in the area and describes the role of local and neighbourhood plans with regard to air quality. It also provides a flowchart method to assist local authorities to determine how considerations of air quality fit into the development management process.

3.1.3 Local Air Quality Management Policy and Technical Guidance

Policy guidance note LAQM.PG (16)[10] provides additional guidance on the links between transport and air quality. LAQM.PG (16) describes how road transport contributes to local air pollution and how transport measures may bring improvements in air quality. Key transport related Government initiatives are set out, including regulatory measures and standards to reduce vehicle emissions and improve fuels, tax-based measures and the development of an integrated transport strategy.

LAQM.PG (16) also provides guidance on the links between air quality and the land use planning system. The guidance advises that air quality considerations should be integrated within the planning process at the earliest stage and is intended to aid local authorities in developing action plans to deal with specific air quality problems and create strategies to improve air quality. It summarises the main ways in which the land use planning system can help deliver compliance with the air quality objectives.

LAQM.TG (16)[11] provides guidance to local authorities and air quality practitioners on all levels of air quality modelling and assessment. Where relevant this guidance has been considered.

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[9] Department for Housing, Communities and Local Government (2014) Planning Practice Guidance: Air Quality
[10] Defra (2016) Local Air Quality Management Policy Guidance PG (16)
[11] Defra (2016) Local Air Quality Management Technical Guidance TG (16)

3.2 Regional Policy and Guidance

3.2.1 London Plan

The London Plan, consolidated with alterations in 2016[12] forms part of the development strategy for the Greater London area until 2036 and integrates all economic, environmental, transport and social frameworks. This has been amended to be consistent with the NPPF. Specifically, for new development proposals, the London Plan, consolidated with alterations, 2016, looks at air quality by proposing the following measures:

- minimise increased exposure to existing poor air quality and make provision to address local problems of air quality such as by design solutions, buffer zones or steps to promote greater use of sustainable transport modes through travel plans;
- promote sustainable design and construction to reduce emissions from the demolition and construction of buildings following the best practice guidance in the GLA and London Councils' 'The control of dust and emissions from construction and demolition';
- be at least 'air quality neutral' and not lead to further deterioration of existing poor air quality (such as areas designated as Air Quality Management Areas);
- ensure that where provision needs to be made to reduce emissions from a development, this is usually made on-site; and
- where the development requires a detailed air quality assessment and biomass boilers are included, the assessment should forecast pollutant concentrations.

A consultation draft of a new London Plan was published in 2019[13]. Within this document, Policy S|1 Improving air quality is to ensure new developments are designed and built, as far as is possible to improve local air quality and reduce the exposure of the public to poor air quality. The measures are as follows:

"A. Development plans, through relevant strategic, site specific and area-based policies should seek opportunities to identify and deliver further improvements to air quality and should not reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality

B. To tackle poor air quality, protect heath and meet legal obligations the following criteria should be addressed:

1. Development proposals should not:

a) lead to further deterioration of existing poor air quality

b) create any new area that exceed air quality limits, or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits

c) create unacceptable risk of high levels of exposure to poor quality

[12] Greater London Authority (2016) The London Plan: The Spatial Development Strategy for London Consolidated With Alterations Since 2011
[13] Draft London Plan (July 2019).

2. In order to meet the requirement in Part 1, as a minimum:

a) Development proposals must be at least air quality neutral

b) Development proposals should use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality in preference to post-design or retro-fitted mitigation measures

c) Major development proposals must be submitted with an Air Quality Assessment. Air quality assessments should show how the development will meet the requirements of B1

d) Development proposals in Air Quality Focus Areas or that are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people, which do not demonstrate that design measures have been used to minimise exposure should be refused

C. Masterplans and development briefs for large-scale development proposals subject to an Environmental Impact Assessment should consider how local air quality can be improved across the area of the proposal as part of an air quality positive approach. To achieve this a statement should be submitted demonstrating:

a) How proposals have considered ways to maximise benefits to local air quality, and

b) What measures or design features will be put in place to reduce exposure to pollution, and how they will achieve this.

D. In order to reduce the impact on air quality during the construction and demolition phase development proposals must demonstrate how they plan to comply with the Non-Road Mobile Machinery Low Emission Zone and reduce emissions form the demolition and construction of buildings following best practice guidance.

E. Development proposals should ensure that where emissions need to be reduced to meet the requirements of Air Quality Neutral or to make the impact of development on local air quality acceptable, this is done on-site. Where it can be demonstrated that emissions cannot be further reduced by on-site measures, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated within the area affected by the development."

These policies have been considered throughout the completion of this Air Quality Assessment.

3.2.2 The London Environment Strategy

The London Environment Strategy (LES)[14] was published in May 2018 and sets out the Mayor's vision for London's environment in 2050. It is a strategy that

[14] Greater London Authority (2018) The London Environment Strategy

brings together approaches from multiple aspects of London's environment in an integrated document. In relation to planning, the LES proposes new large-scale developments in London to be 'air quality positive'. It aims for larger development to go further than being 'air quality neutral' and implement effective design and integration to surrounding area to boost local air quality. The key aim is to ensure that emissions and exposure to pollution are reduced and air quality positive emphasises the importance of considering air quality very early in the design process.

3.2.3 London Local Air Quality Management Technical Guidance

The London Local Air Quality Management technical guidance (LLAQM.TG (16))[15] applies only to London's 32 boroughs (and the City of London), whilst LAQM.TG (16) applies to all other UK local authorities. Although the LLAQM.TG (16) technical guidance is largely based on the updated national guidance LAQM.TG(16), it does incorporate London-specific elements of the LAQM system.

This guidance is designed to support London authorities in carrying out their duties to review and assess air quality in their area. Where relevant this guidance has been considered.

3.3 Local Policy and Guidance

3.3.1 Camden's Clean Air Action Plan 2019-2022

The key priorities of the Plan[16] include:

1. Reducing construction emissions
2. Reducing building emissions
3. Reducing transport emissions
4. Supporting communities and schools
5. Reducing emission from delivery, servicing and freight
6. Continuing public health and awareness raising
7. Lobbying

3.3.2 Camden Local Plan

In the Camden Local Plan, Policy CC4 Air Quality aims to ensure that the impact of development on air quality is mitigated and exposure to poor air quality is reduced in the borough. The policy states:

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[15] Greater London Authority (2016) London Local Air Quality Management Technical Guidance TG (16)
[16] London Borough of Camden (2019). Camden's Clean Air Action Plan 2019-20122

"The Council will take into account the impact of air quality when assessment development proposals, through the consideration of both the exposure of occupants to air pollution and the effect of the development on air quality. Consideration must be taken to the actions identified in the Council's Air Quality Action Plan.

Air Quality Assessments (AQAs) are required where development is likely to expose residents to high levels of air pollution. Where the AQA shows that a development would cause harm to air quality, the Council will not grant planning permission unless measures are adopted to mitigate the impact. Similarly, developments that introduce sensitive receptors (i.e. housing, schools), in locations of poor air quality will not be acceptable unless designed to mitigate the impacts.

Development that involves significant demolition, construction or earthworks will also be required to assess the risk of dust and emissions impacts in an AQA and include appropriate mitigation measures to be secured in a Construction Management Plan."

4 Methodology of Assessment

4.1 Methodology Overview

The overall approach to the air quality assessment comprises:

- A review of the existing air quality conditions at and in the vicinity of the Development;
- An exposure assessment to determine NO_2, PM_{10} and $PM_{2.5}$ concentrations at the Development using dispersion modelling;
- Assessment of the suitability of natural ventilation for the Development; and
- Formulation of mitigation measures, where necessary, so that exposure to poor air quality is minimised.

4.2 Methodology of Baseline Assessment

Existing or baseline ambient air quality refers to the concentrations of relevant substances that are already present in the environment. These are present from various sources, such as industrial processes, commercial and domestic activities, traffic and natural sources.

The following data sources have been used to determine the baseline and future conditions of air quality in the study area:

- The Environment Agency (EA) website[17];
- The Defra Local Air Quality Management website[18];
- The London Air website[19]; and
- LBC local air quality monitoring (LAQM) data and reports[20].

A desk-based review was undertaken using the data sources described above. The review identified the main sources of air pollution, local air quality monitoring data and local background pollutant concentrations.

A scheme-specific diffusion tube survey was started in September 2019 and will continue for six months to determine annual mean NO_2 concentrations around the Development.

[17] Environment Agency website https://environment.data.gov.uk/public-register/view/search-industrial-installations [Accessed September 2019]
[18] Defra, Air Quality Management Areas website https://uk-air.defra.gov.uk/aqma/list [Accessed September 2019]
[19] London Air, https://www.londonair.org.uk/LondonAir/Default.aspx [Accessed September 2019]
[20] London Borough of Camden (2019). London Borough of Camden Air Quality Annual Status Report for 2018.

4.3 Methodology of Exposure Assessment

4.3.1 Assessment Scenarios

An exposure assessment to determine pollutant concentrations at the Development has been carried out using dispersion modelling.

The baseline scenario of the Development was assessed using 2017 background concentrations and vehicle emission estimates, which have been calculated using the latest Defra Emissions Factor Toolkit (EFT) v9[21].

4.3.2 Road Network

The modelled road network, traffic and speed data used in the assessment have been obtained from the Greater London Authority's (GLA) London Atmospheric Emissions Inventory (LAEI)[22], which represents the 2016 condition. The current Defra background and vehicle emission estimates are only available for years between 2017 and 2030. Based on these available data, it is deemed to be reasonable to assume the traffic and speed data from LAEI are suitable to represent conditions in 2017, as the vehicular growth in central London is generally static.

The extent of the modelled road network is shown in Figure 2 and Appendix A provides the details of the modelled roads used for the exposure assessment.

[21] Defra, Emission Factor Toolkit v8 http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html [Accessed September 2019]
[22] LAEI 2016 https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2016 [Accessed September 2016]

Figure 2: Modelled road network

4.3.3 Sensitive Receptors

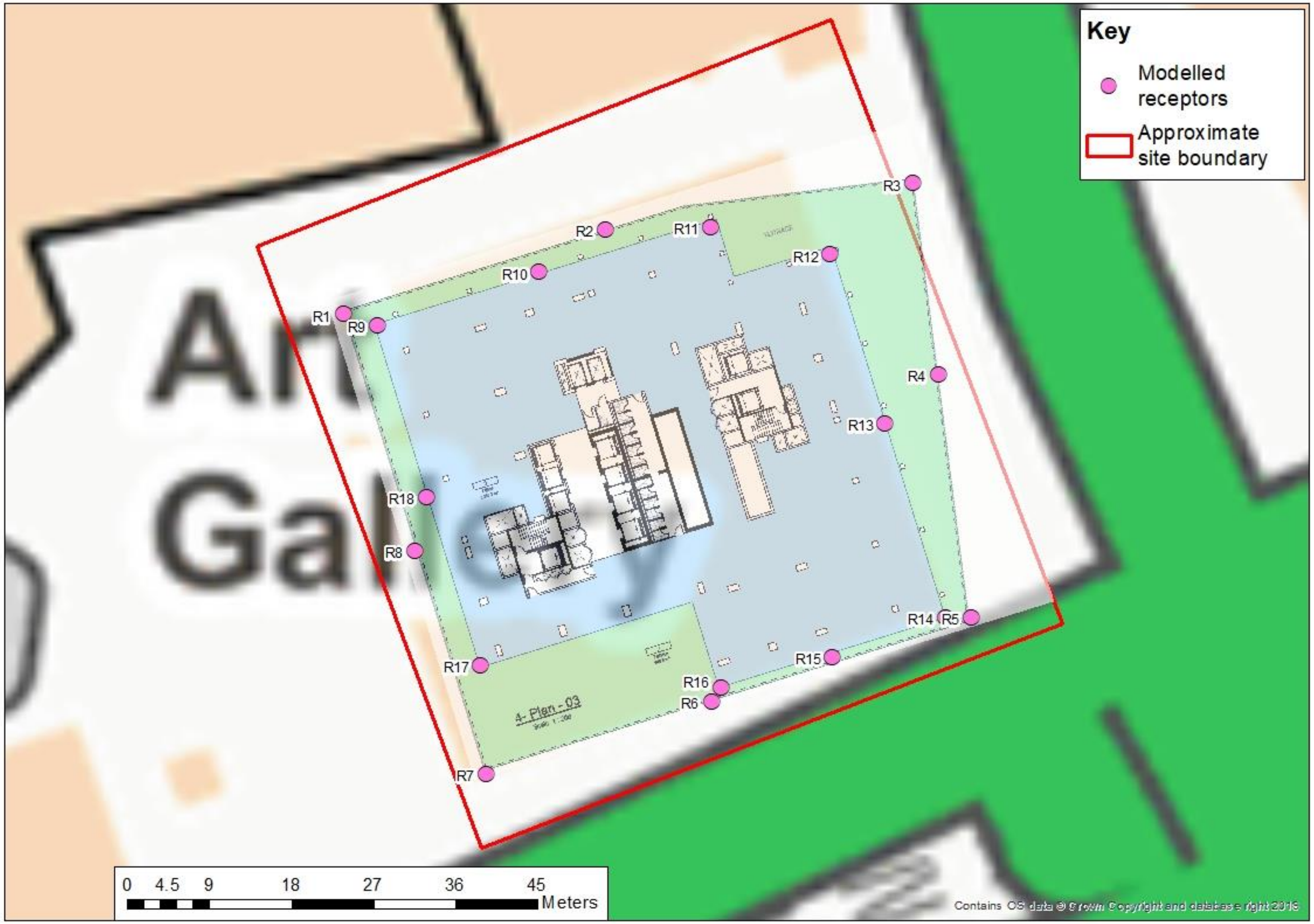
On-site receptors have been selected for the exposure assessment and they are presented in Table 2 and Figure 3. Receptors were selected on all four sides of the building in locations closest to the nearest roads, and at all floor heights of the 39-storey building. Receptors R1 to R8 represents future exposure locations from ground to the third floors, where the proposed building footprints is larger than other floors. Receptors R8 to R18 represent future exposure locations from the fourth floor upwards.

Table 2: Receptors included in the assessment

ID	Receptor	OS grid reference (m)		Height (m)
		X	Y	
R1	On-site receptor facing onto Brock Street	529158	182373	1.5 to 126.7 (across 39 storeys)
R2	On-site receptor facing onto Brock Street	529186	182383	
R3	On-site receptor facing onto Hampstead Road	529220	182388	
R4	On-site receptor facing onto Hampstead Road	529223	182367	
R5	On-site receptor facing onto Euston Road	529226	182340	
R6	On-site receptor facing onto Euston Road	529198	182331	
R7	On-site receptor facing onto Euston Road	529173	182323	
R8	On-site receptor facing onto internal courtyard	529165	182347	
R9	On-site receptor facing onto Brock Street	529161	182372	
R10	On-site receptor facing onto Brock Street	529179	182378	
R11	On-site receptor facing onto Brock Street	529198	182383	
R12	On-site receptor facing onto Hampstead Road	529211	182380	
R13	On-site receptor facing onto Hampstead Road	529217	182361	
R14	On-site receptor facing onto Euston Road	529224	182340	
R15	On-site receptor facing onto Euston Road	529211	182336	
R16	On-site receptor facing onto Euston Road	529199	182333	

ID	Receptor	OS grid reference (m)		Height (m)
		X	Y	
R17	On-site receptor facing onto internal courtyard	529173	182335	
R18	On-site receptor facing onto internal courtyard	529167	182353	

Figure 3: Receptors included in the assessment



4.3.4 Dispersion Model Set-up

This section details the inputs and set-up for the dispersion modelling.

The ADMS-Roads dispersion model, has been used for this assessment. The ADMS models have been widely validated for point and road sources and are accepted by the industry as being 'fit-for-purpose' for air quality assessments. The model incorporates the latest understanding of boundary layer meteorology and dispersion.

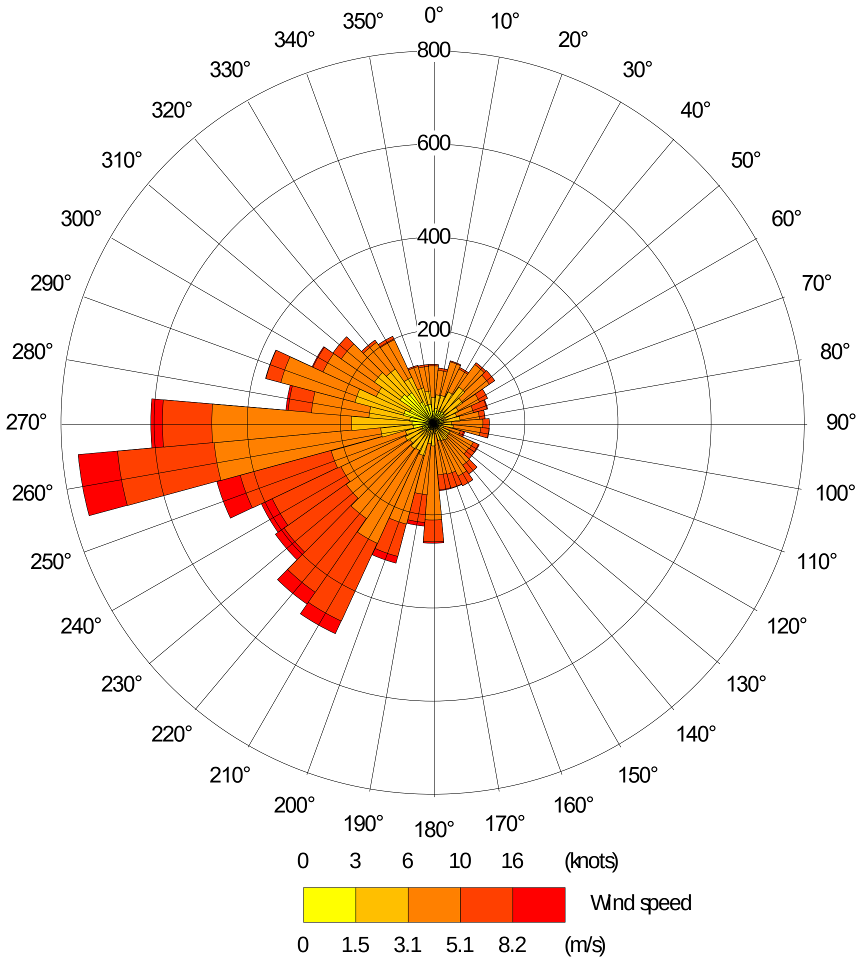
4.3.4.1 Meteorological Data

Meteorological data used in this assessment have been taken from measurements at Heathrow Airport meteorological station for 2017. London Heathrow Airport is located approximately 23km south-west of the Development. This meteorological site is considered to be representative for this assessment.

Most road dispersion models do not use meteorological data if they relate to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75m/s. LAQM.TG (16)[11] guidance states that the meteorological data file is tested in a dispersion model and the relevant output log file checked to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. The guidance recommends that meteorological data should only be used if the percentage of usable hours is greater than 75% and preferably greater than 90%. The meteorological data selected from London Heathrow Airport includes greater than 95% of usable hours. This is above the 90% threshold and this data therefore meets the requirement of the LAQM.TG (16) guidance.

The wind rose for the London Heathrow Airport 2017 meteorological data is presented in Figure 4. The predominant wind direction is from the south-west.

Figure 4: London Heathrow Airport 2017 meteorological data



4.3.4.2 Other Model Parameters

The extent of mechanical turbulence (and hence, mixing) in the atmosphere is affected by the roughness of the surface/ground over which the air is passing. Typical surface roughness values range from 1.5m (for cities, forests and industrial areas) to 0.0001m (for water or sandy deserts).

In this assessment, the general land use in the area around the Development can be described as 'large urban areas' with a corresponding surface roughness of 1.5m. The minimum Monin-Obukhov length was set to 'large conurbations greater than 1 million" with a corresponding value of 100m, this parameter accounts for additional turbulence in the atmosphere as a result of heat production in urban areas.

4.3.5 NOx to NO_2 Conversion

The model predicts NOx concentrations which comprise nitric oxide (NO) and NO_2. NOx is emitted from combustion processes, primarily as NO with a small percentage of NO_2. The emitted NO reacts with oxidants in the air (mainly ozone) to form NO_2. NO_2 is associated with effects on human health and therefore the air quality standards for the protection of human health are based on NO_2 rather than total NOx or NO. A suitable NOx:NO_2 conversion has been applied to the modelled NOx concentrations in order to determine the impact of the NOx emissions on ambient concentrations of NO_2.

LAQM.TG(16)[11] details an approach for calculating the roadside conversion of NO_x to NO_2, which takes into account the difference between ambient NO_x concentrations with and without the proposed development, the concentration of ozone and the different proportions of primary NO_2 emissions in different years. This approach is available as a spreadsheet calculator, with the most up to date version 7.1 having been released in April 2019[23].

4.3.6 Model Verification and Result Processing

Model verification refers to the comparison of modelled and measured pollutant concentrations at the same points to determine the performance of the model. Should the model results for NO_2 be mostly within ±25% of the measured values and there is no systematic over or under-prediction of concentrations, then the LAQM.TG(16)[11] guidance advises that no adjustment is necessary. If this is not the case, modelled concentrations are adjusted based on the observed relationship between modelled and measured NO_2 concentrations to provide a better agreement.

Model verification process was completed using the 2017 baseline scenario. An adjustment factor of 2.2 was obtained during the verification process, which indicated that the model was under-predicting. Further details of the verification factor calculations are presented in Appendix B.

Once the results are processed, the predicted NO_2, PM_{10} and $PM_{2.5}$ concentrations were compared against with the relevant air quality objectives which are set out in section 2.4. The future users of the Development will only be commercial use and there is no requirement to meet the annual mean objectives according to the LAQM.TG(16)[11] guidance (further information of 'Where the Air Quality Objectives Should Apply' is presented in Appendix C). However, it is understood that Development will incorporate good air quality as part of the design, and therefore the results have been compared with the relevant annual mean objectives.

[23] Defra, NO_x to NO_2 calculator http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc [Accessed September 2019]

5 Baseline Assessment

5.1 Sources of Air Pollution

5.1.1 Industrial Processes

Industrial air pollution sources are regulated through a system of operating permits or authorisations, requiring stringent emission limits to be met and ensuring that any releases to the environment are minimised or rendered harmless. Regulated (or prescribed) industrial processes are classified as Part A or Part B processes, and are regulated through the Pollution Prevention and Control (PPC) system[24,25]. The larger more polluting processes are regulated by the Environment Agency (EA), and the smaller less polluting ones by the local authorities. Local authorities tend also to regulate only for emissions to air, whereas the EA regulates emissions to air, water and land.

There are no industrial Part A processes listed on the EA website[17] in 2km of the Development.

5.1.2 Road Traffic

In recent decades, atmospheric emissions from transport on a national basis have grown to match or exceed other sources in respect of many pollutants, particularly in urban areas. The local air quality of the Development is mainly influenced by vehicle emissions associated with heavily trafficked A501 Euston Road to the south and A400 Hampstead Road to the east. Emissions from these roads have been included in the dispersion model for the assessment.

5.2 Local Air Quality

The Environment Act 1995[5] requires local authorities to review and assess air quality with respect to the objectives for seven pollutants specified in the National Air Quality Strategy. Local authorities are required to carry out an Annual Status Report (ASR) every year. If the ASR identifies potential hotspot areas likely to exceed air quality objectives, then a detailed assessment of those areas is required. Where objectives are not predicted to be met, local authorities must declare the area an AQMA. In addition, local authorities are required to produce an Air Quality Action Plan (AQAP), which includes measures to improve air quality within the AQMA.

As part of the review and assessment process, the LBC declared the whole borough an AQMA in 2002 due to exceedances of annual mean NO_2 objectives and annual mean and 24-hour mean PM_{10} objectives[18].

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[24] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
[25] The Environmental Permitting (England and Wales) (Amendment) Regulations 2013, SI 2013/390

5.3 Local Monitoring

LBC undertake automatic and diffusion tube monitoring in the borough. The LAQM reports[20] show there are two automatic monitors and seven diffusion tubes within 2km of the Development. The monitoring data presented below is from 2014 to 2018.

5.3.1 Automatic Monitoring

Automatic monitoring involves drawing air through an analyser continuously to obtain near real-time pollutant concentration data. Details of the two automatic monitors are included in Table 3 and their locations are shown in Figure 5.

Table 4 shows the monitoring results for NO_2 from 2014 to 2018. The NO_2 annual mean objective was exceeded at both automatic monitoring sites from 2014 to 2018, with the exception of the 2017 and 2018 concentrations recorded at London Bloomsbury. A downward trend can be observed in annual mean NO_2 concentrations in the last five years. In addition, the 1-hour mean NO_2 objective was breached at Euston Road from 2014 to 2017.

Table 5 shows the automatic monitoring results for PM_{10} from 2014 to 2018. No exceedances were recorded for both the PM_{10} annual mean and 24-hour mean objectives at the two monitoring sites in the last five years.

Table 3: Details of the automatic monitoring sites within 2km of the site

Site Name	NGR (m)		Site type
	X	Y	
LB: London Bloomsbury	530123	182014	Urban background
CD9: Euston Road	529878	182648	Roadside

Table 4: Automatic monitor NO_2 results

Site Name	NO_2 annual mean (µg/m^3)					NO_2 1-hour mean exceedances				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
LB: London Bloomsbury	**45**	**48**	**42**	38	36	0	0	0	0	0
CD9: Euston Road	**98**	**90**	**88**	**83**	**82***	**221**	**54**	**39**	**25**	18
Objective	**40**					**200µg/m^3 not to be exceeded more than 18 times a year**				

Note: Exceedances of the air quality objectives are highlighted in **bold.**
*Annualised in accordance with LLAQM Technical Guidance, if valid data is less than 75%.

Table 5: Automatic monitor PM_{10} results

Site Name	PM_{10} annual mean (µg/m^3)					PM_{10} 24-hour mean exceedances				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
LB: London Bloomsbury	20	22	20	19	17	11	6	9	6	1
CD9: Euston Road	29	18	24	20	23	5	5	10	3	2
Objective	**40**					**50µg/m^3 not to be exceeded more than 35 times a year**				

5.3.2 Diffusion Tube Monitoring

LBC operates a number of diffusion tubes in the borough; seven of these are within 2km of the Development. The details of the diffusion tubes are shown in Table 6 and their locations are shown in Figure 5.

Table 7 shows the monitoring results for annual mean NO_2 concentrations from 2014 to 2018. The monitoring results indicated that the annual mean NO_2 concentrations are above the objective at all roadside locations. Trend analysis indicates no clear pattern in annual mean NO_2 reduction for majority of the monitoring sites, however the lowest concentrations were recorded in 2018 in comparison to other years. Compliance in annual mean concentration was recorded at the urban background locations, except for Tavistock Gardens in 2014 and 2015.

Table 6: Details of the diffusion tube monitoring sites within 2km of the site

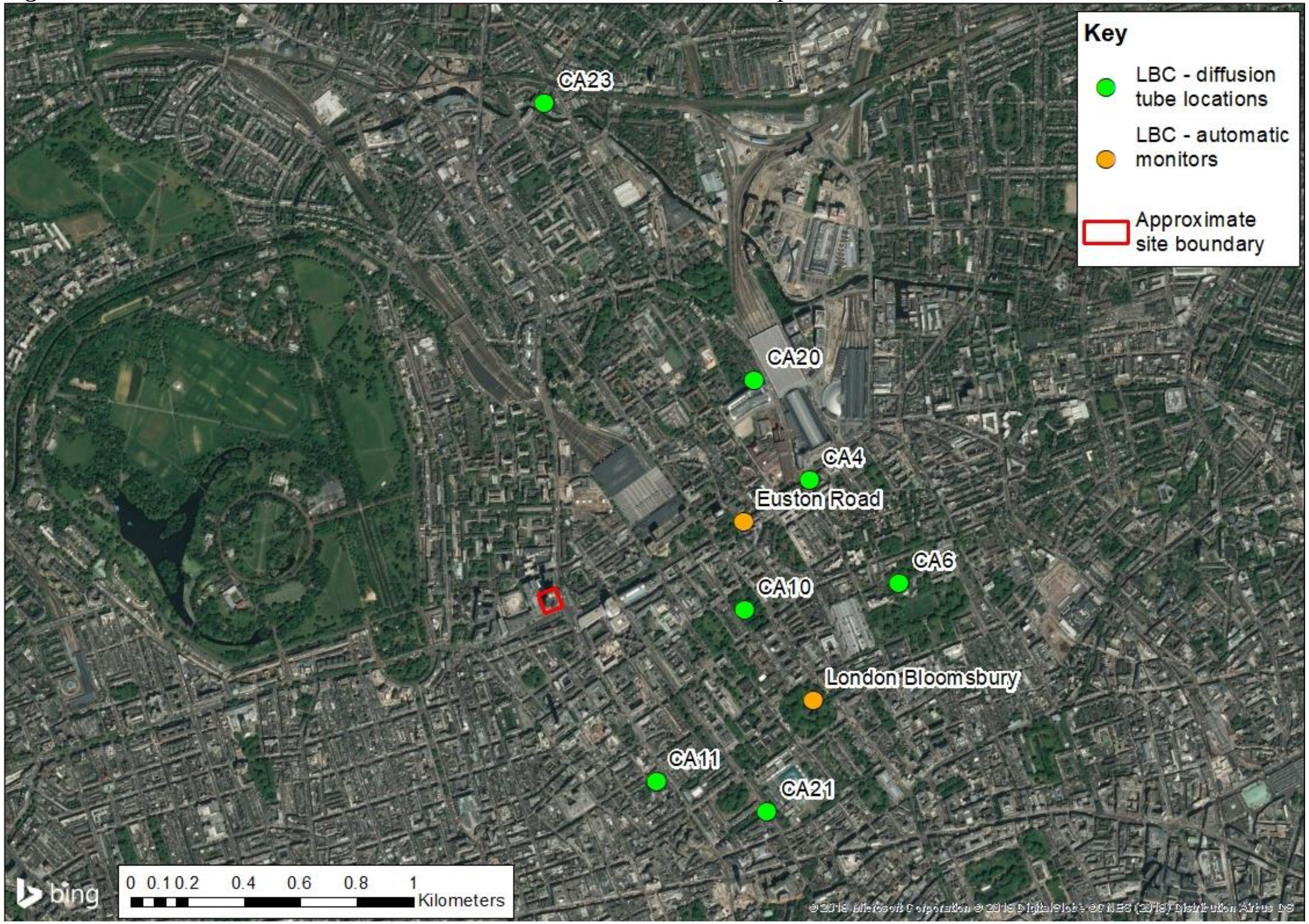
Site name	NGR (m)		Site type
	X	Y	
CA4: Euston Road	530110	182795	Roadside
CA6: Wakefield Gardens	530430	182430	Urban background
CA10: Tavistock Garden	529880	182334	Urban background
CA11: Tottenham Court Road	529568	181728	Kerbside
CA20: Brill Place	529914	183147	Roadside
CA21: Bloomsbury Street	529962	181620	Roadside
CA23: Camden Road	529173	184127	Roadside

Table 7: Diffusion tube NO_2 results

Site name	NO_2 annual mean (µg/m^3)				
	2014	2015	2016 [a]	2017	2018
CA4: Euston Road	**89.7**	**86.7**	**82.7**	**92.5**	**69.2**
CA6: Wakefield Gardens	36.4	35.8	31.3	-	26.7
CA10: Tavistock Garden	**46.5**	**55.6**	39.7	-	35.4
CA11: Tottenham Court Road	**86.8**	**85.6**	**83.6**	-	**65.7**
CA20: Brill Place	**52.3**	**48.9**	**47.5**	**57.3**	**41.1**
CA21: Bloomsbury Street	**80.8**	**71.4**	**72.2**	**80.7**	**59.4**
CA23: Camden Road	**72.2**	**63.3**	**61.7**	**75.4**	**55.6**
Objective	**40**				

Notes: Exceedance of the air quality objective are highlighted in **bold**.
'-' indicates no data for these sites for this year.

Figure 5: Automatic monitors and diffusion tubes within 2km of the Development



5.4 Background Concentrations

The Defra website[18] includes estimated background concentrations for NO_2, PM_{10} and $PM_{2.5}$ for each 1km by 1km OS grid square. Table 8 shows the estimated Defra 2017, 2019 – 2020 background concentrations.

Table 8: Defra's estimated 2017, 2019 – 2020 background pollutant concentrations

Description	OS grid square		Annual Mean Concentrations (µg/m^3)								
			2017			2019			2020		
	X	Y	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$
Development and verification at Euston Road automatic monitoring station	529500	182500	**43.7**	19.8	13.2	38.0	19.2	12.7	35.6	18.8	12.5
Verification for CA4: Euston Road diffusion tube location	530500	182500	**43.7**	19.9	13.3	37.8	19.3	12.8	35.6	18.9	12.5

Note: Exceedance of the air quality objective are highlighted in **bold**.

The estimated Defra background for annual mean PM_{10} and $PM_{2.5}$ concentrations are below the relevant objectives (40µg/m^3 and 25µg/m^3 respectively). However, the annual mean NO_2 concentration is above the objective of 40µg/m^3 in 2017 and 2019. However, by 2020 background concentrations for NO_2, PM_{10} and $PM_{2.5}$ are expected to all be below the relevant objectives.

As the vehicle emissions in the vicinity of the Development have been accounted and modelled in the assessment, as such, it is deemed to be robust to apply NO_2 concentrations recorded at the London Bloomsbury background location. This corresponds to estimated Defra background concentration from 2019.

In the assessment, 2017 Defra background concentrations for PM_{10} and $PM_{2.5}$ have been used.

6 Assessment Results

This chapter provides a summary of the assessment results for the predicted NO_2, PM_{10} and $PM_{2.5}$ concentrations at the Development. The full results are presented in Appendix D.

6.1 Annual Mean NO_2 Concentrations

The objective for annual mean NO_2 concentrations is 40µg/m^3. The highest predicted concentration is 72.3µg/m^3, which has been predicted at receptor location R5_0 (ground floor receptor fronting onto Euston Road). Furthermore, exceedances have been also predicted from ground to 8th floor at all facades of the Development. High concentrations were anticipated at these locations, as they are in close proximity to the highly trafficked Euston Road and Hampstead Road.

Predicted concentrations at receptors (R1, R8 and R2) fronting onto Brock Street and the internal courtyard area (notably at the lower levels) are generally lower in comparison to the other modelled locations, as these receptors are set back from the road sources.

The influence of the road traffic emissions is very marginal from the 12th floor upwards at all the modelled receptor locations. The predicted concentrations at floor levels greater than 12 have dropped below the annual mean objective and are in line with background concentrations (38µg/m^3). This suggests that emissions from the road traffic do not have a great effect above this height.

6.2 Annual Mean PM_{10} and $PM_{2.5}$ Concentrations

Predicted annual mean concentrations for PM_{10} and $PM_{2.5}$ at all modelled receptors are all well below the air quality objectives of 40µg/m^3 and 25µg/m^3 respectively.

6.3 Mitigation

Given the high background concentrations due to the Development location, consideration should be given to mitigation measures which can reduce the impact on air quality in the area by encouraging sustainable travel and reducing the number of servicing and delivery vehicles to the building.

It is recommended that mechanical ventilation for at least the first 8 storeys of the building is implemented, with air intakes on the western and/or northern facades of the building at as highest point as possible.

Openable windows are not recommended at lower floors, and information should be provided to building occupiers on air quality and of air quality forecast services such as airText and London Air, so that residents can be informed of high pollution events during which they can choose to close higher windows.

Air intakes for mechanical ventilation should have filters installed to reduce concentrations of NO_2 in the intake air. Filters should be maintained in accordance with the filter manufacturers standards.

7 Conclusions

An air quality exposure assessment has been undertaken to determine the suitability of the Euston Tower redevelopment for natural ventilation.

A baseline assessment has been carried out to review the air quality conditions in the vicinity of the Site. The current LBC monitoring indicates that annual mean NO_2 concentrations at roadside locations exceed the air quality objective, but objective has been met at urban background monitoring locations in recent years. Compliance for PM_{10} concentrations has been recorded in the past years.

A modelling assessment using ADMS-Roads was carried out to the predict the NO_2, PM_{10} and $PM_{2.5}$ concentrations for the 2017 baseline condition from the ground to 38th floor. The results indicate no exceedances have been predicted for annual mean PM_{10} and $PM_{2.5}$ concentrations. For annual mean NO_2 concentrations, exceedances have been predicted at the selected on-site receptors from ground to 8th floor. As such, the model results suggest natural ventilation may not be suitable at these locations and mitigation may be required, for instance, mechanical ventilation with air intakes located in an area with acceptable air quality.

Although the model results indicate exceedances at the ground to 8th floors within the Development, this represent the baseline condition in 2017. Air quality in the vicinity of the Development may be improved during its operational year, considering factors such as anticipated advances in vehicle technology and transport measures implemented across London. Importantly, the suitability of implementing natural ventilation for the Development will also be confirmed by the site-specific NO_2 diffusion tube survey (commenced in September 2019), monitoring results will be used to inform the ventilation strategy and further advice in relation to air quality will be provided.

Appendix A

Traffic Data used in the Assessment

A1 Traffic Data

Road ID	Road description	Speed (kph)	2017 Baseline	
			AADT	% HGV
AQ6	Hampstead Road	15.2	10493.5	15.2
AQ13	Euston Road	10.8	9975.3	10.8
AQ20	Tottenham Court Road	12.3	10453.5	12.3
AQ37	Euston Road	4.5	15894.4	4.5
AQ93	Euston Road	5.4	11376.0	5.4
AQ27	Tottenham Court Road	15.8	10895.4	15.8
AQ94	Euston Road	5.4	11376.0	5.4
AQ26	Tottenham Court Road	11.3	10341.4	11.3
AQ95	Euston Road	5.4	11376.0	5.4
AQ52	Euston Road	13.4	12420.8	13.4
AQ55	Euston Road	9.9	20024.6	9.9
AQ48	Gower Street	19.4	13238.1	19.4
AQ54	Euston Road	11.2	20315.9	11.2
AQ9	Hampstead Road	-	0.0	-
AQ30	Tottenham Court Road	11.8	20794.9	11.8
AQ32	Hampstead Road	-	0.0	-
AQ35	Euston Road	6.9	32613.3	6.9
AQ36	Euston Road	6.9	32613.3	6.9
AQ31	Tottenham Court Road	11.8	20794.9	11.8
AQ22	Euston Road	-	0.0	-
AQ41	Euston Road	6.9	32631.2	6.9
AQ8	Hampstead Road	14.2	10366.3	14.2
AQ100	Euston Road	12.3	12269.9	12.3
AQ44	Euston Road	9.3	16736.8	9.3
AQ16	Euston Road	-	0.0	-
AQ40	Euston Road	6.9	32631.2	6.9
AQ101	Euston Road	7.7	11653.1	7.7
AQ39	Euston Road	6.9	32631.2	6.9
AQ17	Euston Road	-	0.0	-
AQ103	Euston Road	6.5	32491.2	6.5
AQ51	Euston Road	5.4	11376.0	5.4
AQ43	Euston Road	9.3	16736.8	9.3
AQ49	Euston Road	12.3	12269.9	12.3
AQ11	Tottenham Court Road	7.8	9646.9	7.8
AQ12	Tottenham Court Road	7.8	9646.9	7.8
AQ29	Tottenham Court Road	14.1	21348.9	14.1

Road ID	Road description	Speed (kph)	2017 Baseline	
			AADT	% HGV
AQ25	Tottenham Court Road	11.4	10042.6	11.4
AQ10	Hampstead Road	10.5	4967.6	10.5
AQ97	Euston Road	5.4	11376.0	5.4
AQ24	Hampstead Road	11.4	10042.6	11.4
AQ98	Euston Road	5.4	11376.0	5.4
AQ1	Hampstead Road	15.2	20987.1	15.2
AQ18	Euston Road	-	0.0	-
AQ14	Euston Road	16.6	10664.0	16.6
AQ46	Gower Street	19.4	13238.1	19.4
AQ99	Euston Road	12.3	12269.9	12.3
AQ34	Euston Road	9.2	16718.9	9.2
AQ96	Euston Road	5.4	11376.0	5.4
AQ42	Euston Road	9.3	16736.8	9.3
AQ33	Euston Road	9.2	16718.9	9.2
AQ53	Euston Road	14.3	12561.2	14.3
AQ2	Hampstead Road	15.2	20987.1	15.2
AQ4	Hampstead Road	15.2	20987.1	15.2
AQ3	Hampstead Road	15.2	20987.1	15.2
AQ102	Euston Road	7.7	11653.1	7.7
AQ7	Hampstead Road	15.2	10493.5	15.2
AQ21	Tottenham Court Road	15.8	10895.4	15.8
AQ15	Euston Road	16.3	10962.8	16.3
AQ38	Euston Road	4.5	15894.4	4.5
AQ28	Tottenham Court Road	14.1	21348.9	14.1
AQ5	Hampstead Road	15.2	20987.1	15.2
AQ47	Gower Street	15.8	12684.1	15.8
AQ23	Hampstead Road	16.2	10620.7	16.2
AQ50	Euston Road	5.4	11376.0	5.4
AQ45	Gower Street	19.4	13238.1	19.4
AQ19	Euston Road	12.1	12495.5	12.1
AQ63	Euston Road	6.5	46317.5	6.5
AQ90	Judd Street	6.1	11144.2	6.1
AQ77	Euston Road	9.6	23945.4	9.6
AQ89	Judd Street	6.1	11144.2	6.1
AQ91	Judd Street	6.1	11144.2	6.1
AQ61	Euston Road	8.5	23665.6	8.5
AQ62	Euston Road	8.5	23665.6	8.5
AQ81	Euston Road	10.6	24198.3	10.6
AQ79	Euston Road	9.6	23945.4	9.6

Road ID	Road description	Speed (kph)	2017 Baseline	
			AADT	% HGV
AQ85	Midland Road	4.7	5579.7	4.7
AQ86	Midland Road	13.7	6158.3	13.7
AQ75	Private Road	4.4	45303.7	4.4
AQ87_s	Midland Road	9.4	11738.1	9.4
AQ72	Euston Road	10.6	24220.9	10.6
AQ88	Judd Street	3.1	5488.4	3.1
AQ92	Judd Street	3.1	5488.4	3.1
AQ56	Euston Road	9.9	20024.6	9.9
AQ57	Euston Road	9.9	20024.6	9.9
AQ58	Euston Road	9.7	19976.9	9.7
AQ59	Euston Road	4.5	22651.9	4.5
AQ60	Euston Road	10.0	20041.7	10.0
AQ64	Euston Road	9.6	47863.1	9.6
AQ65	Euston Road	9.6	23931.6	9.6
AQ66	Euston Road	9.6	23931.6	9.6
AQ67	Euston Road	9.6	23931.6	9.6
AQ68	Euston Road	9.6	23931.6	9.6
AQ69	Euston Road	9.6	23945.4	9.6
AQ70	Euston Road	9.5	23917.7	9.5
AQ74	Euston Road	9.5	23917.7	9.5
AQ76	Euston Road	11.6	24496.3	11.6
AQ78	Euston Road	11.6	24496.3	11.6
AQ80	Euston Road	11.6	25026.1	11.6
AQ82	Euston Road	25.1	7686.4	25.1
AQ84	Euston Road	28.4	22107.2	28.4
AQ83	Euston Road	28.4	22107.2	28.4
AQ73	Euston Road	10.6	24220.9	10.6
AQ71	Euston Road	9.5	23917.7	9.5
AQ5_s	Hampstead Road	15.2	20987.1	15.2
AQ87	Midland Road	9.4	11738.1	9.4

Appendix B

Model Verification

B1 Model Verification

Model verification refers to the comparison of modelled and measured pollutant concentrations at the same points to determine the performance of the model. Should the model results for NO_2 be mostly within ±25% of the measured values and there is no systematic over or under-prediction of concentrations, then the LAQM.TG16 guidance advises that no adjustment is necessary. If this is not the case, modelled concentrations are adjusted based on the observed relationship between modelled and measured NO_2 concentrations to provide a better agreement.

The modelled road network was extended to be close to diffusion tube locations included in the monitoring undertaken by LBC. There are monitoring locations located on the model road network, and they are a diffusion location CA4 - Euston Road and an automatic monitor: CD9 - Euston Road.

Model verification can be undertaken for road sources as this requires comparison of modelled concentrations against monitored concentrations. A comparison of the monitored and modelled data is shown in Table B1.

Table B1: Comparison of modelled and monitored annual mean NO_2 for 2017

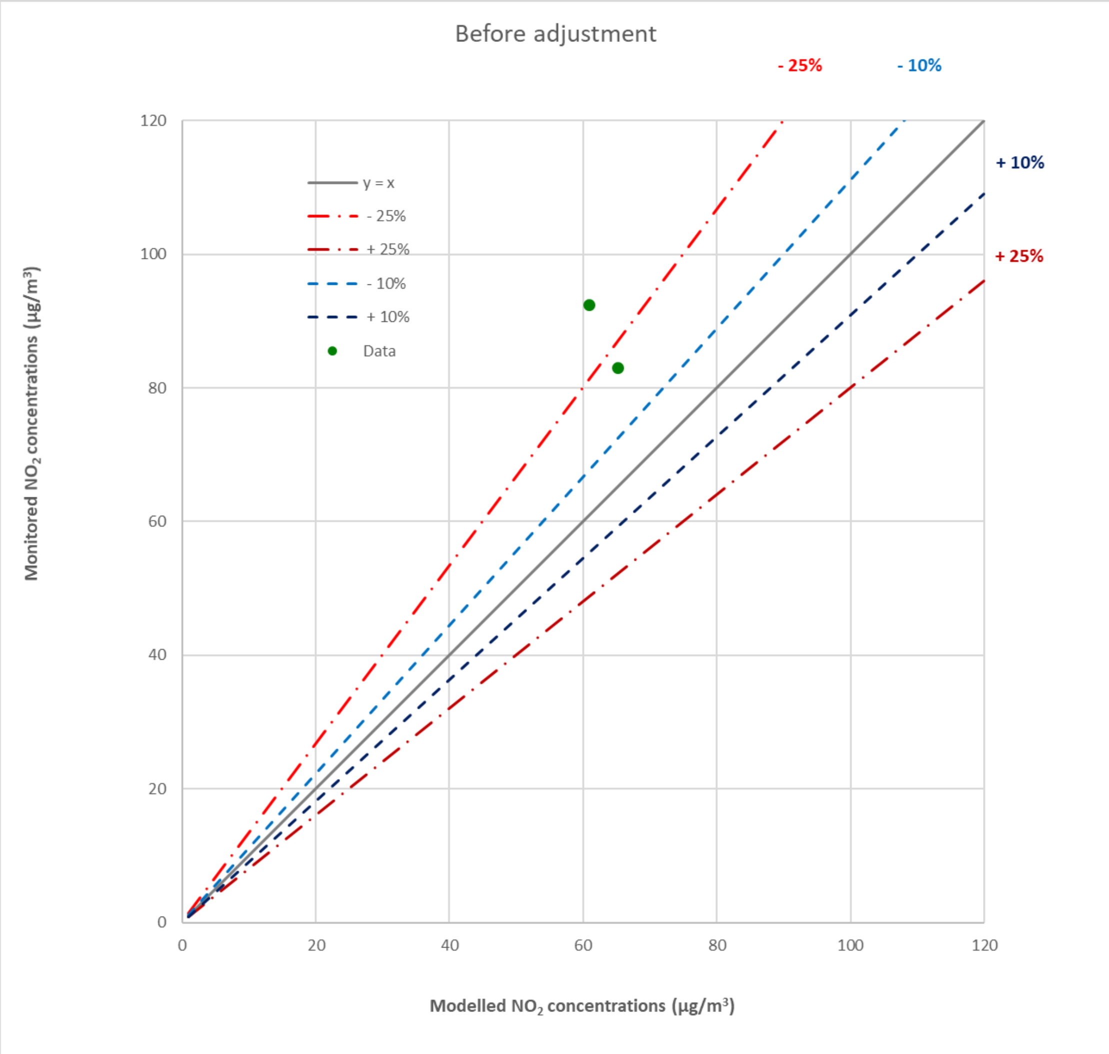
Site name	Monitoring pollutant	Monitored concentration ($\mu g/m^3$)	Modelled concentration ($\mu g/m^3$)	Difference of modelled vs monitored (%)
CA4 – Euston Road	NO_2	92.5	60.9	-34.1
CD9 – Euston Road	NO_2	83.0	65.1	-21.6

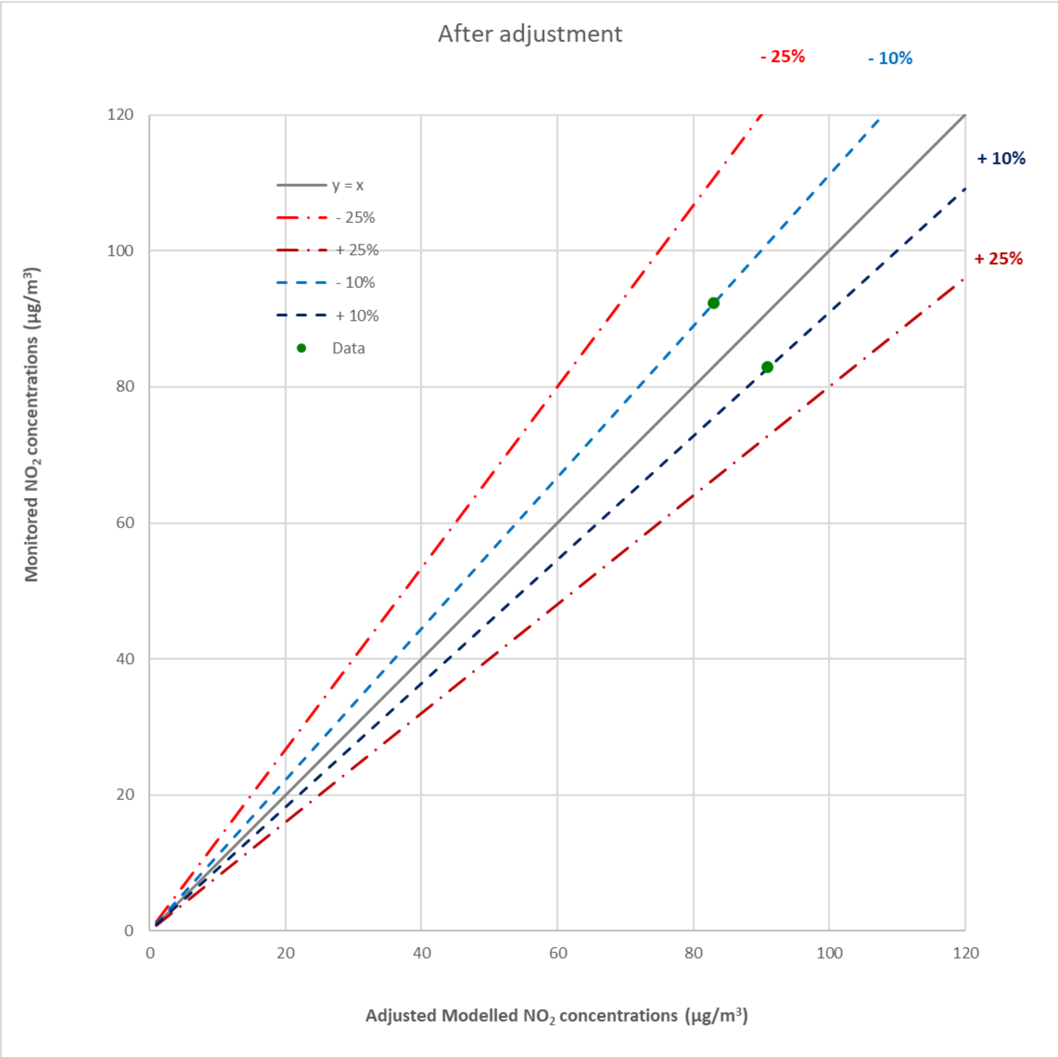
The verification process of the monitoring sites showed that the model was under-predicting NO_2 at CA4 and CD9 by 34.1% and 21.6% respectively. The difference between modelled and monitored was >±25% at both sites. The monitored and modelled NO_2 road contribution concentrations, were plotted and the equation of the trend line based on linear regression through zero calculated. This showed that a verification factor of 2.2 could be applied to all modelled NOx results from road traffic. The use of the factor produced the results presented in Appendix D. A graphical comparison of the monitored and modelled annual mean NO_2 concentrations before and after adjustment are should in Figure B1.

Table B2: Comparison of adjusted modelled and monitored annual mean for 2017

Site name	Monitoring pollutant	Monitored concentration ($\mu g/m^3$)	Adjusted modelled concentration ($\mu g/m^3$)	Difference of modelled vs monitored (%)
CA4 – Euston Road	NO_2	92.5	92.5	-10.3
CD9 – Euston Road	NO_2	83.0	83.0	9.4

Figure B1: Monitored and modelled annual mean NO_2 concentrations before and after adjustment





No adjustment of PM_{10} or $PM_{2.5}$ concentrations has been undertaken.

Appendix C

Where the Air Quality Objectives Should Apply

C1 Where the Air Quality Objectives Should Apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour mean and 8-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties[10].	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and: 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-min mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

Appendix D

Model Results

D1 Model Results

Table D1: NO_2 annual mean concentrations (µg/m^3)

Level	Height (m)	NO_2 annual mean concentrations (µg/m^3)																	
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
0	1.5	**48.8**	**50.5**	**58.7**	**60.8**	**72.3**	**66.3**	**62.9**	**53.1**	-	-	-	-	-	-	-	-	-	-
1	5.7	**48.1**	**49.4**	**54.2**	**56.6**	**63.9**	**60.4**	**58.3**	**51.6**	-	-	-	-	-	-	-	-	-	-
2	9.4	**46.9**	**47.8**	**49.8**	**51.8**	**55.2**	**53.9**	**52.8**	**49.3**	-	-	-	-	-	-	-	-	-	-
3	14	**45.0**	**45.5**	**46.2**	**47.2**	**48.2**	**47.8**	**47.4**	**46.3**	-	-	-	-	-	-	-	-	-	-
4	17.2	-	-	-	-	-	-	-	-	**43.9**	**44.0**	**44.2**	**44.4**	**44.9**	**45.2**	**45.2**	**45.1**	**44.8**	**44.4**
5	20.4	-	-	-	-	-	-	-	-	**42.7**	**42.8**	**42.9**	**43.0**	**43.2**	**43.3**	**43.3**	**43.2**	**43.1**	**42.9**
6	23.6	-	-	-	-	-	-	-	-	**41.7**	**41.8**	**41.8**	**41.9**	**41.9**	**42.0**	**41.9**	**41.9**	**41.8**	**41.8**
7	26.8	-	-	-	-	-	-	-	-	**40.9**	**40.9**	**41.0**	**41.0**	**41.0**	**41.0**	**41.0**	**41.0**	**40.9**	**40.9**
8	30	-	-	-	-	-	-	-	-	**40.3**	**40.3**	**40.3**	**40.4**	**40.3**	**40.4**	**40.3**	**40.3**	**40.2**	**40.3**
9	33.2	-	-	-	-	-	-	-	-	39.8	39.8	39.8	39.9	39.8	39.9	39.8	39.8	39.7	39.8
10	36.4	-	-	-	-	-	-	-	-	39.4	39.4	39.5	39.5	39.5	39.5	39.5	39.4	39.4	39.4
11	39.6	-	-	-	-	-	-	-	-	39.1	39.1	39.2	39.2	39.2	39.2	39.2	39.1	39.1	39.1
12	42.8	-	-	-	-	-	-	-	-	38.9	38.9	38.9	39.0	39.0	39.0	38.9	38.9	38.9	38.9
13	46.7	-	-	-	-	-	-	-	-	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
14	49.9	-	-	-	-	-	-	-	-	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6
15	53.1	-	-	-	-	-	-	-	-	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
16	56.3	-	-	-	-	-	-	-	-	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
17	59.5	-	-	-	-	-	-	-	-	38.3	38.3	38.3	38.4	38.4	38.4	38.3	38.3	38.3	38.3

Level	Height (m)	NO_2 annual mean concentrations (µg/m^3)																	
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
18	62.7	-	-	-	-	-	-	-	-	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3
19	65.9	-	-	-	-	-	-	-	-	38.2	38.2	38.2	38.3	38.3	38.3	38.2	38.2	38.2	38.2
20	69.1	-	-	-	-	-	-	-	-	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2
21	72.3	-	-	-	-	-	-	-	-	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2
22	75.5	-	-	-	-	-	-	-	-	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2
23	78.7	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
24	81.9	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
25	85.1	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
26	88.3	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
27	91.5	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
28	94.7	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
29	97.9	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
30	101.1	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
31	104.3	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
32	107.5	-	-	-	-	-	-	-	-	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
33	110.7	-	-	-	-	-	-	-	-	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
34	113.9	-	-	-	-	-	-	-	-	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
35	117.1	-	-	-	-	-	-	-	-	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
36	120.3	-	-	-	-	-	-	-	-	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
37	123.5	-	-	-	-	-	-	-	-	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
38	126.7	-	-	-	-	-	-	-	-	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0

Note: Exceedances of the air quality objectives for annual mean NO_2 concentration are highlighted in **bold**.

Table D2: PM_{10} annual mean concentrations (μg/m³)

Level	Height (m)	PM_{10} annual mean concentrations (μg/m³)																	
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
0	1.5	20.3	20.4	20.9	21.0	21.6	21.2	21.0	20.5	-	-	-	-	-	-	-	-	-	-
1	5.7	20.3	20.3	20.6	20.7	21.1	20.9	20.8	20.4	-	-	-	-	-	-	-	-	-	-
2	9.4	20.2	20.3	20.4	20.5	20.6	20.5	20.5	20.3	-	-	-	-	-	-	-	-	-	-
3	14	20.1	20.2	20.2	20.2	20.3	20.3	20.2	20.2	-	-	-	-	-	-	-	-	-	-
4	17.2	-	-	-	-	-	-	-	-	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
5	20.4	-	-	-	-	-	-	-	-	20.0	20.0	20.0	20.0	20.0	20.1	20.1	20.0	20.0	20.0
6	23.6	-	-	-	-	-	-	-	-	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
7	26.8	-	-	-	-	-	-	-	-	19.9	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.9	19.9
8	30	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
9	33.2	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
10	36.4	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
11	39.6	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
12	42.8	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
13	46.7	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
14	49.9	-	-	-	-	-	-	-	-	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
15	53.1	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
16	56.3	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
17	59.5	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
18	62.7	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
19	65.9	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8

Level	Height (m)	PM$_{10}$ annual mean concentrations (µg/m^3)																	
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
20	69.1	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
21	72.3	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
22	75.5	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
23	78.7	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
24	81.9	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
25	85.1	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
26	88.3	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
27	91.5	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
28	94.7	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
29	97.9	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
30	101.1	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
31	104.3	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
32	107.5	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
33	110.7	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
34	113.9	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
35	117.1	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
36	120.3	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
37	123.5	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
38	126.7	-	-	-	-	-	-	-	-	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8

Table D3: $PM_{2.5}$ annual mean concentrations (µg/m³)

Level	Height (m)	$PM_{2.5}$ annual mean concentrations (µg/m³)																	
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
0	1.5	13.6	13.6	13.9	14.0	14.5	14.2	14.1	13.7	-	-	-	-	-	-	-	-	-	-
1	5.7	13.5	13.6	13.8	13.8	14.1	14.0	13.9	13.7	-	-	-	-	-	-	-	-	-	-
2	9.4	13.5	13.5	13.6	13.7	13.8	13.7	13.7	13.6	-	-	-	-	-	-	-	-	-	-
3	14	13.4	13.5	13.5	13.5	13.5	13.5	13.5	13.5	-	-	-	-	-	-	-	-	-	-
4	17.2	-	-	-	-	-	-	-	-	13.4	13.4	13.4	13.4	13.4	13.5	13.5	13.4	13.4	13.4
5	20.4	-	-	-	-	-	-	-	-	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
6	23.6	-	-	-	-	-	-	-	-	13.3	13.3	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.3
7	26.8	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
8	30	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
9	33.2	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
10	36.4	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
11	39.6	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
12	42.8	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
13	46.7	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
14	49.9	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
15	53.1	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
16	56.3	-	-	-	-	-	-	-	-	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
17	59.5	-	-	-	-	-	-	-	-	13.2	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.2	13.2
18	62.7	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
19	65.9	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
20	69.1	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2

Level	Height (m)	$PM_{2.5}$ annual mean concentrations (µg/m³)																	
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
21	72.3	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
22	75.5	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
23	78.7	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
24	81.9	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
25	85.1	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
26	88.3	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
27	91.5	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
28	94.7	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
29	97.9	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
30	101.1	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
31	104.3	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
32	107.5	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
33	110.7	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
34	113.9	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
35	117.1	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
36	120.3	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
37	123.5	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
38	126.7	-	-	-	-	-	-	-	-	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2

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