16

Euston Tower

Retention Options Appraisal

16.1 Aim and Approach

16.1.1 General

This Section of the Feasibility Study considers design solutions that find the best balance between retaining elements of the existing tower, and the opportunities enabled by new-build elements. Ultimately this is looking at the extent of retention and extension, and the opportunities, challenges, advantages, and disadvantages caused by these approaches.

It was shown in Volume One that there is little opportunity, nor merit, in retaining any elements of the existing tower beyond its structure. The other major elements — the facade and MEP systems — are too outdated and poorly performing to retain in-situ, and have already mostly been stripped out in the case of MEP. Accordingly, retention in this study focuses on the extent of the existing structural system that can be retained and incorporated into a new proposal.

16.1.2 Outline of this Section

The following describes the outline of this Section of the study:

- **Section 16.2** describes the key considerations and parameters for the appraisals
- **Section 16.3** presents a selection of assessments that form the appraisal, with options from across the retention spectrum. It is acknowledged that the options appraisal cannot be exhaustive, but it is intended to be illustrative of the general principles.

The aim is to systematically step through the interventions, and assess each intervention, transparently and objectively, against a set of overarching considerations. However, because the merits of a scheme are determined by multiple parameters, it is challenging to assess individual parameters (e.g. number of slabs retained, extent of core retained) in an isolated manner. Rather they need to be looked at in the context of an overall proposal. Therefore they are combined into a set of proposals with varying degrees of intervention. This is detailed in Section 16.3 where the proposals are assessed:

- **Major Refurbishment and Extension**
  Shown in Volume One not to be feasible
- **Retention and Partial Extension**
  Max Retention
- **Retention and Extension**
  "Full" Retention
- **Partial Retention and Extension and Disassemble and Reuse**
  Retain Consecutive Slabs (Office)
  Retain Consecutive Slabs (Office and Lab)
  Retain Interstitial Slabs (Office)
  Retain Interstitial Slabs (Office and Lab)
  Retain the Core
- **New Build**
  New Build.

Throughout this study, options are assessed using the same, typical extended floorplate. The extent of this floorplate is intended to be indicative of one plausible extension only, and it does not presuppose the outcome of any developments around massing. An exception is the Retention and Partial Extension option which uses a smaller extension.

Ultimately the conclusions are not sensitive to the shape or absolute dimensions of the extended floorplate. This to say that the outcome of this assessment would be the same regardless of the shape of the extension.

The options appraisal in this section are based on detailed, individual studies of core layouts, slab retention, and section retention. These detailed studies are included in the Appendices:

- **Appendix A** looks at core designs and floorplate layouts with differing degrees of retention. It looks at the plans in isolation and does not consider the impact of the stack.
- **Appendix B** studies options for retaining different proportions of the existing floor slab. Here each option is paired with a commensurate core layout, noting that others could be chosen though this would not affect the outcomes. It looks at the plans in isolation and does not consider the impact of the stack.
- **Appendix C** considers the vertical section looking at how many slabs could be retained. It looks at the sections in isolation, not considering the floorplate layouts.

Figure 16.1 View from the roof of Euston Tower 2022

16.2 Considerations and Parameters

16.2.1 Considerations

The brief for this Section can be summarised as follows:

- Retain as much of the existing structure as possible
- Design floorplates and a structural system that are future-proofed
- Prioritise health & safety, and buildability
- Ensure reasonable efficiencies and viability
- Consider potential to incorporate lab-enabled spaces.

Retain Structure
All options in this study are based on retaining as much as possible of the existing concrete structure. The various structural elements which make up the existing structure are: basement foundations, slabs, columns, central core, and satellite cores. The degree to which each of these elements is retained varies between the options studied.

Future-proofed
There are two time lenses associated with future-proofing. The in-use lens looks at flexibility and adaptability of the building during its lifetime. This considers the floorplate layout (core positioning, grids, circulation) and how it may influence future spatial flexibility. It also considers adaptability, which are more intrusive moves (e.g. creating a double height space) that would give the building added longevity by enabling it to flex to future demands.

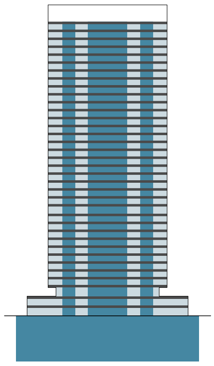
The end of life lens looks at design for disassembly. Here the aim is to design in methods of non-destructive disassembly where possible, to promote material reuse and reduce waste in the future. The degree to which the options could be future-proofed is contingent on any limitations carried over from the existing structure.

Health & Safety and Buildability
Demolishing and constructing within an existing building, often simultaneously, introduces different health & safety risks relative to typical blue sky construction. Similarly cutting and carving elements out of the existing structure generally changes its loading characteristics, and temporary stability works are often needed to support this.

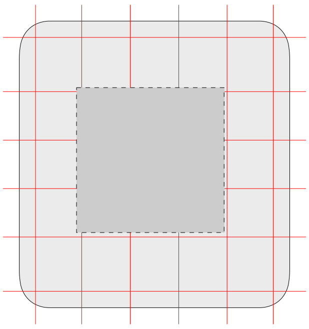
Each option presents a different degree of retention, upgrade, and extension of the existing structure, with a unique set of health & safety considerations and differing extent of temporary works required.

Efficiency and Viability
It is critical that the options could be plausibly delivered at reasonable viabilities and with reasonable Estimated Rental Values (ERVs). This means giving consideration to construction complexity (and therefore programme and cost), lettability, and also overall efficiency of the massing and floorplates.

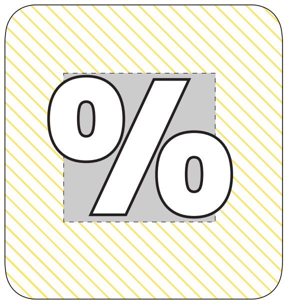
Lab-enabled
Flexibility to incorporate lab-enabled spaces is desirable to maximise future use options and contribute to the growth and success of the Knowledge Quarter. However, it is acknowledged that, while it remains a desire and a consideration, the ability to provide or not provide lab-enabled spaces should not dictate building use.



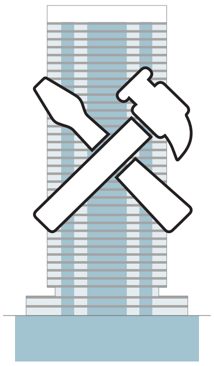
RETAIN STRUCTURE
Endeavour to retain as much structure as possible



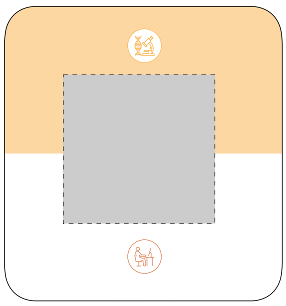
FUTURE-PROOFED
Ability to flex and adapt to changing trends and demands



EFFICIENCY AND VIABILITY
Deliver market-attractive floorplates with reasonable efficiencies



HEALTH & SAFETY AND BUILDABILITY
A construction methodology that is safe and practical



LAB-ENABLED
Provide spaces capable of being used as lab spaces

Figure 16.2 Key considerations for assessing the options in this study

16.2.2 Parameters

As a means of testing the extent of structural retention that could be achieved, the following parameters are investigated:

- Floorplate layout
- Extent of slab retained
- Extent of section retained.

Floorplate Layout
The floorplate layout must incorporate the design of a core or cores that maximises reuse of the existing structural elements, brings the building up to compliance with current Building Regulations (see Volume One and Section 15), and delivers an acceptable floorplate efficiency (net to gross).

The resulting layout, from a perspective of circulation and grid, should also be flexible to accommodate multiple configurations, and occupiers, both now and well into the future.

Extent of Slab Retained
It is not always possible, or desirable, to retain the full slab. This is partially owing to the upgrades required to bring the existing building up to compliance with current Building Regulations (see Volume One and Section 15), and partially owing to new elements dictated by the extended floorplates.

This parameter considers how much of the existing slab could be retained to produce a plausible and structurally sound proposal.

Extent of Section Retained
This parameter is evaluating how much of the existing building could be retained vertically, while achieving as many of the brief requirements as possible. There are multiple elements to consider within this parameter, specifically the central core, satellite cores, number of slabs retained, and combinations thereof.

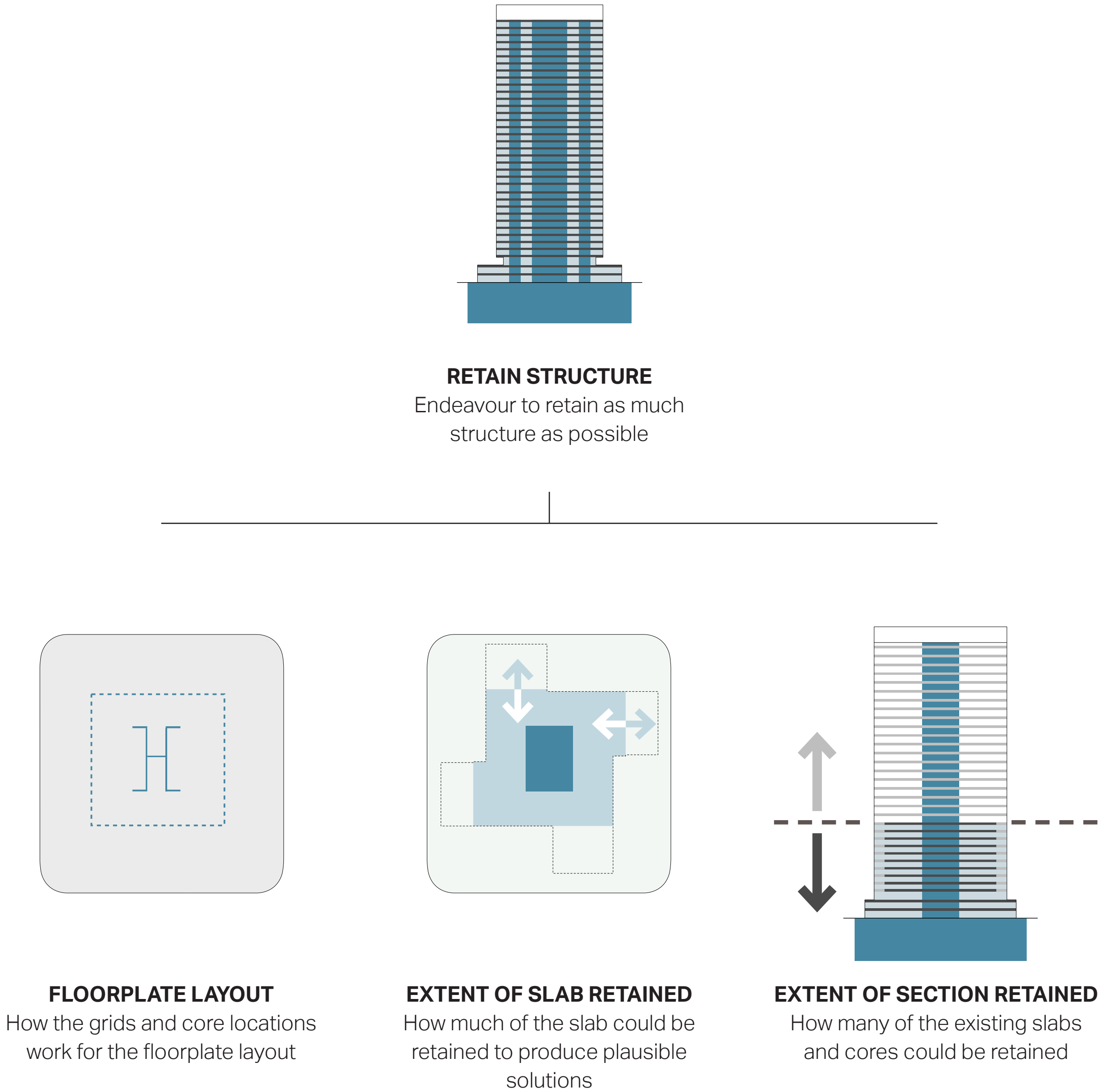


Figure 16.3 Key parameters for developing the options in this study

16.3 Options Appraisal

There are five approaches presented in this Section. The approaches are categorised under the following headings:

- Major Refurbishment
- Retention and Partial Extension
- Retention and Extension
- Partial Retention and Extension (Disassemble and Reuse)
- New Build.

In Volume One, it was shown that a major refurbishment option — working within the existing envelope — is not feasible. Of the remainder, there are plausible options that span the gamut from least deconstruction in the case of the retention and partial extension options, to most deconstruction in the case of the new build option. This is shown in Figure 16.4.

With the exception of the new build option, all options would retain the existing below ground substructure and foundations. The extent of existing structure above ground, and the way in which it would be maintained, is the main difference between the options.

Major Refurbishment

- Shown in Volume One not to be feasible. It is not considered further.

Retention and Partial Extension

- Max Retention option that maximises existing structure retention. It retains all existing floor slabs with new construction only for a small extension that is supported off of the existing structure, and the new cores which are located outside of the footprint of the existing building. It maintains the central core structure and the existing floor to floor height of 3,200mm.

Retention and Extension

- **"Full" Retention** option that retains all existing floor slabs with new construction for the extension only. It maintains the central core structure and two of the satellite cores. It maintains the existing floor to floor height of 3,200mm.

Partial Retention and Extension and Disassemble and Reuse

Five options are explored in this category:

- **Retain Consecutive Slabs (Office)** option that retains all existing floor slabs below Level 12, and builds new slabs above. It maintains the central core structure. Existing slabs maintain the existing floor to floor height of 3,200mm, while new slabs have a floor to floor height of 3,800mm suitable for office use.
- **Retain Consecutive Slabs (Office and Lab)** option that retains most existing floor slabs below Level 12, and builds new slabs above. It maintains the central core structure. Portions of the existing slabs are removed below Level 12, in order to provide double-height space suitable for lab use. Existing office areas maintain the existing floor to floor height of 3,200mm with 6,400mm for the lab spaces, while new slabs have a floor to floor height of 3,800mm suitable for office use.
- **Retain Interstitial Slabs (Office)** option that strategically retains interstitial (approximately every 6th) existing floor slabs, and builds new slabs in between. 6 slabs are retained above the podium. It maintains the central core structure. It delivers office storeys with three different floor to floor heights: 3,840mm in the lower portion of the stack, 3,980mm in the mid portion, 3,840mm in the upper portion, and 4,800mm for the uppermost two storeys.
- **Retain Interstitial Slabs (Office and Lab)** option that strategically retains interstitial existing floor slabs, and builds new slabs in between. 6 slabs are retained above the podium. It maintains the central core structure. It delivers lab-enabled storeys with floor to floor height 4,266mm in the lower portion of the stack and office storeys with floor to floor heights of 3,980mm and 3,840mm in the mid and upper portions of the stack respectively. The uppermost storey is 7,040mm.
- **Retain the Core** option that retains the central core and below ground foundations only. All slabs are built new. Office levels have a floor to floor height of 3,800mm, with the flexibility to include lab-enabled floors with higher floor to floor heights of 4,100mm.

New Build

- **New Build** option demolishes and recycles the full existing tower. No structure is retained (including foundation and substructure).It delivers office levels with a floor to floor height of 3,800mm, with the flexibility to include lab-enabled floors with higher floor to floor heights of 4,100mm.

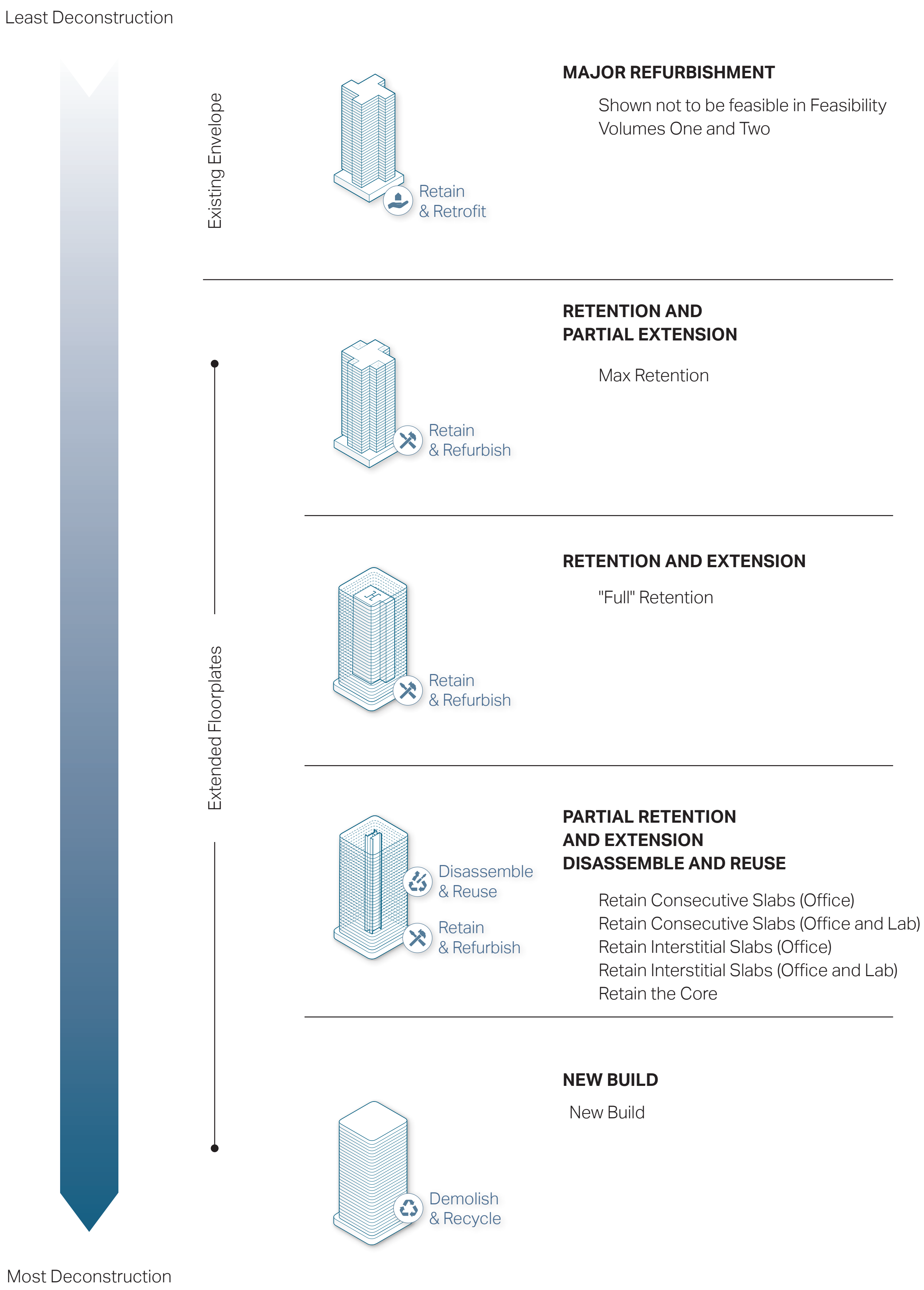


Figure 16.4 Overview of options

16.3.1 Retention and Partial Extension - Max Retention

Description

This option seeks to maximise retention, retaining all existing floor slabs. It would maintain the central core structure, but remove and infill all four satellite cores. New core areas would be added outside the footprint of the existing floorplate, and the floorplates extended by 900mm. Floors would maintain the existing floor to floor height of 3,200mm.

Structural retention would be at best 93% retention by carbon (or 92% by volume). See Figure 16.9 where the reduction from maximum is due primarily to the core layout which does not retain the satellite cores.

The section and floor slab retention diagrams are shown in Figure 16.8, with the structural retention diagrams shown in Figure 16.9.

The programme stack and room sections are shown in Figure 16.10 overleaf.

Ultimately the existing floor to floor height is challenging for delivering a modern office offering. While improved over the existing building, this option would create a larger quantum of compromised floor space, noting that the additional space at the perimeter is difficult to use effectively due to the existing column positions and proximities to the external cores. At the same time, it would carry the existing column grid, and retain the limitations of the existing structure, hindering flexibility and adaptability in-use, and potential for non-destructive disassembly at end of life. This option is not considered further because it does not solve these issues.

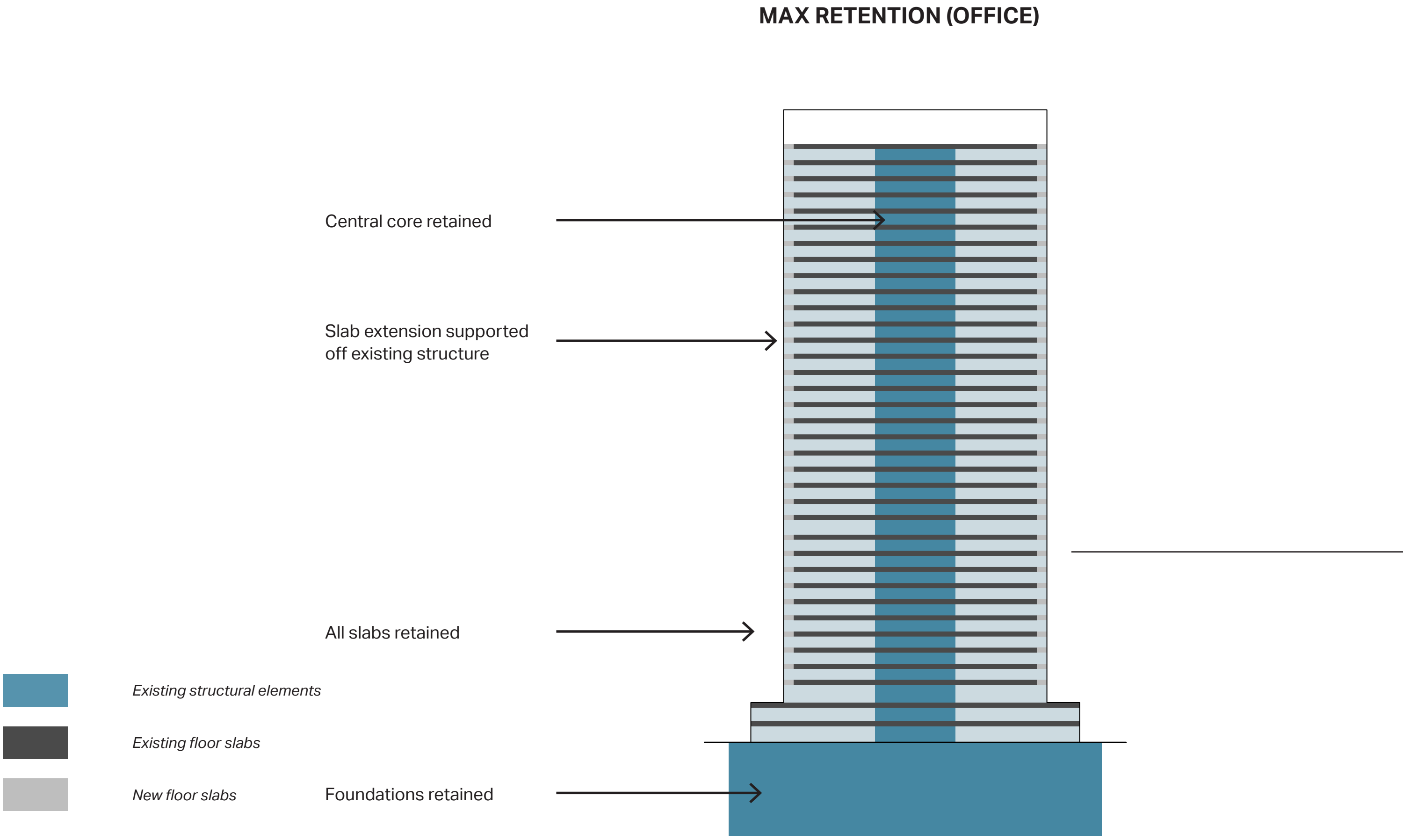
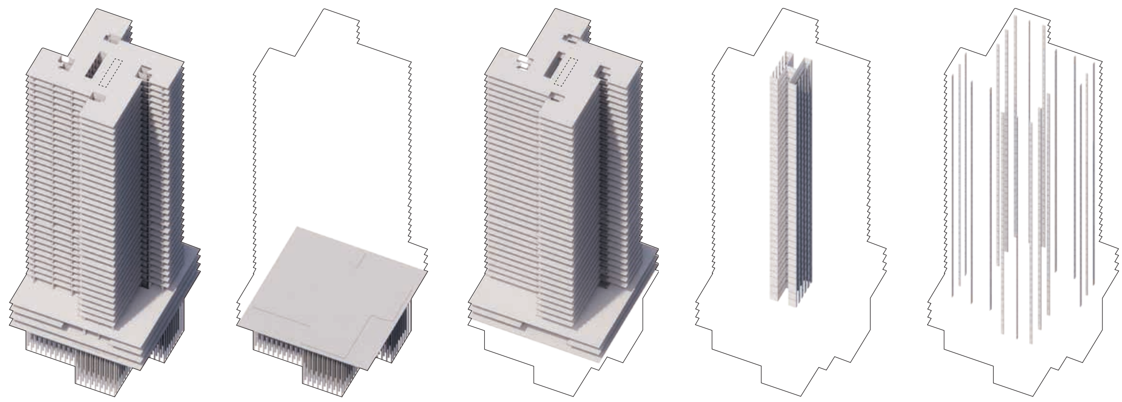


Figure 16.5 Diagram showing retained structural elements in this option (section above and slabs opposite)



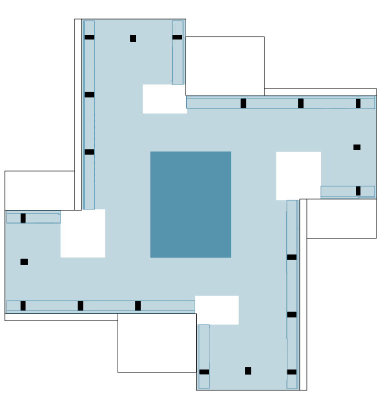
MAXIMUM POSSIBLE WITHOUT EXTENSION*
89 %

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**8,361** tCO2e	**1,683** tCO2e	**5,348** tCO2e	**679** tCO2e	**651** tCO2e
Ratio of Carbon	**93** %	**19** %	**60**%	**8** %	**7** %

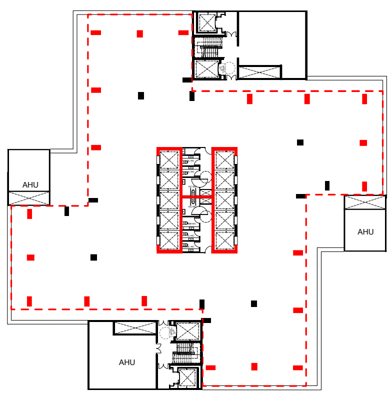
** Assumes no floorplate extension (i.e. working within the existing envelope), meaning new risers need to be cut out of the existing floorplate. Refer to Section 15. With extended floorplates, possibility exists to position risers outside of this existing footprint, resulting in potential higher degrees of retention.*

Figure 16.6 Embodied carbon and retention of structure broken down by structural element

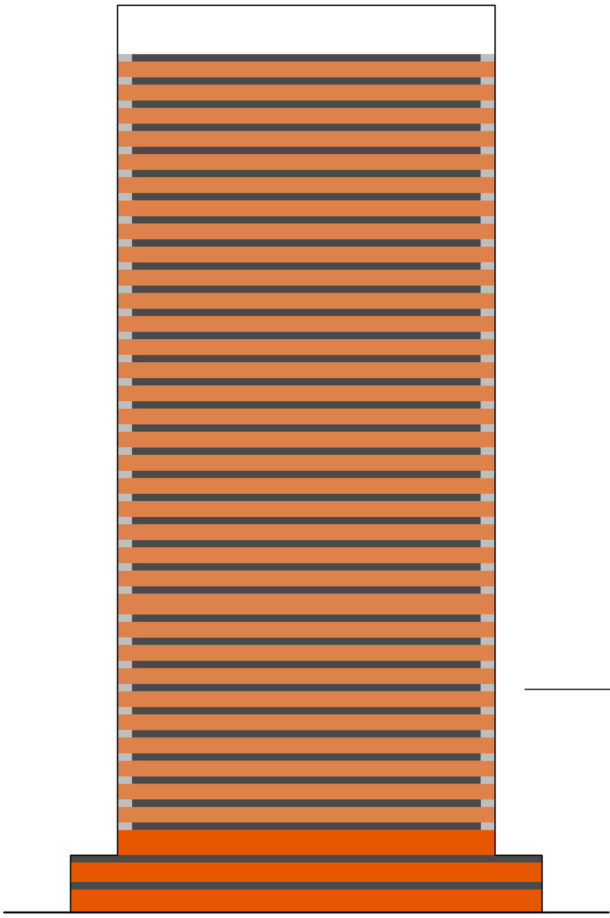
ALL LEVELS
Central core retained, full existing slab retained, all satellite cores removed



INDICATIVE CORE LAYOUT
Retain central core and append new core areas outside existing footprint



PROGRAMME AND SECTION STACK
Max Retention (Office)



3.2m floor to floor office space

New-build floor slab

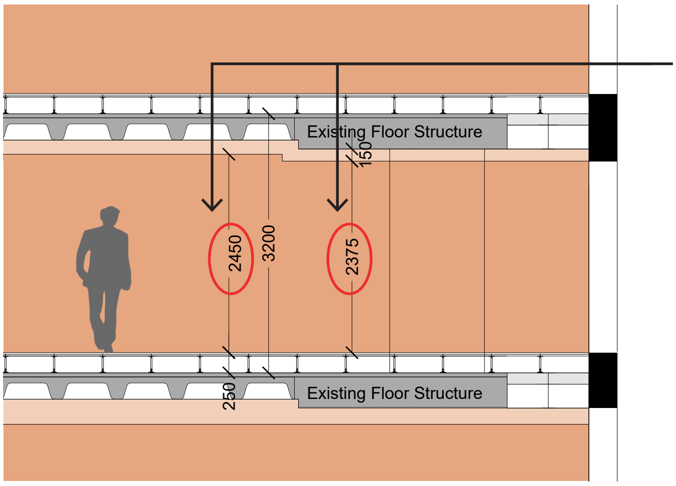
Podium amenity

Retained floor slab

Figure 16.7   Programme stack diagram (above) and room section (opposite)

ALL LEVELS (DROPPED CEILING)

Floor to floor	3,200mm
Floor to ceiling	2,375mm (2,450mm achievable under areas of existing ribbed slab)



Floor to ceiling height of 2,375mm compromises quality of space. With the extension, there is even more quantum of compromised floor space. 2,450mm achievable only under areas of existing ribbed slab. These levels could be delivered without a dropped ceiling and achieve 2,425mm clear (refer to Section 16.3.2).

Structural Rationale for the Extension
This option would retain all existing floor slabs and extend the existing floorplate by 900mm as the maximum extension that can be cantilevered off of the existing structure. New core elements are added outside the footprint of the existing floorplate to reduce the need for any new major penetrations in the existing floor slabs.

To achieve this structurally, a new steel frame would be constructed in the new areas with the structural depth of the floorplate limited to the existing structural floor depth, i.e. 15 in. or ca. 380mm. It is most sensible for this extension to be supported off the existing structure. As such, a load balance approach is practical.

Removal of the satellite cores is not trivial. Modifications to the existing stability structure mean that new, supplementary stability structure is required. This would be achieved by using the new appended core elements as part of the global stability system.

A larger horizontal extension could be provided if the vertical structure and foundations are strengthened. This would require new vertical structure and substructure, making the marginal area gain carbon intensive.

Future-proofed
Flexibility of the floorplates would be inhibited by having to work within the constraints of the existing column grid due to retaining the existing slabs. Existing columns would be positioned with spans that are not ideal for a modern office layout, and would be irregular meaning they are difficult to subdivide rationally.

From an adaptability perspective, there is no opportunity to design in double-height amenity spaces, or additional soft spots. This would inhibit the building being able to change to suit future trends, increasing its risk of becoming obsolete prematurely. This limitation is extended to the ability to design the structural system for ease of disassembly, promoting material reuse and reducing potential waste in the future.

Health & Safety and Buildability
Buildability would be moderately complex. The risk of unknowns in the existing structure is increased with significant levels of retention, and the lack of consistency from level to level is likely to introduce further complexity at each of the interfaces between existing and new structure.

A large part of the construction complexity is driven by the temporary works requirements. In this case there would be moderate temporary works required where there would be unconstrained slab edges on every level. Where the existing satellite cores would be removed, the key is maintaining continuity of the perimeter ring beam to support the retained slab, meaning that new construction would be required prior to demolition of the satellite cores. This would introduce an additional health & safety risk by having demolition and construction activities happening simultaneously and in close proximity.

Efficiency and Viability
This option would be challenging from a viability perspective because, while it represents an improvement over the existing building, floor space is still compromised. All levels would retain the existing building floor to floor height of 3,200m, which was shown in Volume One (and Section 2 of this document), to be challenging for delivering a modern office offering, making leasing difficult on these floors, if not impossible. Additionally, significant works are required to deliver little additional net area, and the area that is delivered (the 900mm cantilever at the perimeter zone) is hindered by the existing column positions.

Lab-enabled
This option presents no opportunity for lab-enabled spaces due to floor to floor heights being too low for lab use.

Site Capacity
This option does not optimise site capacity, and public realm upgrades would be limited by the scale of the redevelopment. Refer to Volume One Section 5.4. It does not provide the in-demand lab-enabled space required in London.

16.3.2 Retention and Extension - "Full" Retention

Description

This option seeks to maximise retention, retaining all existing floor slabs. It would maintain the central core structure, as well as the west and east satellite cores. Floors would maintain the existing floor to floor height of 3,200mm. Floors would be extended to deliver an expanded floorplate.

Maximum structural retention would be at best 89% retention by carbon (or 90% by volume) once the slabs are upgraded to current regulations within the existing floorplate, as shown previously in Section 15. In this case 84% retention by carbon would be achieved (or 85 % by volume). See Figure 16.9 where the reduction from maximum is due primarily to the core layout which does not retain all the satellite cores.

The section and floor slab retention diagrams are shown in Figure 16.8, with the structural retention diagrams shown in Figure 16.9.

The programme stack and room sections are shown in Figure 16.10 overleaf.

Ultimately the existing floor to floor height is challenging for delivering a modern office offering. This option would only create a larger quantum of highly compromised floor space. At the same time, it would carry the existing column grid, and retain many of the limitations of the existing structure, hindering flexibility and adaptability in-use, and potential for non-destructive disassembly at end of life. This option is not considered further because it does not solve these issues.

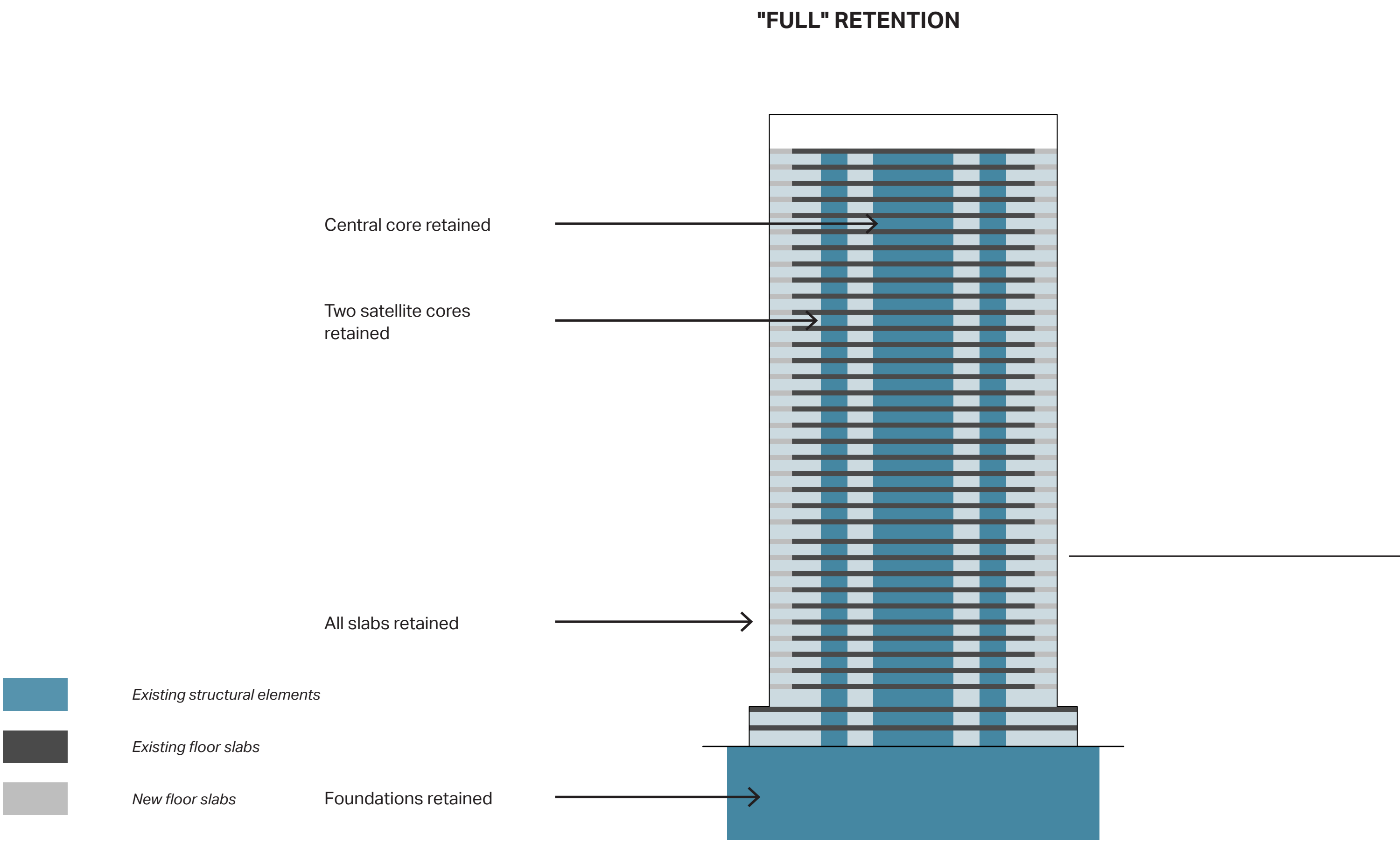
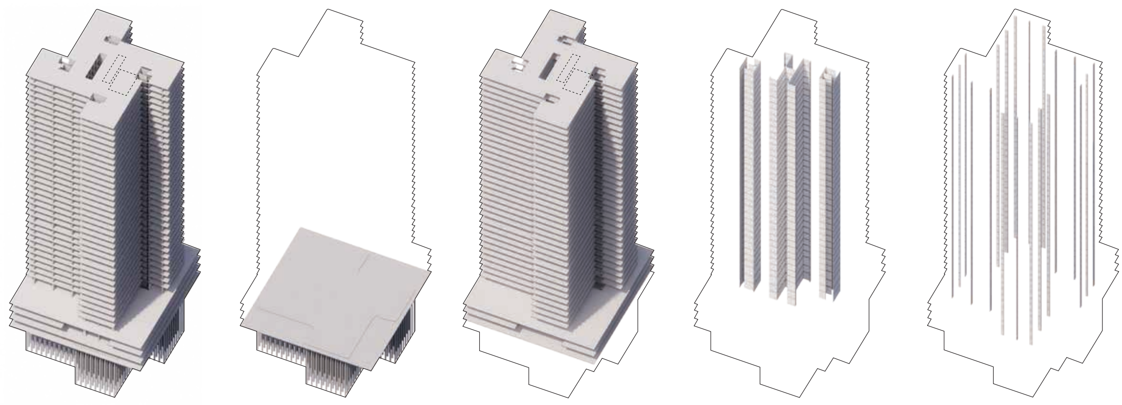


Figure 16.8 Diagram showing retained structural elements in this option (section above and slabs opposite)

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS



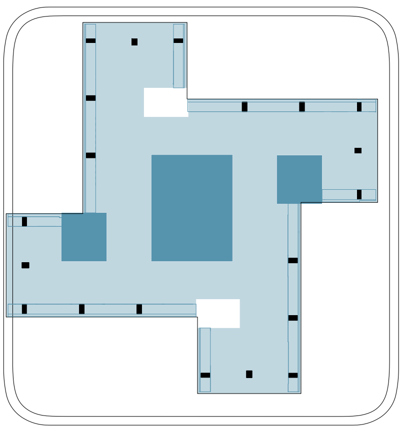
MAXIMUM POSSIBLE WITHOUT EXTENSION*
89 %

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**7,525** tCO_2e	**1,683** tCO_2e	**4,278** tCO_2e	**912** tCO_2e	**651** tCO_2e
Ratio of Carbon	**84** %	**19** %	**48**%	**10** %	**7** %

** Assumes no floorplate extension (i.e. working within the existing envelope), meaning new risers need to be cut out of the existing floorplate. Refer to Section 15. With extended floorplates, possibility exists to position risers outside of this existing footprint, resulting in potential higher degrees of retention.*

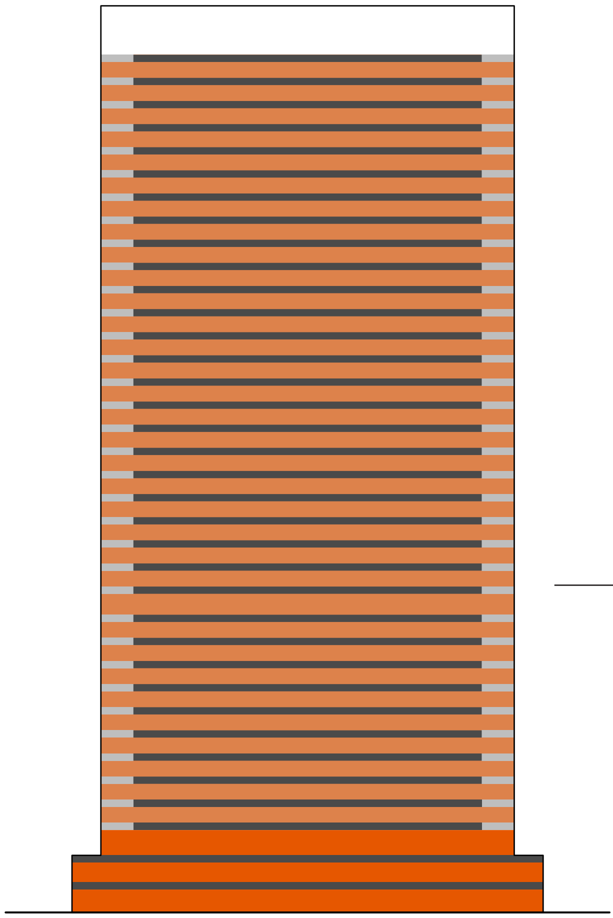
Figure 16.9 Embodied carbon and retention of structure broken down by structural element

ALL LEVELS
Central and two satellite cores retained, full existing slab retained, north and south satellite cores removed



INDICATIVE CORE LAYOUT
Retain Central Core and Two Satellite Cores

PROGRAMME AND SECTION STACK
"Full" Retention



3.8m floor to floor office space

3.2m floor to floor office space

Podium amenity

New-build floor slab

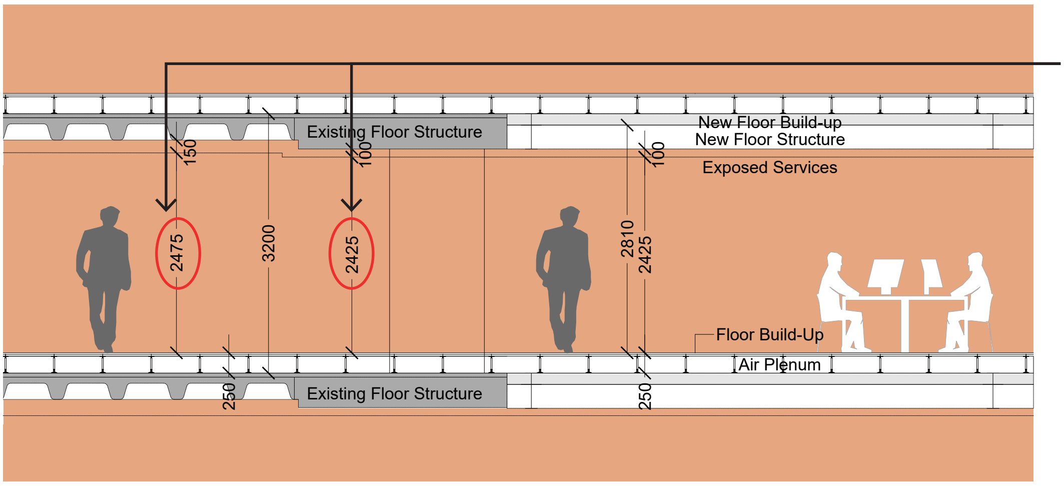
Retained floor slab

Figure 16.10 Programme stack diagram (above) and room sections (opposite)

ALL LEVELS (EXPOSED SERVICES)

Floor to floor 3,200mm

Floor to ceiling 2,425mm (2,475mm achievable under areas of existing ribbed slab)

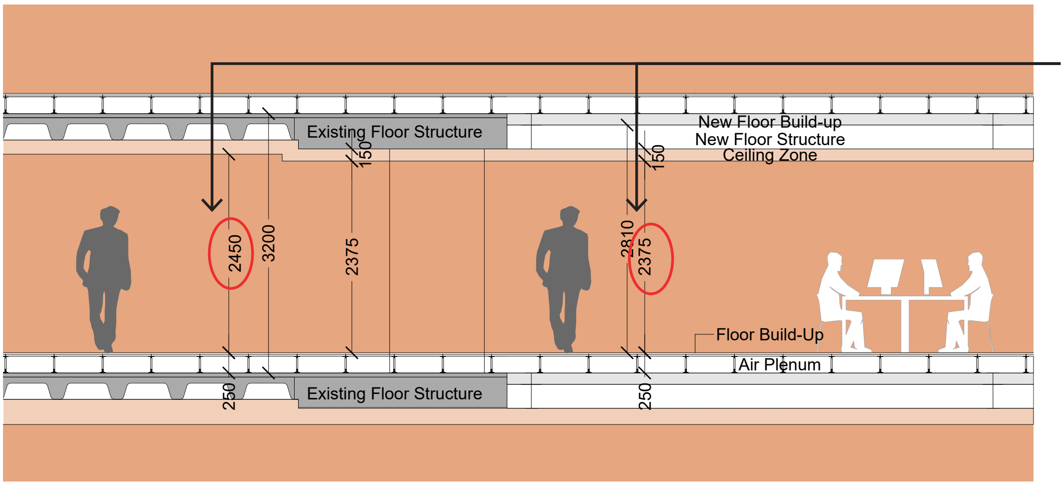


Floor to underside of services height of 2,475mm is achievable only under areas of existing ribbed slab. A clear height to the underside of services of 2,425mm is achievable across all other areas of the floorplate. Exposing the services may not be to every tenant's liking.

ALL LEVELS (DROPPED CEILING)

Floor to floor 3,200mm

Floor to ceiling 2,375mm (2,450mm achievable under areas of existing ribbed slab)



Floor to ceiling height of 2,375mm compromises quality of space. With the extension, there is even more quantum of compromised floor space. 2,450mm achievable only under areas of existing ribbed slab.

Floor to Ceiling Heights
In Figure 16.10, options are shown for the floor sections. One option has exposed services (to maximise floor to ceiling heights or perception of height), and one option has a dropped ceiling to maximise flexibility for tenants.

The exposed services option could achieve 2,475mm clear, which would be compliant with the BCO recommendation for floor to ceiling heights in refurbished buildings (2,450-2,800mm) only under areas of existing ribbed slab. There would be extensive areas of the floor slab that would not be compliant with the BCO recommendation.

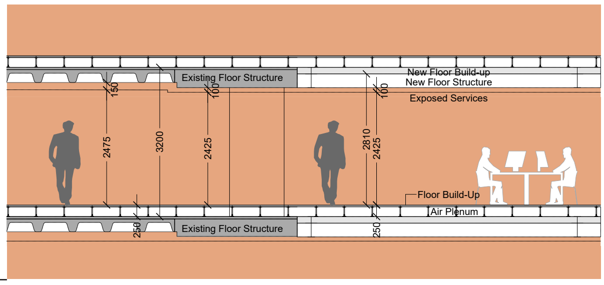
The dropped ceiling option could not achieve 2,450mm clear height, and would not comply with the BCO recommendation for floor to ceiling heights in refurbished buildings (2,450-2,800mm), save for under areas of existing ribbed slab. There would therefore be extensive areas of the floor slab that would not be compliant with the BCO recommendation.

In order to maximise clear height, services would be kept clear of the ring beam zone so far as possible because the ring beam is deeper than the rest of the floor system (see Figure 16.11). This would lead to restrictions on floor layout in these areas (e.g. no lighting fixtures would be placed below the ring beam), and crossovers, like sprinkler mains, would be rationalised to minimise the localised points where clear height would be below the BCO recommendation.

Ultimately this strategy would result in compromised floor space. The extent of this compromise is shown in the diagram in Figure 16.12.

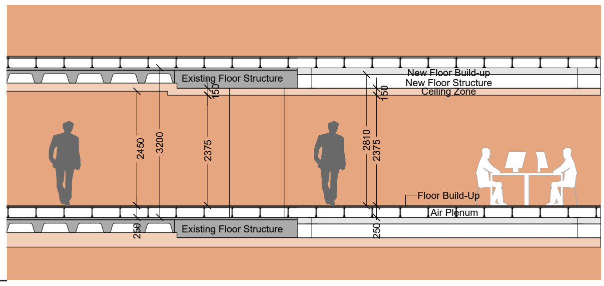
Figure 16.11 Existing ring beam is deeper than the rest of the structural floor system, creating a pinch point for clear floor to ceiling heights once new ceiling services are installed

EXPOSED SERVICES



Indicative section

DROPPED CEILING



Indicative section

Services below existing ribbed slab zone. BCO refurb compliant with clear height 2,450mm (dropped ceiling) or 2,475mm (exposed services)

Restricted services zone / non-compliant zone. If services drop into this area would not be BCO compliant

BCO guidelines for refurbishments

Floor to celling heights 2,450-2,800mm

Figure 16.12 Floor to ceiling heights compared to BCO recommendation for refurbishments

16.3.3 Partial Retention and Extension - Retain Consecutive Slabs (Office)

Description

This option would retain all existing floor slabs below Level 12, and build new slabs above. It would maintain the central core structure. Existing slabs would maintain the existing floor to floor height of 3,200mm, new slabs would have a floor to floor height of 3,800mm suitable for modern office use. Floors would be extended to deliver an expanded floorplate.

The section and floor slab retention diagrams are shown in Figure 16.5. The programme stack and room sections are shown in Figure 16.7 overleaf.

Level 12 is chosen as the split between the lower retained stack and the upper portion where new slabs would be built out. This is because the existing Level 12 is an MEP service level and has a larger floor to floor height (3.9m) than the typical existing office floors (3.2m). The vertical transport strategy would be reliant on using double decker lifts (reducing the footprint of lifts required and therefore resulting in improved floorplate efficiency), but these are contingent on a consistent inter-storey height. The alternatives are twin lifts (which can accommodate varying inter-storey heights) for which there is a single-source supply procurement risk, or using conventional single-decker lifts, but this would inflate the core and significantly erode the net to gross efficiency. Respectively, these two alternatives result in a level of risk that is unacceptable to the development (if the twin lifts cannot be procured the development cannot go ahead as planned), and a net to gross efficiency that will be not be viable to deliver. Accordingly, within the constraints of the vertical transport strategy, it would not be possible to retain a single level with an odd floor to floor height.

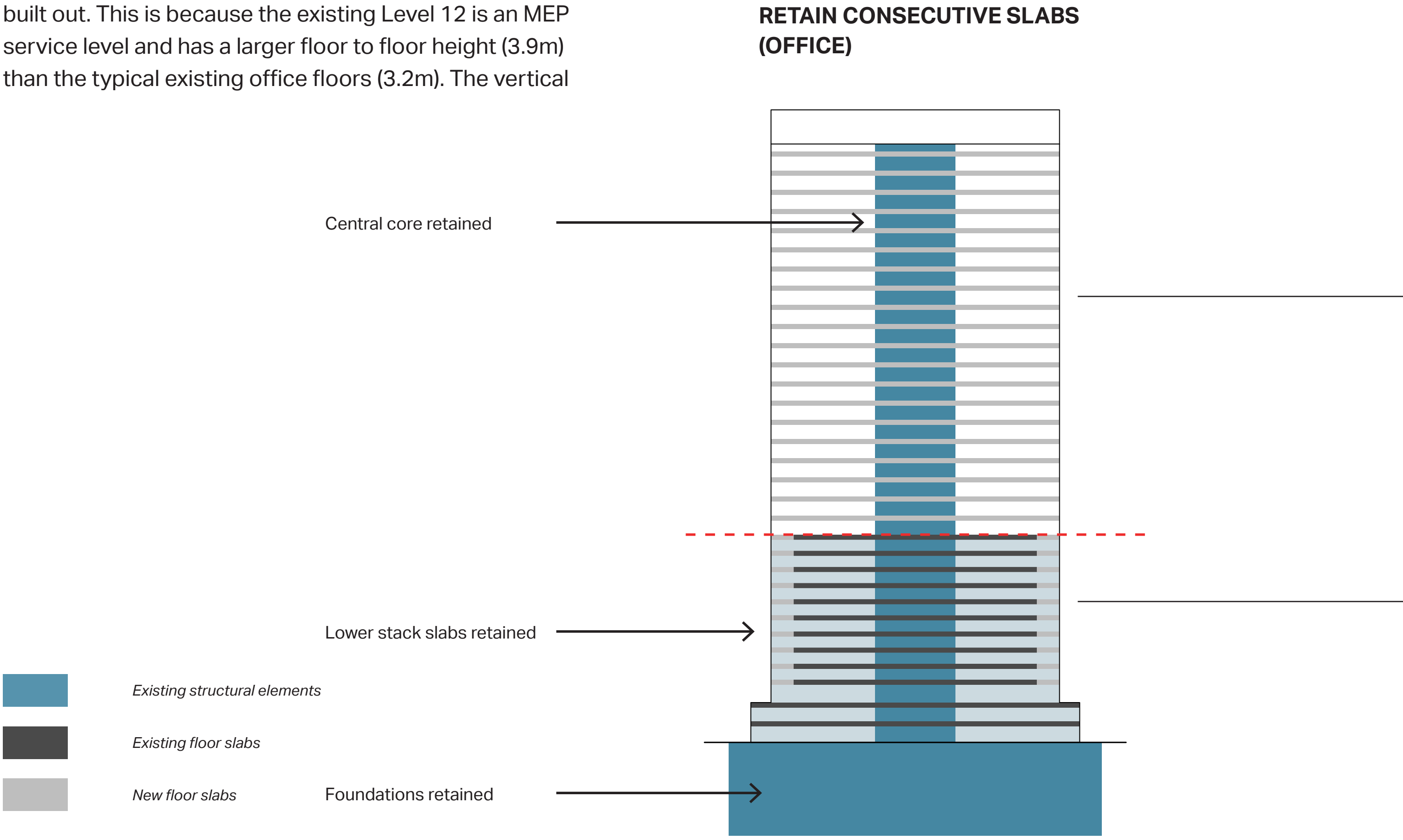
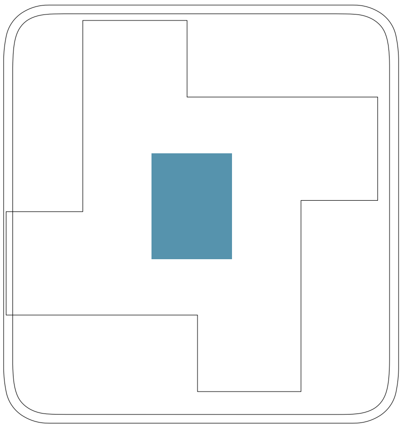
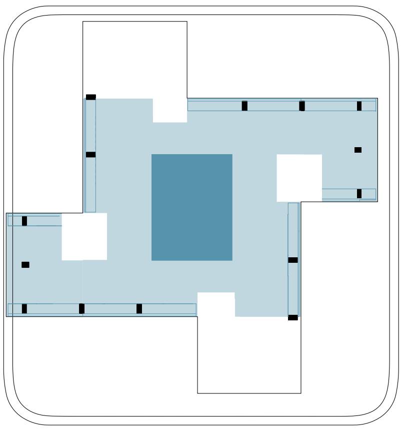


Figure 16.13 Diagram showing retained structural elements in this option (section above and slabs opposite)

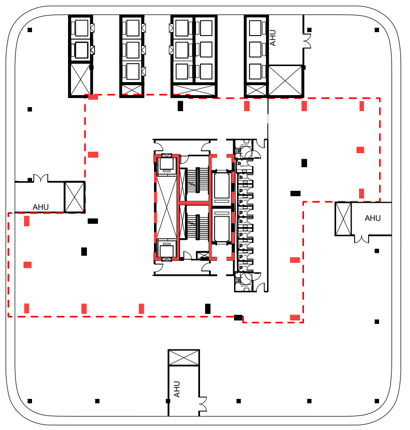
UPPER STACK
Core retained, floorplates removed



LOWER STACK
Core retained, central square and east and west pinwheel arms retained



INDICATIVE CORE LAYOUT
Retain Central Core with Centralised North Core



PROGRAMME AND SECTION STACK
Retain Consecutive Slabs (Office)

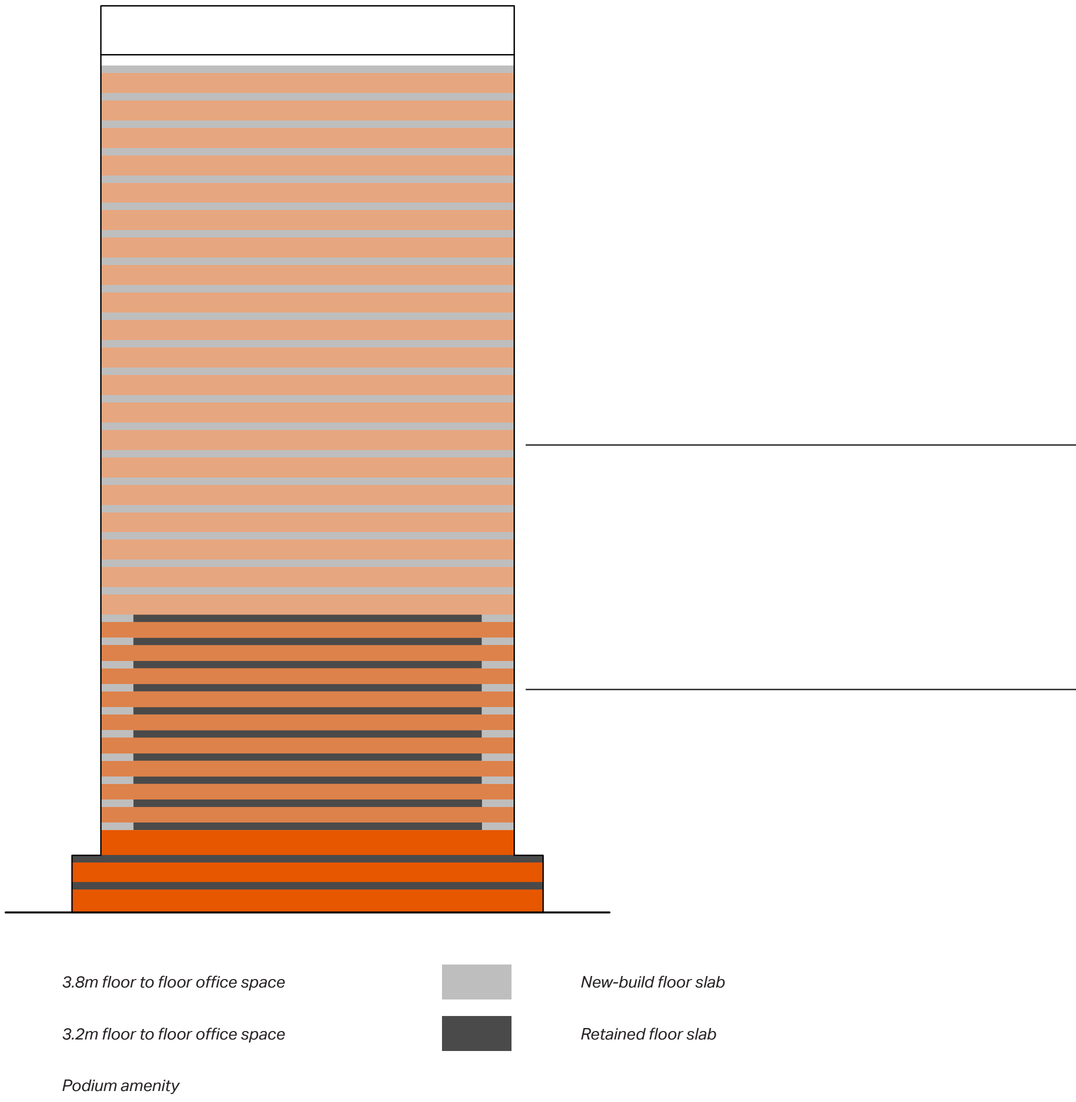
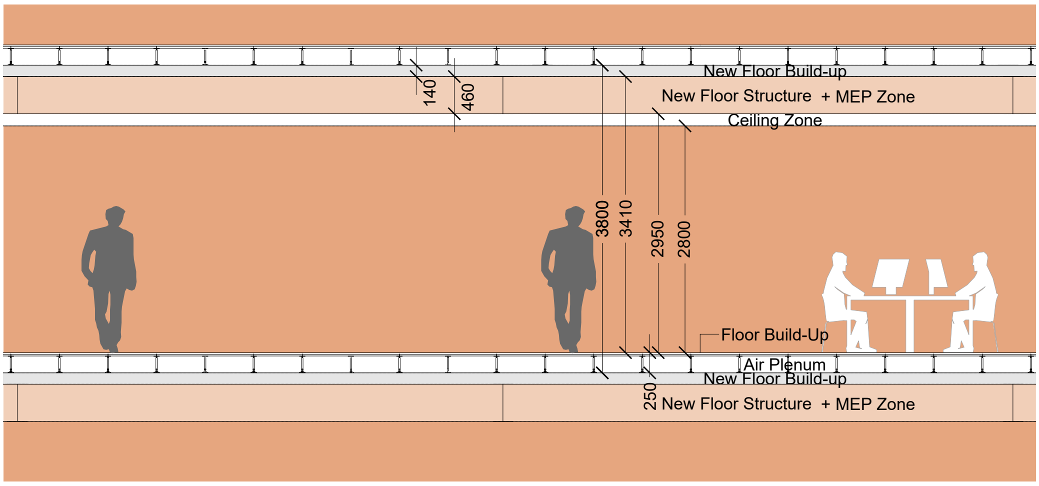
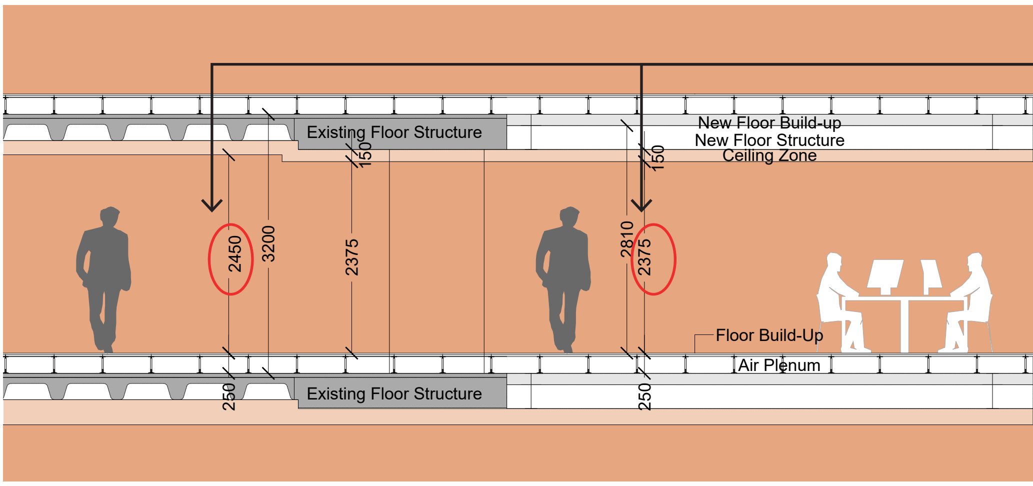


Figure 16.14 Programme stack diagram (above) and room sections (opposite)

UPPER STACK
Floor to floor 3,800mm
Floor to ceiling 2,800mm



LOWER STACK (DROPPED CEILING)
Floor to floor 3,200mm
Floor to ceiling 2,375mm (2,450mm achievable under areas of existing ribbed slab)



Floor to ceiling height of 2,375mm compromises quality of space. With the extension, there is even more quantum of compromised floor space. 2,450mm achievable only under areas of existing ribbed slab. These levels could be delivered without a dropped ceiling and achieve 2,425mm clear (refer to Section 16.3.2).

Structural Retention
This option would retain all existing floor slabs below (and including) Level 12, with new build floors above. This gives 13 retained slabs in total with 20 new-build slabs.

There would be 29 storeys in total above the podium for a total of 32 storeys.

For this option, the core and slab retention strategy would reduce the need for any new major penetrations in the existing floor slabs, by removing the north pinwheel arm, and consolidating all new core elements in this area. The south pinwheel arm would be removed to alleviate the double column arrangements and improve floorplate flexibility.

This would result in approximately 41% of the structure retained by carbon (or 45 % by volume). This is shown schematically in Figure 16.15.

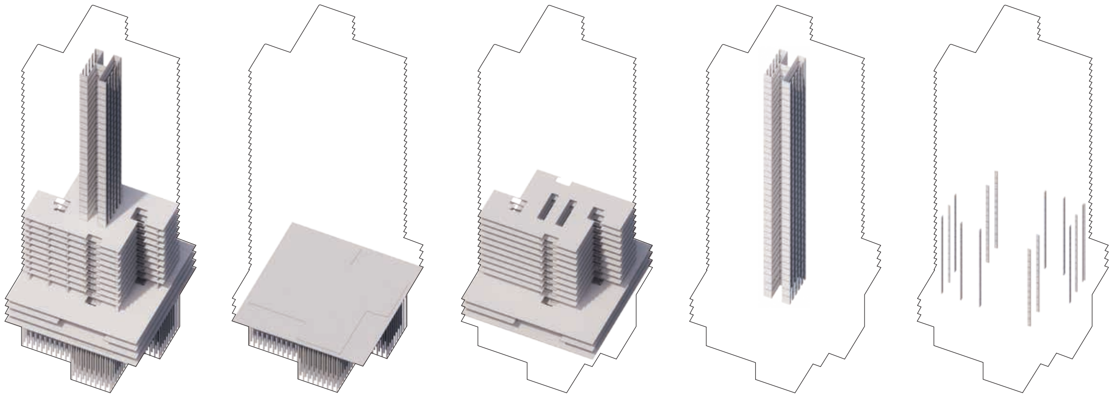
Future-proofed
Flexibility of the floorplates would be inhibited by having to work within the constraints of the existing column grid due to retaining most of the existing slabs in the lower portion of the stack. In the central area, existing columns would be positioned with spans that are not ideal for a modern office layout, and would be irregular meaning they are difficult to subdivide rationally.

In the upper stack where new slabs are proposed, it would be possible to transfer to a new grid over a few storeys. However transfer structures are inefficient from a carbon perspective, and ultimately the grid would remain constrained by being largely dependent on the existing building grid.

From an adaptability perspective, the opportunity to design in double-height amenity spaces, or additional soft spots would be limited to areas of new slab (either the extended areas or the new slabs above Level 12). This would inhibit the building being able to change to suit future trends, increasing its risk of becoming obsolete prematurely. Over the full building, this limitation is not insignificant applying to approximatively 34% of the levels (10 out of 29 storeys), as well as the podium.

This limitation is extended to the ability to design the structural system for ease of disassembly, promoting material reuse and reducing potential waste in the future.

How adaptability and design for disassembly is imagined in the new structural system is shown in Section 18.

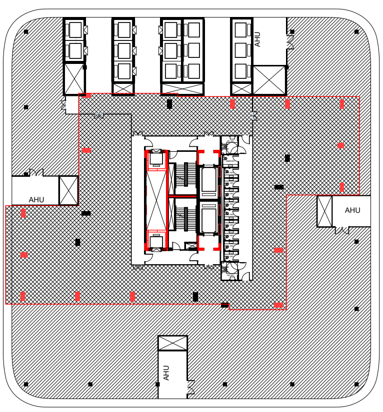


MAXIMUM POSSIBLE WITHOUT EXTENSION* 89 %

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**3,681** tCO2e	**1,683** tCO2e	**1,160** tCO2e	**679** tCO2e	**158** tCO2e
Ratio of Carbon	**41** %	**19** %	**13** %	**8** %	**2** %

** Assumes no floorplate extension (i.e. working within the existing envelope), meaning new risers need to be cut out of the existing floorplate. Refer to Section 15. With extended floorplates, possibility exists to position risers outside of this existing footprint, resulting in potential higher degrees of retention.*

Figure 16.15 Embodied carbon and retention of structure broken down by structural element



Potential double height above L12 only

Potential double height all floors

Wherever there are not existing slabs there is potential for double height amenity spaces and additional soft spots to be introduced.

Figure 16.16 Opportunities for structural adaptability

Volume 1: Assessing the Existing Building
Volume 2: Pathways for Alternative Uses
Vol 3
Introduction
Lettability & Daylighting
Establishing a New Baseline
Retention Options Appraisal
Carbon Assessments
Resource Efficiency & Future Proofing
Conclusion

Health & Safety and Buildability
Buildability would be complex. The risk of unknowns in the existing structure is increased with greater levels of retention, and the lack of consistency from level to level is likely to introduce further complexity at each of the interfaces between existing and new structure.

A large part of the construction complexity is driven by the temporary works requirements. In this case there would be moderate temporary works required on the retained slab levels where there would be unconstrained slab edges. Where the existing satellite cores would be removed, the key is maintaining continuity of the perimeter ring beam to support the retained slab, meaning that new construction would be required prior to demolition of the satellite cores. This would introduce an additional health & safety risk by having demolition and construction activities happening simultaneously and in close proximity (see Figure 16.17).

The central core would need to be braced before demolition of the existing slabs above Level 12, as it would be unconstrained once these levels are removed. Some temporary back propping would however be required for below grade retaining walls.

The construction sequence is shown schematically in Figure 16.17.

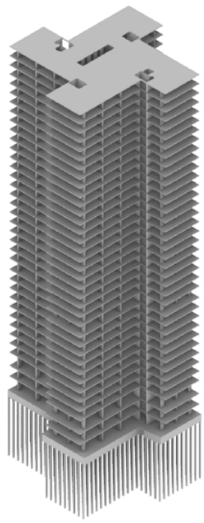
Efficiency and Viability
This option would be challenging from a viability perspective because it would still deliver a significant amount of compromised floor space. All the retained levels would retain the existing building floor to floor height of 3,200m, which was shown in Volume One (and Section 2 of this document), to be challenging for delivering a modern office offering, making leasing difficult on these floors, if not impossible.

Floorplate efficiency would be 66%.

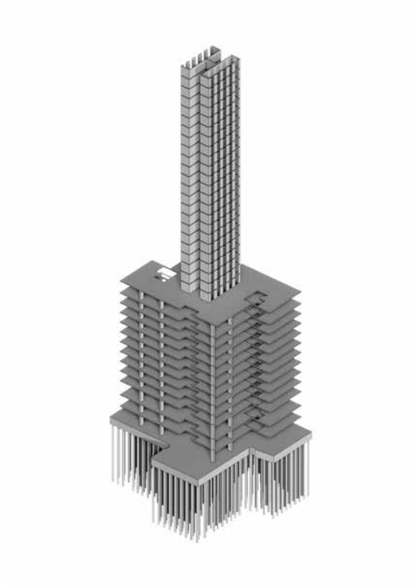
Lab-enabled
This option presents no opportunity for lab-enabled spaces due to floor to floor heights being too low for lab use.

Site Capacity
This option significantly improves site capacity, and would have the capacity to provide widespread public realm upgrades due to its scale. Refer to Volume One Section 5.4. It does not provide the in-demand lab-enabled space required in London.

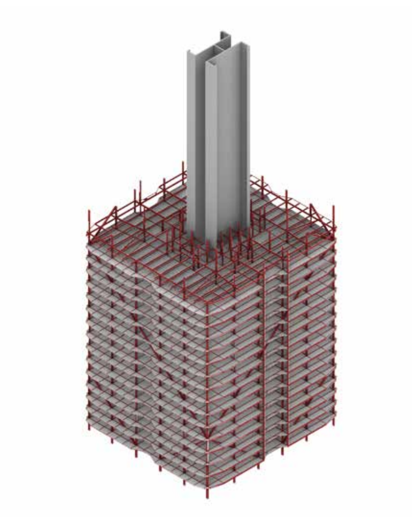
1. EXISTING BUILDING
Construction sequence is complex, due to the retained floor slabs and unrestrained core



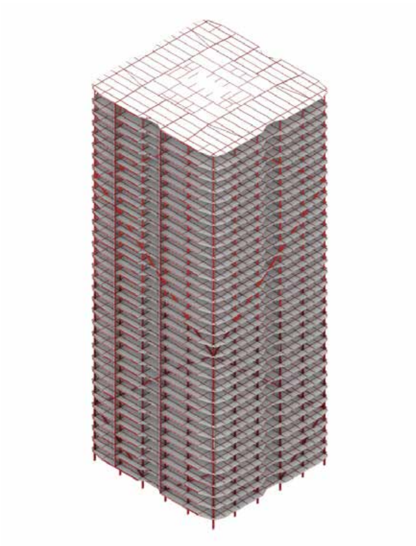
2. REMOVE FACADE
Existing facade carefully deconstructed and materials used in recycling and upcycling



3. REMOVE UPPER SLABS
Slabs are removed back to the core in the upper stack and pinwheel arms trimmed off in the lower stack. Further temporary works required to restrain the free-standing core



4 EXTEND FLOORPLATES
Construction of the permanent steels and floorplates can begin using conventional methods



5. COMPLETED STRUCTURE
The structure is completed and installation of facade, services, vertical transport, etc. can follow

Figure 16.17 Construction sequence diagram

16.3.4 Partial Retention and Extension - Retain Consecutive Slabs (Office and Lab)

Description

This option would retain part of the existing floor slabs below Level 12, and build new slabs above. It would maintain the central core structure. The southern portions of the existing slabs would be removed below Level 12, in order to provide double-height space suitable for lab use. This position is not ideal due to the additional solar exposure of the south-facing, double height spaces, but it is constrained by requiring continuity of the floor slab from the north core lifts. The remainder of the floorplate would be intended as write up spaces adjacent to the labs. Existing slabs would maintain the existing floor to floor height of 3,200mm, with 6,400mm for the lab spaces, while new slabs would have a floor to floor height of 3,800mm suitable for office use. Floors would be extended to deliver an expanded floorplate.

The section and floor slab retention diagrams are shown in Figure 16.18. The programme stack and room sections are shown in Figure 16.19 overleaf.

Level 12 is chosen as the split between the lower retained stack and the upper portion where new slabs would be built out. This is because the existing Level 12 is an MEP service level and has a larger floor to floor height (3.9m) than the typical existing office floors (3.2m), but does result in a single comprised office floor. The vertical transport strategy would be reliant on using double decker lifts (reducing the footprint of lifts required and therefore resulting in improved floorplate efficiency), but these are contingent on a consistent inter-storey height. The alternatives are twin lifts (which can accommodate varying inter-storey heights) for which there is a single-source supply procurement risk, or using conventional single-decker lifts, but this would inflate the core and significantly erode the net to gross efficiency. Respectively, these two alternatives result in a level of risk that is unacceptable to the development (if the twin lifts cannot be procured the development cannot go ahead as planned), and a net to gross efficiency that will be not be viable to deliver. Accordingly, within the constraints of the vertical transport strategy, it would not be possible to retain a single level with an odd floor to floor height.

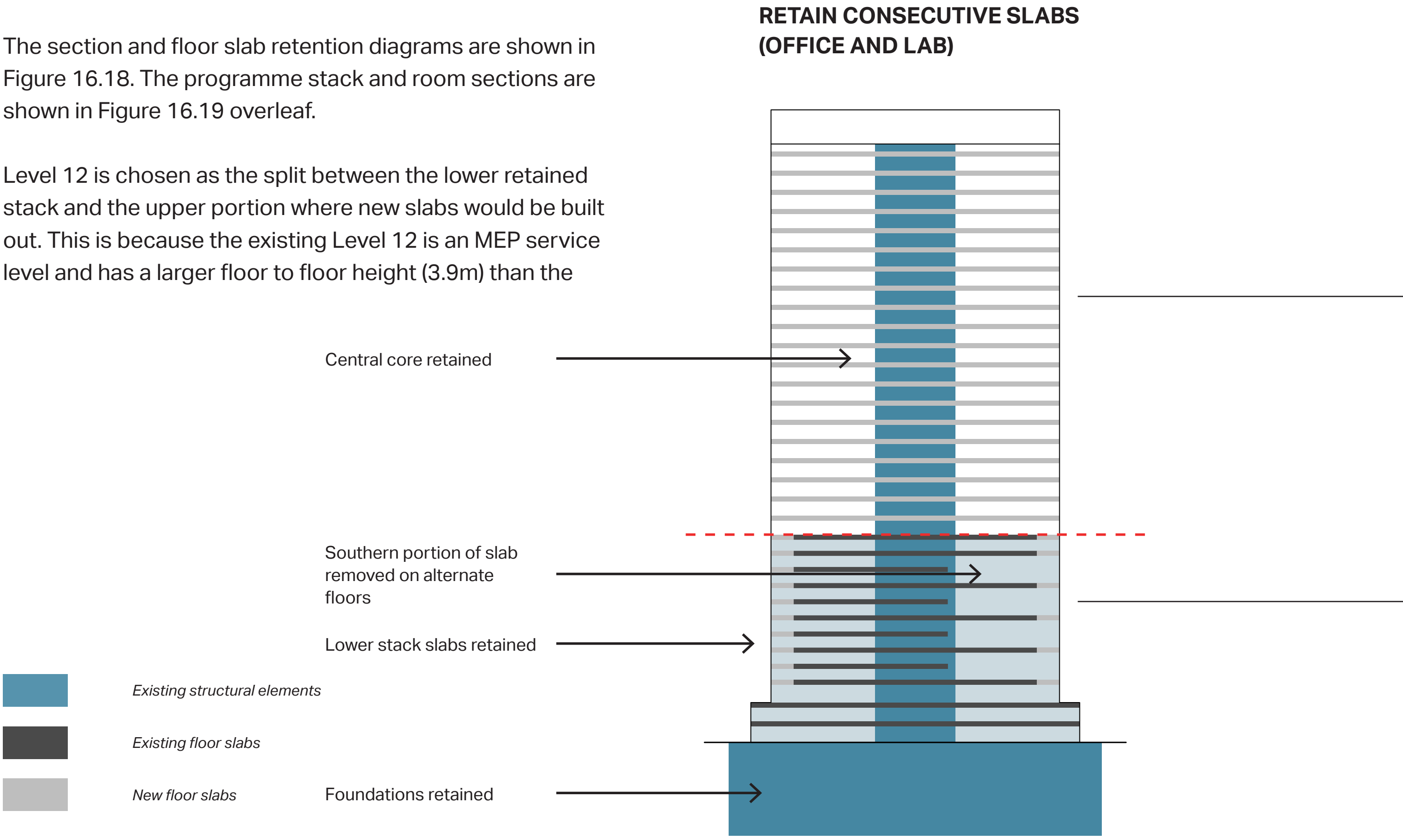
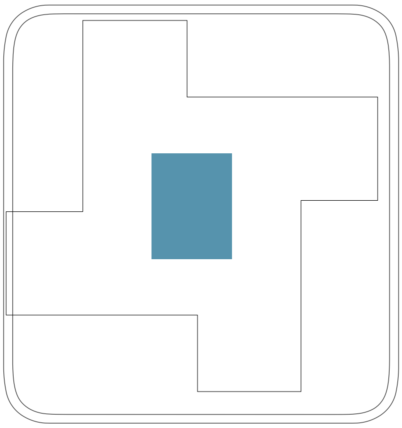
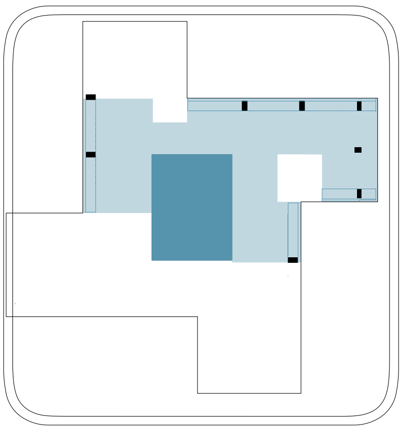


Figure 16.18 Diagram showing retained structural elements in this option (section above and slabs opposite)

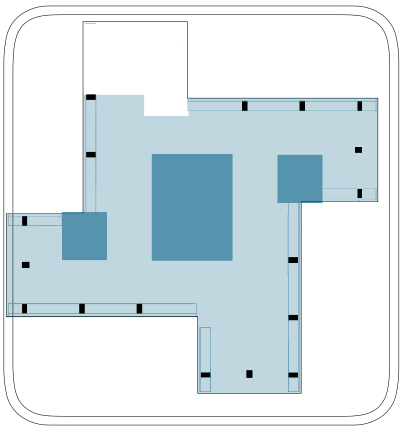
UPPER STACK
Central core retained, floorplates and satellite cores removed



LOWER STACK (LAB-ENABLED AREAS)
Central core retained, most central floor slab retained, satellite cores and southern slab removed



LOWER STACK (LAB-ENABLED WRITE UP)
Central core retained, most floor slab retained, satellite cores and northern pinwheel arm removed



PROGRAMME AND SECTION STACK

Retain Consecutive Slabs (Office and Lab)

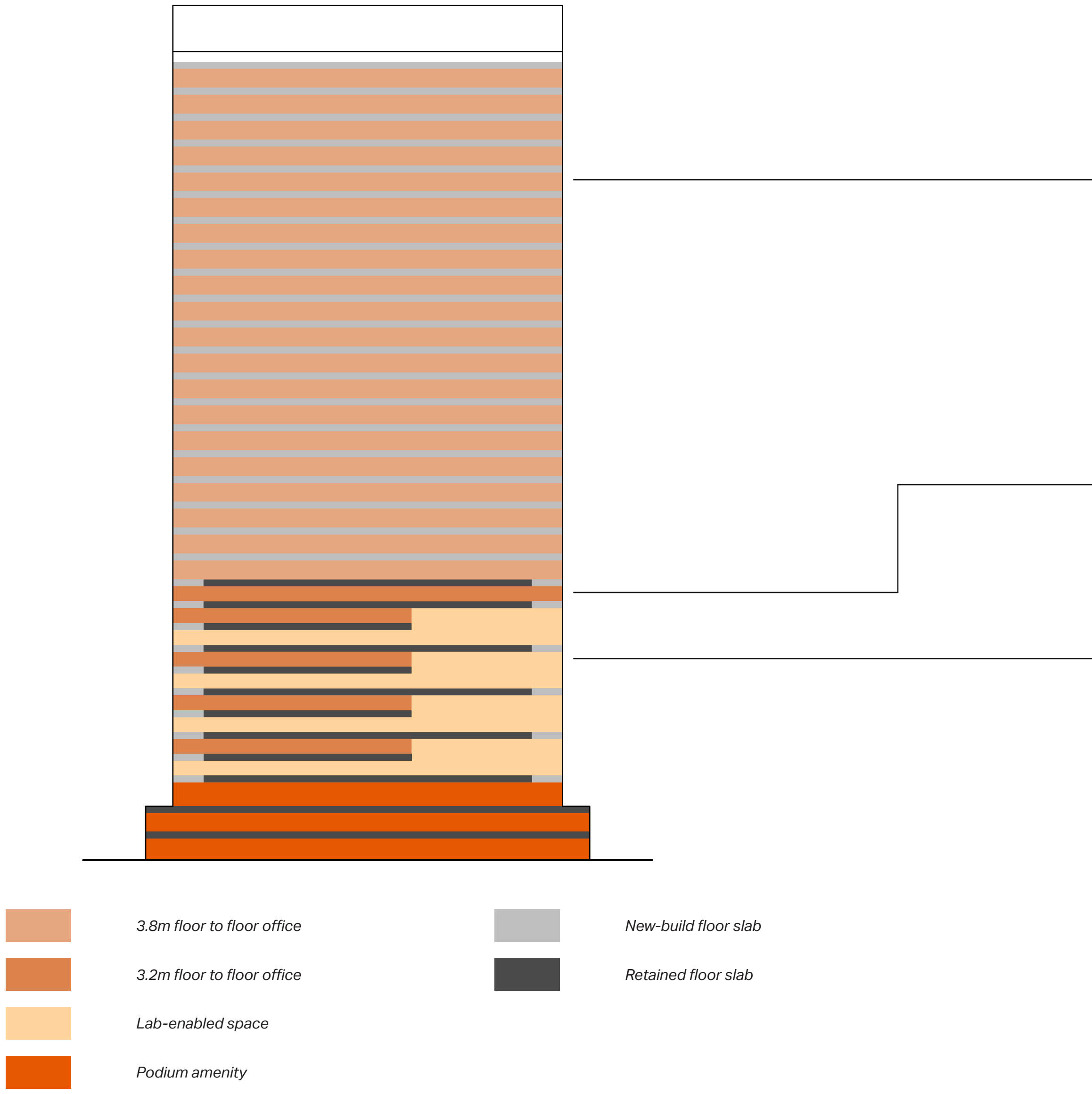
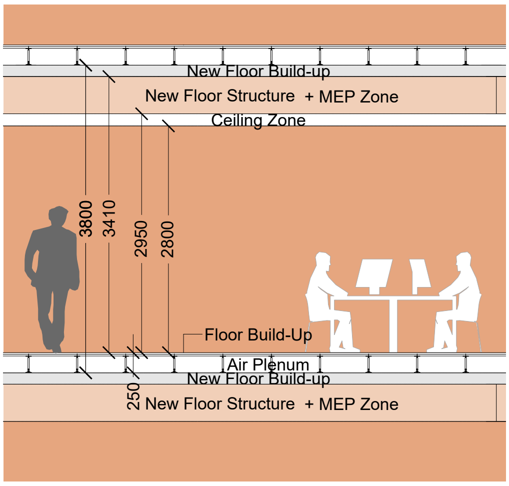
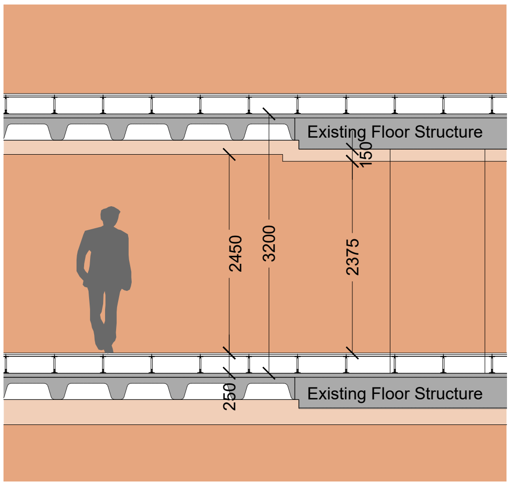


Figure 16.19 Programme stack diagram (above) and room sections (opposite)

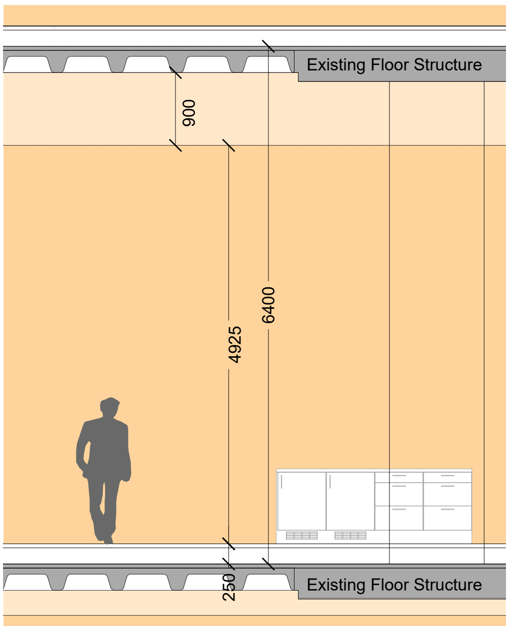
UPPER STACK
Floor to floor 3,800mm
Floor to ceiling 2,800mm



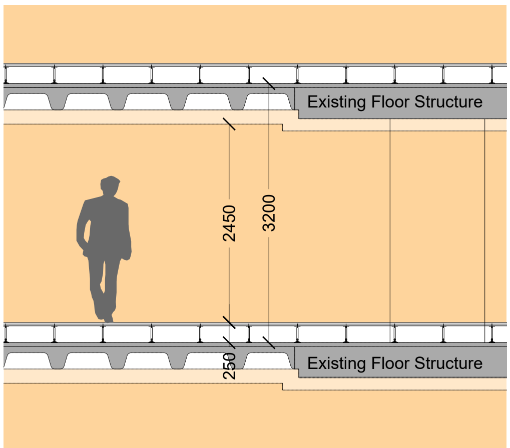
LOWER STACK
Floor to floor 3,200mm
Floor to ceiling 2,375 mm
2,450mm under ribbed slab



LAB-ENABLED SPACE
Floor to floor 6,400mm
Floor to ceiling 4,925mm



LAB-ENABLED WRITE UP SPACE
Floor to floor 3,200mm
Floor to ceiling 2,375mm
2,450mm under ribbed slab



Structural Retention
This option would retain part of the existing floor slabs below (and including) Level 12, and build new slabs above. This gives 13 retained slabs with 20 new-build slabs. 4 of the retained slabs would be trimmed back to provide double height lab spaces.

There would be 29 storeys in total above the podium for a total of 32 storeys.

For this option, the central core is retained with a new centralised north core. The north pinwheel arm would be trimmed back to facilitate the new core area.

During construction significant temporary works would be required. Full-height temporary works would be needed to support retained areas of slabs during demolition, particularity at unsupported slab edges. At the same time, there would be temporary works required during demolition to protect slabs and workers below. Figure 16.21 shows an example of the type of temporary works required.

This would result in approximately 41% of the structure retained by carbon (or 45 % by volume). This is shown schematically in Figure 16.20.

Future-proofed
Many of the issues around future proofing are the same as in the other consecutive slabs partial retention option from Section 16.3.3.

Flexibility of the floorplates would be inhibited by having to work within the constraints of the existing column grid due to retaining most of the existing slabs in the lower portion of the stack. This would lead to several double column arrangements. In the central area, existing columns would be positioned with spans that are not ideal for a modern office layout, and would be irregular meaning they are difficult to subdivide rationally.

The desire to retain structure results in a compromised office-only level at Level 11.

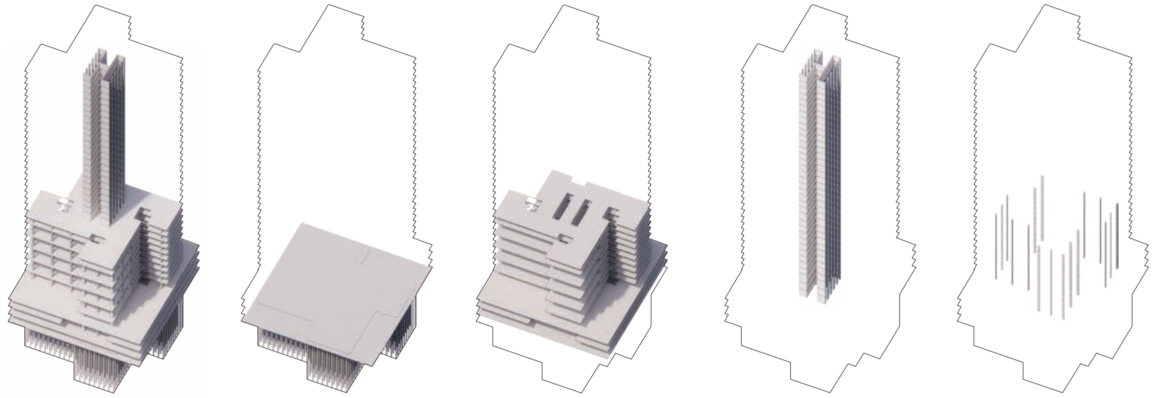
In the upper stack where new slabs are proposed, it would be possible to transfer to a new grid over a few storeys. However transfer structures are inefficient from a carbon perspective, and ultimately the grid would remain constrained by being largely dependent on the existing building grid.

From an adaptability perspective, the opportunity to design in double-height amenity spaces, or additional soft spots would be limited to areas of new slab (either the extended areas or the new slabs above Level 12). This would inhibit the building being able to change to suit future trends, increasing its risk of becoming obsolete prematurely. Over the full building, this limitation is not insignificant applying to approximatively 34% of the levels (10 out of 29 storeys), as well as the podium.

This limitation is extended to the ability to design the structural system for ease of disassembly, promoting material reuse and reducing potential waste in the future.

How adaptability and design for disassembly is imagined in the new structural system is shown in Section 18.

OVERALL | FOUNDATION | SLAB | CORES | COLUMNS

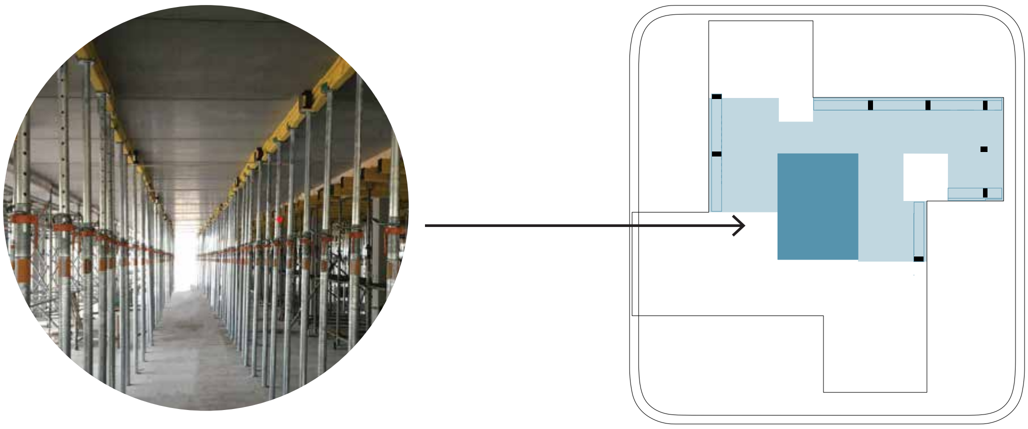


MAXIMUM POSSIBLE WITHOUT EXTENSION*
89 %

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**3,650** tCO2e	**1,683** tCO2e	**1,101** tCO2e	**679** tCO2e	**187** tCO2e
Ratio of Carbon	**41** %	**19** %	**12** %	**8**%	**2** %

* Assumes no floorplate extension (i.e. working within the existing envelope), meaning new risers need to be cut out of the existing floorplate. Refer to Section 15. With extended floorplates, possibility exists to position risers outside of this existing footprint, resulting in potential higher degrees of retention.

Figure 16.20 Embodied carbon and retention of structure broken down by structural element



Full-height temporary works required to support slabs during demolition

Figure 16.21 Full-height temporary works required to support slabs during demolition

Health & Safety and Buildability
Like the other consecutive slabs partial retention option from Section 16.3.3, buildability would be complex. The risk of unknowns in the existing structure is increased with greater levels of retention, and the lack of consistency from level to level is likely to introduce further complexity at each of the interfaces between existing and new structure.

A large part of the construction complexity would be driven by the temporary works requirements. In this case there would be complex temporary works required on the retained slab levels where there would be unconstrained slab edges. Where the existing satellite cores would be removed, the key is maintaining continuity of the perimeter ring beam to support the retained slab, meaning that new construction would be required prior to demolition of the satellite cores. This would introduce an additional health & safety risk by having demolition and construction activities happening simultaneously and in close proximity.

Some temporary back propping would be required for below grade retaining walls where the ground floor slab would be removed to enable new piling.

The construction sequence is very similar to the other consecutive slabs partial retention option from Section 16.3.3, shown schematically in Figure 16.17. A key difference here is trimming back the lab levels to create the double-height spaces.

With the double-height spaces, the existing column spans would be doubled accordingly (6.4m instead of the existing 3.2m span). These columns would need to be strengthened to accommodate this, which would likely be achieved by concrete or steel jacketing. See techniques in Figure 16.23.

Efficiency and Viability
This option would be challenging from a viability perspective because it would deliver a solution that is ultimately inefficient and compromised.

By delivering the lab-enabled spaces by omitting every other existing floor level, the resulting floor to floor height of 6,400mm would be over dimensioned. The same level of servicing could be achieved in approximately 4,100mm. This leads to a volumetric inefficiency, where significantly more area could be delivered within the same envelope, and it does not optimise the site's capacity.

The write-up spaces and/or office spaces that share volume with labs in the lower portion of the stack, would have a floor to floor height of 3,200mm, which was shown in Feasibility Volume One (and Section 2 of this document), to be challenging for delivering a modern office offer. These spaces would be difficult to let due to the market demanding greater floor to ceiling heights.

The core layout in this option would deliver net to gross efficiency of 66% (see Section A.4).

Site Capacity
This option improves site capacity, and would have the capacity to provide public realm upgrades due to its scale. Refer to Volume One Section 5.4. It does provide the in-demand lab-enabled space required in London, but in way that is not spatially efficient.

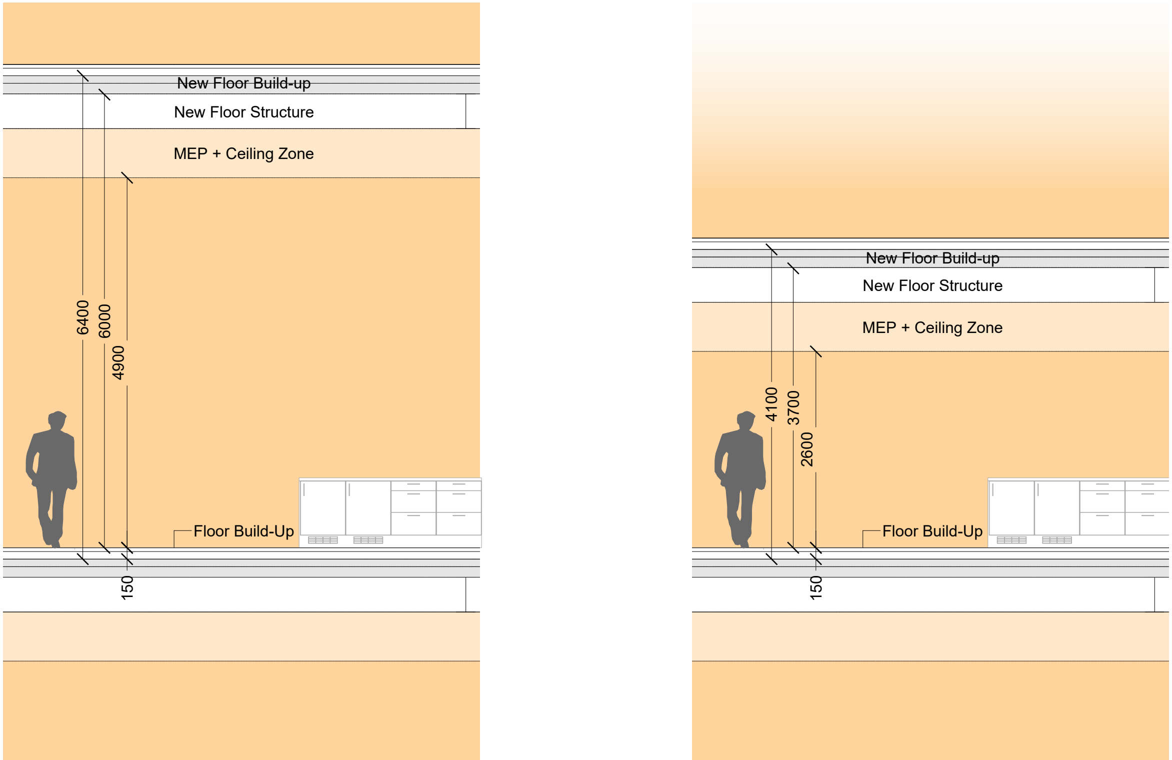


Figure 16.22 The lab spaces are volumetrically inefficiency as they could be delivered in 4,100mm floor to floor

OPTIONS FOR COLUMN STRENGTHENING

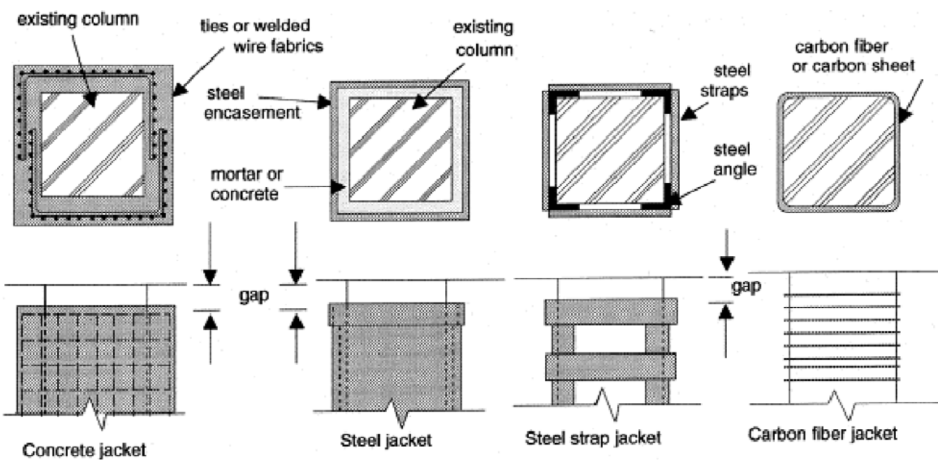


Figure 16.23 Techniques for strengthening retained columns where column spans are increased

16.3.5 Partial Retention and Extension - Retain Interstitial Slabs (Office)

Description

This option would retain strategic slabs throughout the section, in a way that allows the floor to floor height to be reset. Every 6th slab above the podium would be retained, the remaining 5 removed, and 4 new slabs added in between. Floors would be extended to deliver an expanded floorplate.

It would maintain the central core structure, and relevant columns throughout. The north, west, and south arms of the pinwheel would be trimmed back entirely to avoid the double column arrangements and improve flexibility, especially as the column positions from the retained floors must be maintained throughout the stack.

Floor to floor heights would not be consistent. Most floors would have 3,840mm floor to floor, but there would be some with 3,980mm. This is due to incorporating the additional height from existing Level 12 which is an MEP service level. The uppermost two levels would have a floor to floor height of 4,080mm.

While the office levels floor to floor heights would indeed be compatible with a modern office offering, they would vary through the stack:

- 5 storeys at 3,840mm in the lower stack
- 5 storeys at 3,980mm in the mid stack
- 15 storeys at 3,840mm in the upper stack
- 2 storeys at 4,080mm at the crown.

This would make the stack incompatible with a double-decker vertical transportation strategy. Considerations for the alternatives (twin lifts or conventional single-decker lifts) are as per Section 16.3.3. Respectively they present an unacceptable level of risk to the development, and a net to gross efficiency that will be not be viable to deliver.

The section and floor slab retention diagrams are shown in Figure 16.24. The programme stack and room sections are shown in Figure 16.25 overleaf.

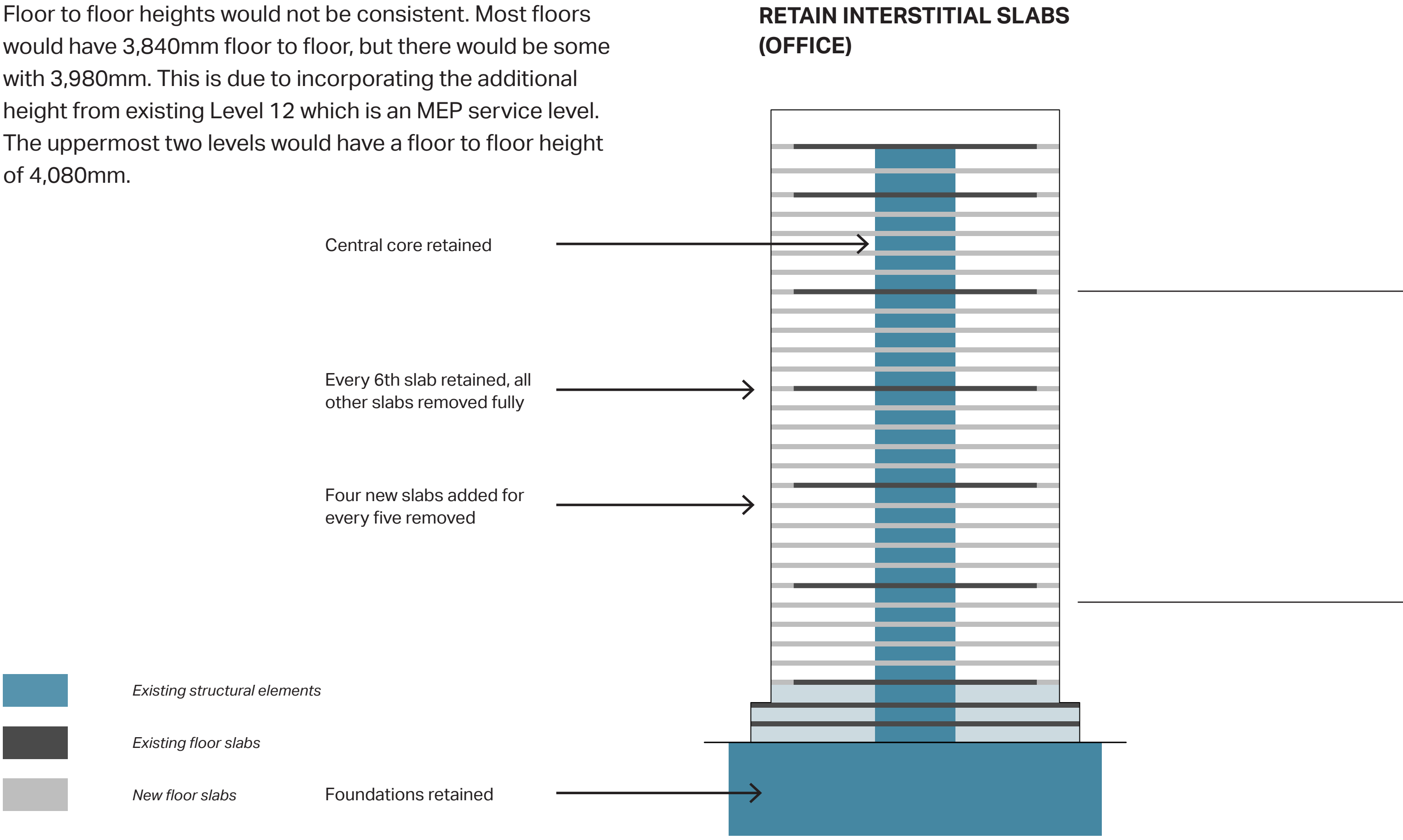
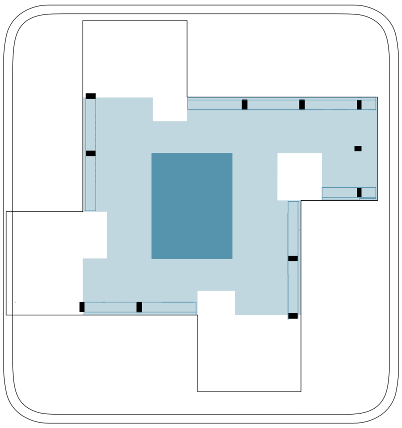
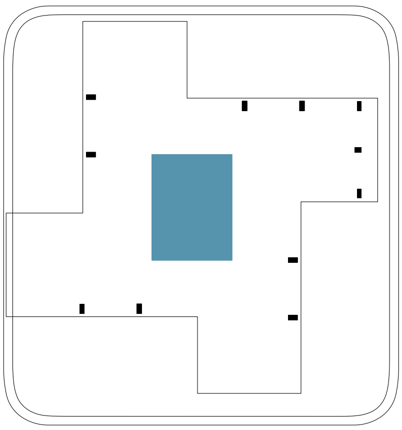


Figure 16.24 Diagram showing retained structural elements in this option (section above and slabs opposite)

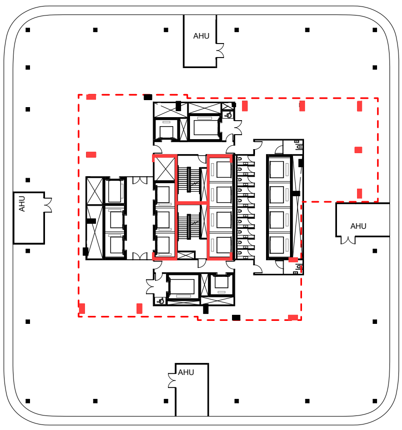
EVERY 6TH LEVEL STACK
Central core retained, most floor slab retained, north, west, south pinwheel arms and satellite cores removed



ALL OTHER LEVELS
Central core retained, floorplates removed



INDICATIVE CORE LAYOUT
Expanded Central Core



PROGRAMME AND SECTION STACK

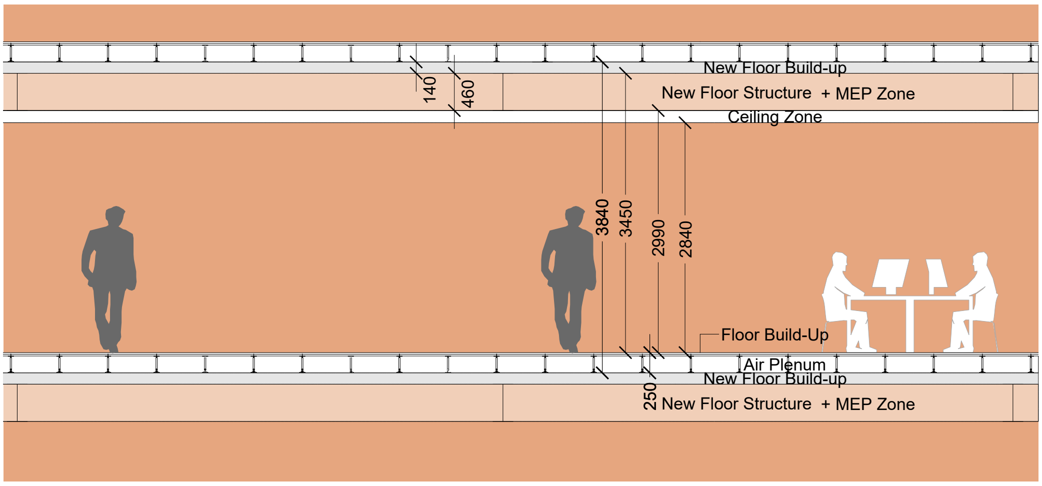
Retain Interstitial Slabs (Office)

Figure 16.25 Programme stack diagram (above) and room sections (opposite)

OFFICE SPACE

Floor to floor 3,840mm

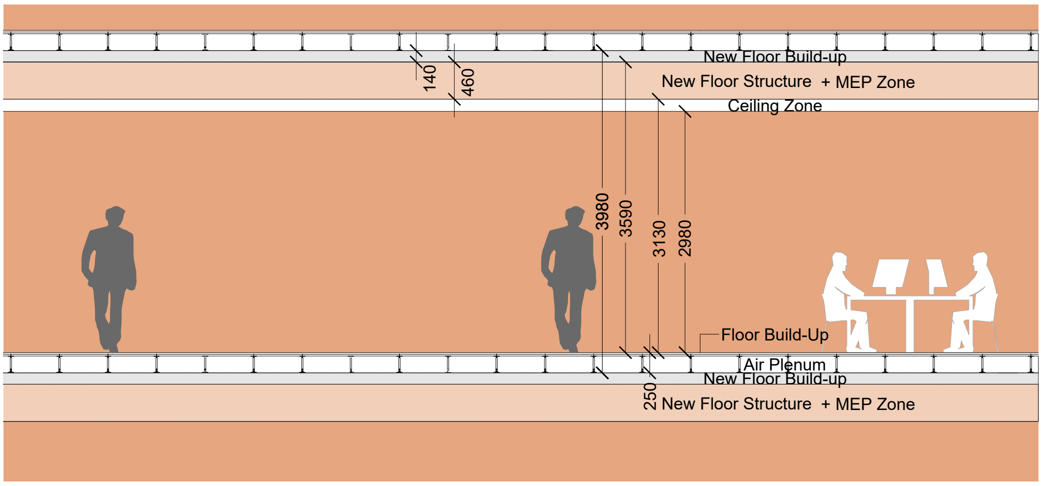
Floor to ceiling 2,840mm



OFFICE SPACE

Floor to floor 3,980mm

Floor to ceiling 2,980mm



Structural Retention
This option would strategically retain interstitial floor slabs to allow the new-build floor slabs built in between to reset the floor to floor heights. It gives 9 retained slabs dispersed throughout the stack with 21 new-build slabs in between.

There would be 27 storeys in total above the podium, for a total of 30 storeys.

This option would retain the existing central core, but all four satellite cores would be removed. The north, west, and south pinwheel arms would be trimmed back entirely to improve floorplate flexibility.

Retaining the slabs together with the central core option would lead to the requirement for many new core penetrations within the existing slab areas. The resulting floor slab retention would be quickly eroded due to the new penetrations, and the demolition due to the ribbed slabs.

This would result in approximately 38% of the structure retained by carbon (or 42% by volume). This is shown schematically in Figure 16.26.

During construction significant temporary works and coordination would be required. Full-height temporary works would be needed to support retained areas of slabs during demolition, particularity at unsupported slab edges. At the same time, there would be temporary works required during demolition to protect slabs and workers below. Because the columns would be retained throughout the stack (driven by having retained floors throughout the stack), they must be reinforced/restrained because during demolition of the slabs. This would necessitate a complex construction/deconstruction methodology, and introduce further temporary works.

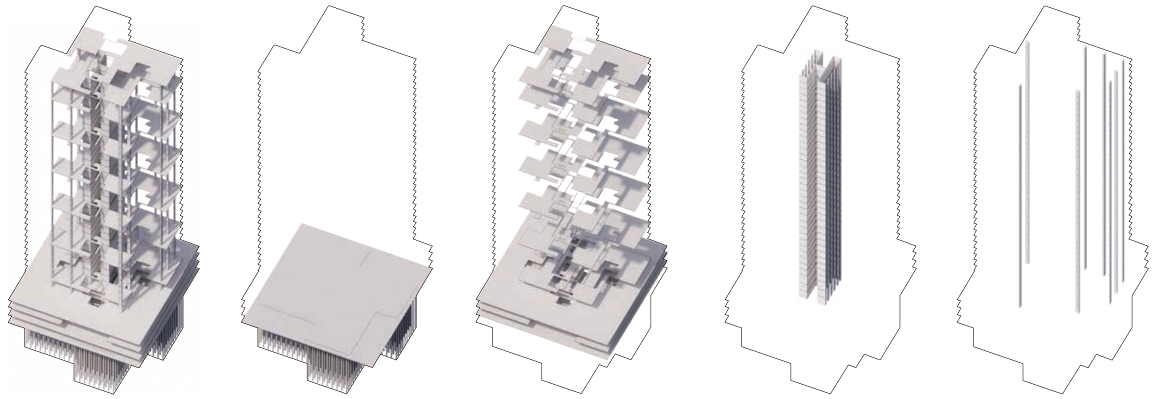
Future-proofed
Flexibility of the floorplates would be inhibited by a compromised column arrangement, having to work within the constraints of the existing column grid due to the retained slabs. Unlike the consecutive slabs partial retention options in the preceding Sections, in this option there would be retained slabs throughout the stack. This means that it would not be practical to transfer column grids between the retained and new-build stacks. This leads to all slabs having to work within the constraints of the retained columns. Though the double column arrangements could be somewhat mitigated by removing three of the four pinwheel arms, in the central area, existing columns would be positioned with spans that are not ideal for a modern office layout, and would be irregular meaning they are difficult to subdivide rationally.

From an adaptability perspective, the opportunity to design in double-height amenity spaces, or additional soft spots would be limited to areas of new slab (either the extended areas or the new interstitial slabs).

Even the new areas would be compromised to an extent, because the structural system options available for the new-build areas would be limited by the complex construction methodology that is required to retain the interstitial slabs. Pre-fabricated, modular systems are best-suited to being disassembled non-destructively, but these systems need to be "dropped in" and this methodology would be incompatible with the steelwork required to temporarily brace the retained structures. The result is that the ensuing floor system is likely to be poured in-situ, which is not readily disassembled.

This lack of adaptability is a key inhibitor as the aim with the structural system is to design something long-lasting, and flexible and adaptable to future trends, to reduce the risk of premature obsolescence.

How adaptability and design for disassembly is imagined in the new structural system is shown in Section 18.



MAXIMUM POSSIBLE WITHOUT EXTENSION*
89 %

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**3,359** tCO2e	**1,683** tCO2e	**861** tCO2e	**552** tCO2e	**263** tCO2e
Ratio of Carbon	**38** %	**19** %	**10** %	**6** %	**3** %

** Assumes no floorplate extension (i.e. working within the existing envelope), meaning new risers need to be cut out of the existing floorplate. Refer to Section 15. With extended floorplates, possibility exists to position risers outside of this existing footprint, resulting in potential higher degrees of retention.*

Figure 16.26 Embodied carbon and retention of structure broken down by structural element

Health & Safety and Buildability
In this option, the nature of the retention would make buildability highly complex. The risk of unknowns in the existing structure is increased with greater levels of retention, and the lack of consistency from level to level is likely to introduce further complexity at each of the interfaces between existing and new structure.

The construction sequence is shown schematically in Figure 16.27. The complexity comes from having demolition and new construction happening simultaneously in the same spaces, itself introducing an additional health & safety risk. A key factor is maintaining stability of the existing cores and columns during demolition. A method to achieve this, would be to install the steel framework before the existing slabs are removed. A challenge here is that this new steelwork ideally would align with structure of the new floor levels (so that it could become permanent steels), but these levels do not align with the existing slabs. The result is that workers would need to work in tight spaces, installing steels extremely close to existing concrete slabs. At the same time, satellite cores would need to be replaced with new columns before the intermediary floors can be removed.

Once the steels are in and the relevant slabs are removed, the floorplates can be extended using in-situ concrete slabs. As outlined previously, having the steels in place with existing slabs above precludes any "drop in" systems. However even pouring concrete in this manner would be complex as construction would be happening around steels and portions of existing slab.

Like the other options, there would be complex temporary works required on the retained slab levels where there would be unconstrained slab edges. This is exacerbated where the new penetrations would be formed in the existing slab system. There would be additional temporary works required to prop the below-grade retaining walls where portions of the ground floor slab would be removed.

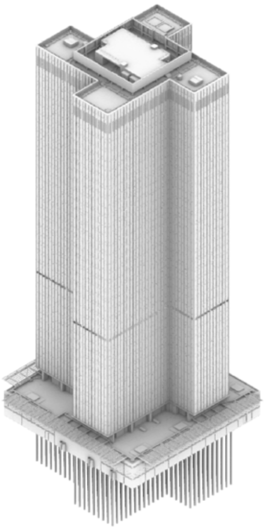
Efficiency and Viability
This option would be challenging from a viability perspective because it would deliver a solution that is complex and costly to build, with low efficiencies, and ultimately would not deliver high levels of retained structure.

Lab-enabled
This option presents no opportunity for lab-enabled spaces due to floor to floor heights being too low for lab use.

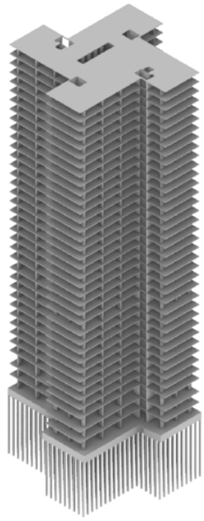
In order to accommodate lab-enabled spaces, an alternative stack could be developed with sufficient floor to floor heights. This stack is shown in Figure 16.28 overleaf.

This option has all the same limitations, construction complications, and the like as the office only option. Like the office only option, the stack split would not accommodate an efficient double-decker vertical strategy. Ultimately there would be a lot of complexity added to deliver only a small fraction of retained structure.

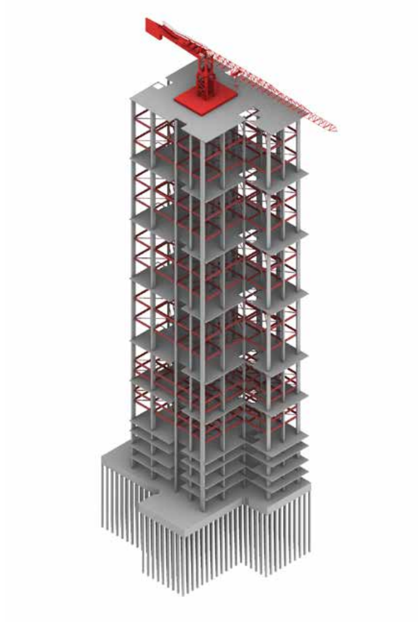
Site Capacity
This option improves site capacity, and would have the capacity to provide public realm upgrades due to its scale. Refer to Volume One Section 5.4. It could provide the in-demand lab-enabled space required in London, if the interstitial slabs are strategically chosen to support lab-enabled uses.



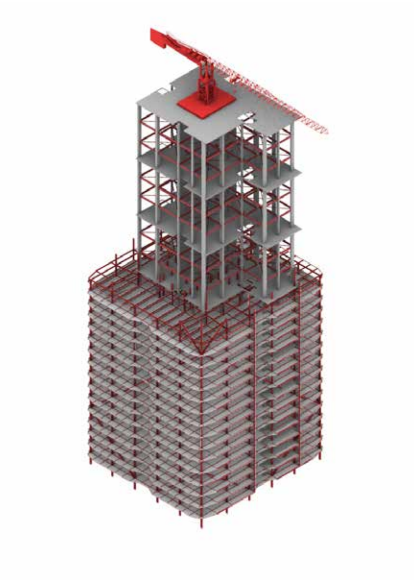
1. EXISTING BUILDING
Construction sequence is complex, due to the retained floor slabs and unrestrained core



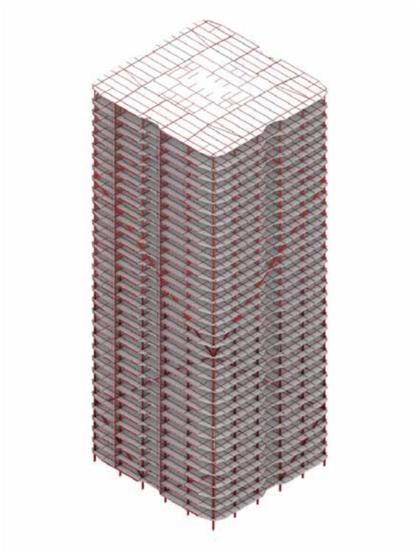
2. REMOVE FACADE
Existing facade carefully deconstructed and materials used in recycling and upcycling



3. REMOVE INTERSTITIAL SLABS
Steels installed before interstitial slabs are removed to restrain columns. Satellite cores need to be replaced with columns before intermediary floors are removed



4 EXTEND FLOORPLATES
Permanent steels installed and floorplates extended using in-situ concrete slabs



5. COMPLETED STRUCTURE
The structure is completed and installation of facade, services, vertical transport, etc. can follow

Figure 16.27 Construction sequence diagram

PROGRAMME AND SECTION STACK
Retain Interstitial Slabs (Office and Lab)

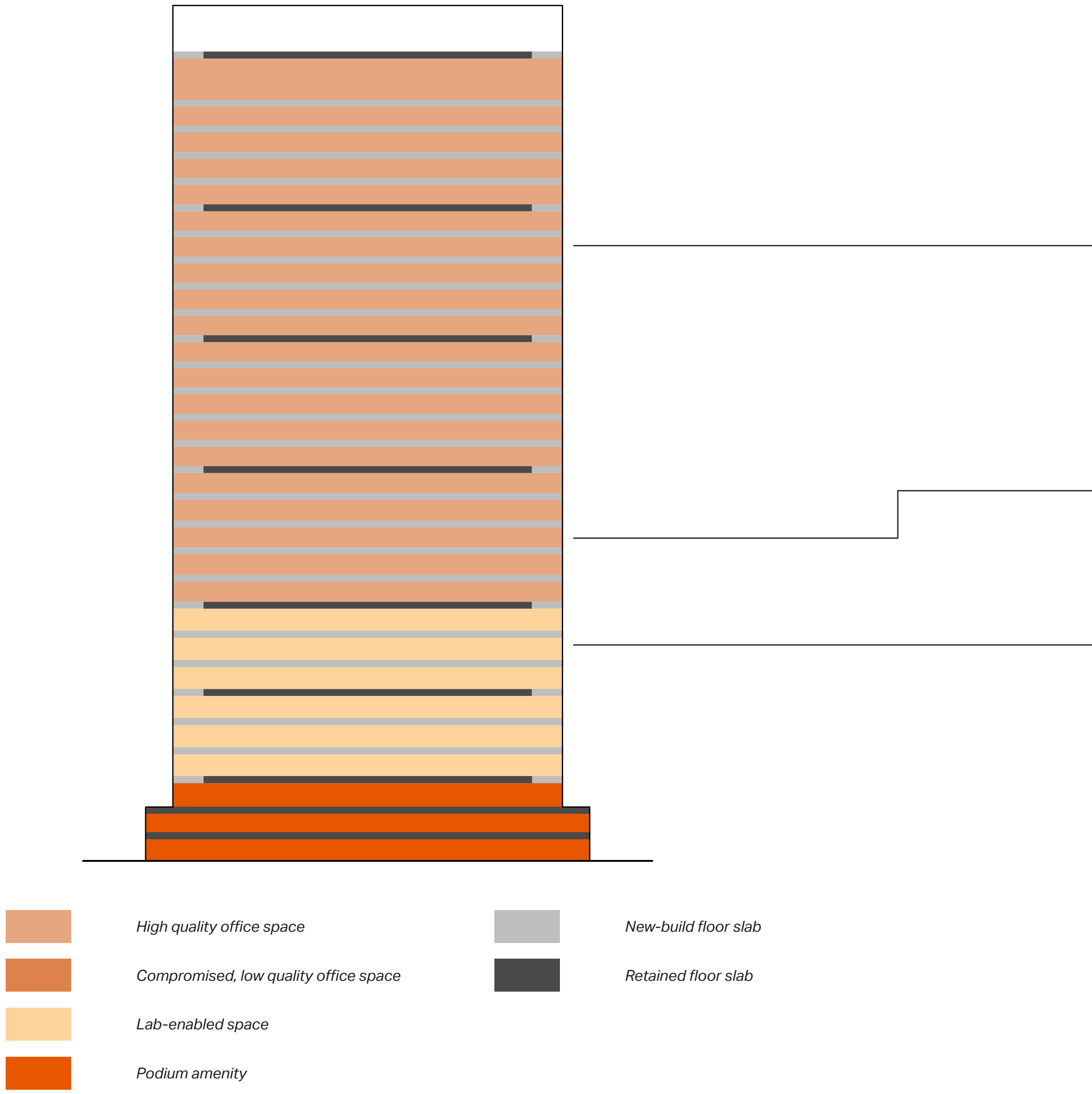
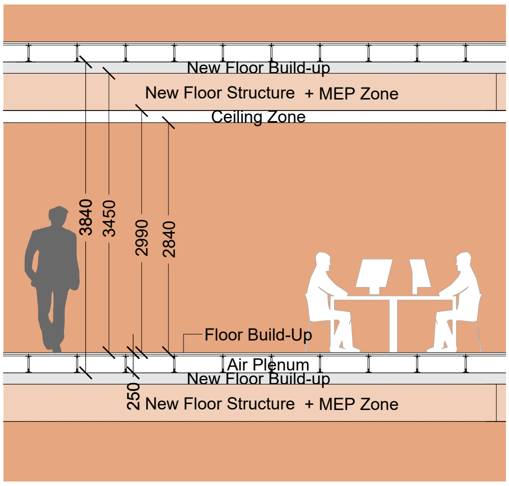
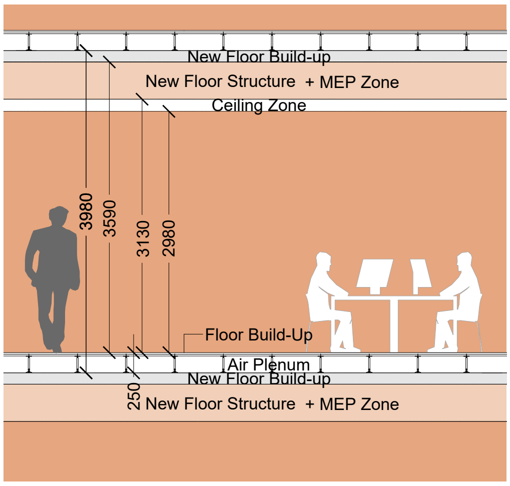


Figure 16.28 Programme stack diagram for office and lab (above) and room sections (opposite)

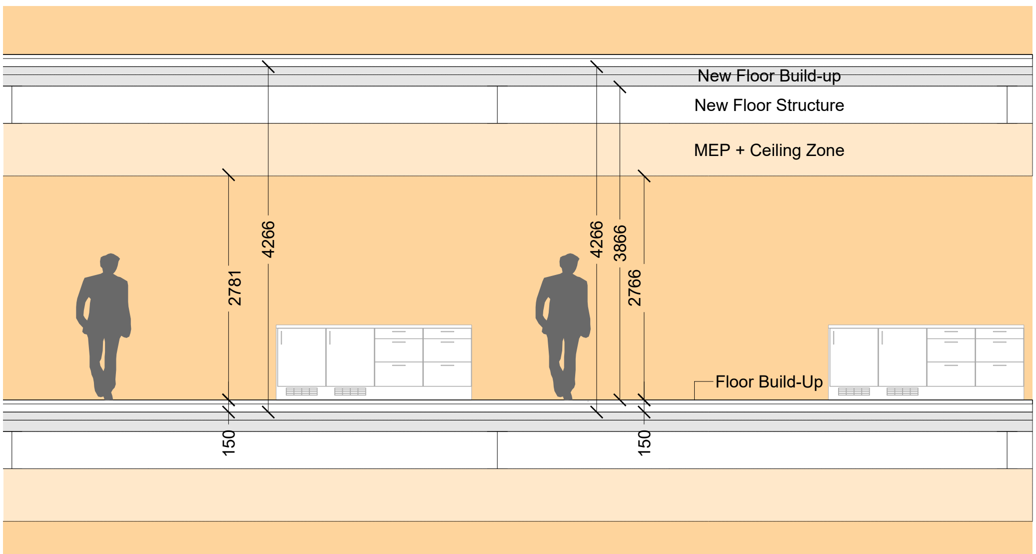
OFFICE SPACE
Floor to floor 3,840mm
Floor to ceiling 2,840mm



OFFICE SPACE
Floor to floor 3,980mm
Floor to ceiling 2,980mm



LAB-ENABLED SPACE
Floor to floor 4,266mm
Floor to ceiling 2,781mm



16.3.6 Partial Retention and Extension - Retain the Core

Description

This option would retain the central core and the below ground substructure and foundations only. All slabs would be removed and built from new, enabling freedom to choose floor to floor heights for optimum efficiency. The floor footprint would be extended to deliver an expanded floorplate.

This option would provide the flexibility to include lab-enabled space with floor to floor height of 4,100mm in the lower stack, with office floors above with a floor to floor height of 3,800mm, as shown in this option.

The vertical transport strategy would be reliant on using double decker lifts (reducing the footprint of lifts required and therefore resulting in improved floorplate efficiency). All levels have the same inter-storey height, and are therefore appropriate for the vertical transportation strategy.

The section and floor slab retention diagrams are shown in Figure 16.29. The programme stack and room sections are shown in Figure 16.30 overleaf.

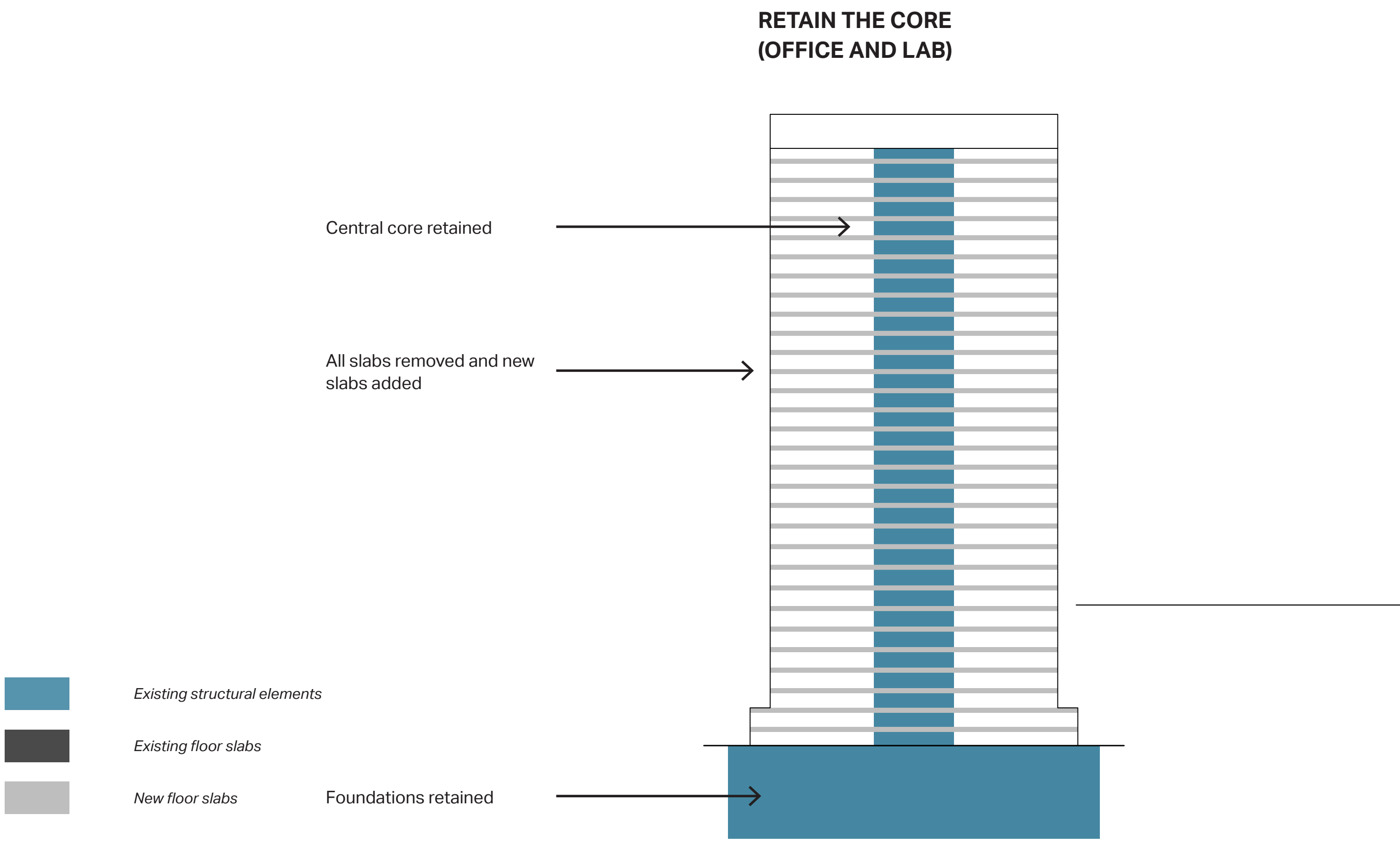
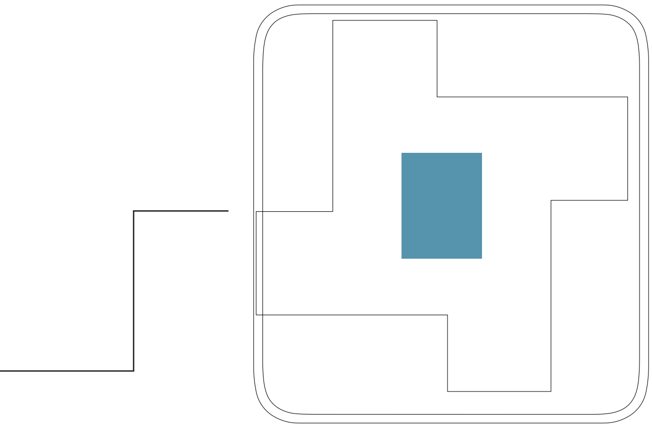
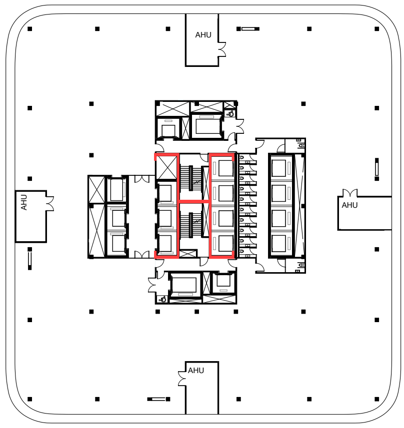


Figure 16.29 Diagram showing retained structural elements in this option (section above and slabs opposite)

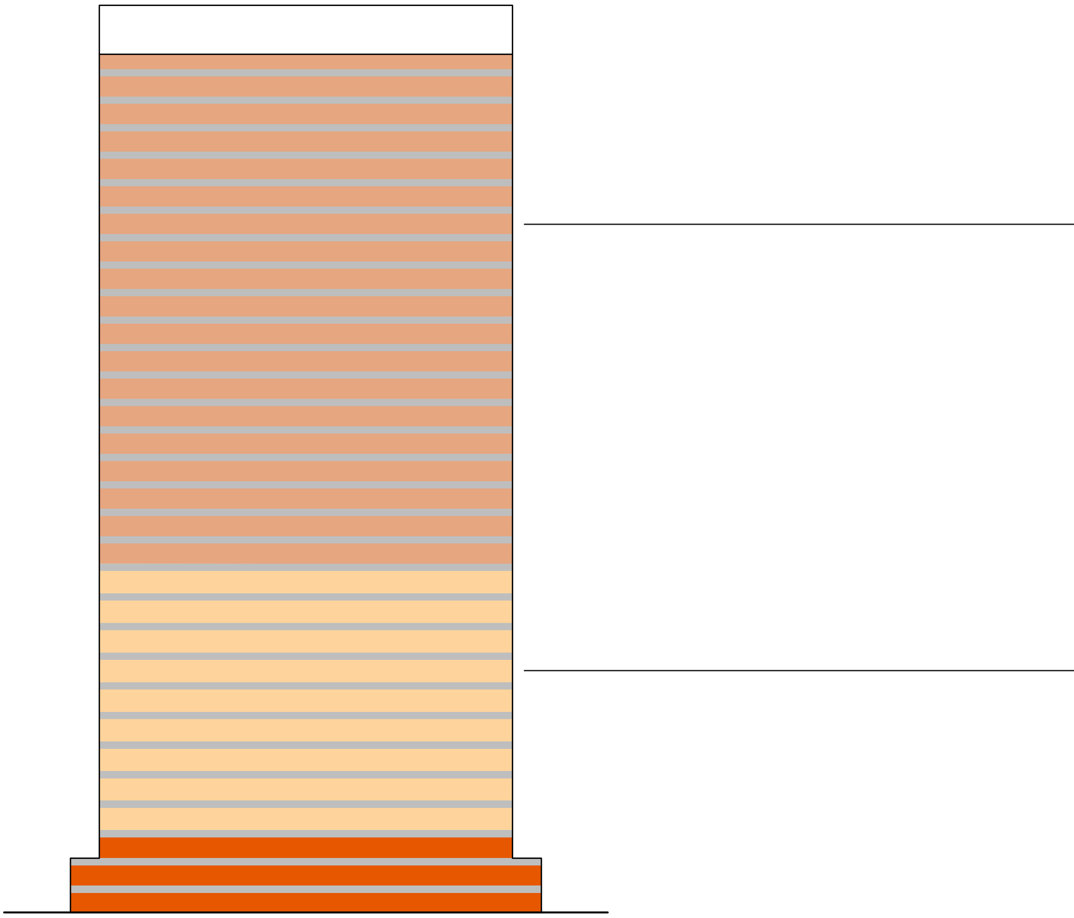
ALL LEVELS
Central core retained, floorplates removed



INDICATIVE CORE LAYOUT
Expanded Central Core



PROGRAMME AND SECTION STACK
Retain the Core



3.8m floor to floor office

Potential to include lab-enabled space

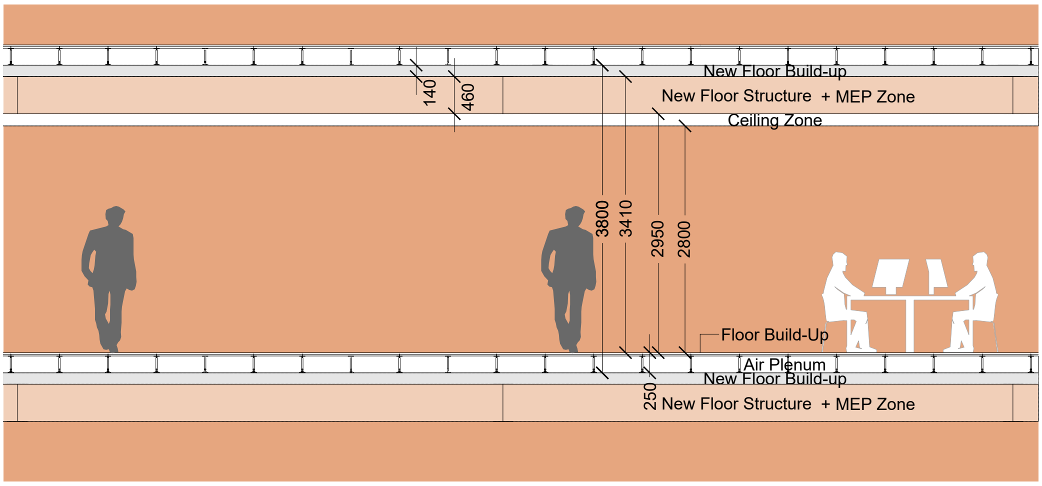
New-build floor slab

Retained floor slab

Figure 16.30 Programme stack diagram (above) and room sections (opposite)

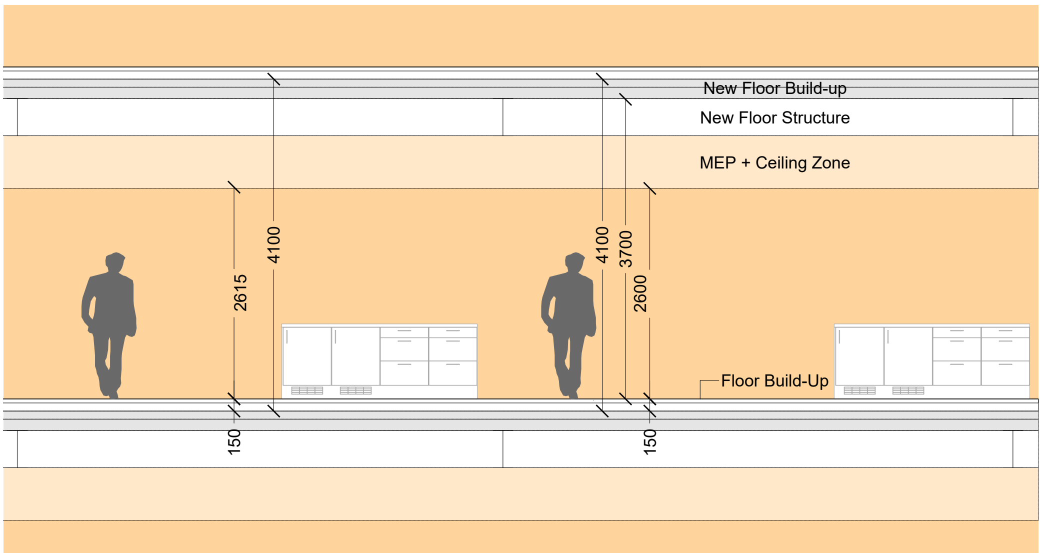
OFFICE SPACE

Floor to floor 3,800mm
Floor to ceiling 2,800mm



POTENTIAL LAB-ENABLED SPACE

Floor to floor 4,100mm
Floor to ceiling 2,600mm



Structural Retention
This option would retain the central core and foundation only, with all new-build floor slabs including columns.

There would be 27 storeys in total above the podium, of which in this example 9 are lab-enabled, and 18 are office only, differentiated by their floor to floor heights. There would be 30 storeys in total.

This option would retain the existing central core, but all four satellite cores would be removed. The floorplates would allow freedom to choose optimised grids which improve flexibility compared to the floorplates that retain grid elements.

This would result in approximately 25% of the structure retained by carbon (or 31% by volume). This is shown schematically in Figure 16.32.

During construction, temporary works would be required to brace the free-standing core (see Figure 16.32). But the extent of temporary works would be significantly less onerous than in the options that retain floor slabs, as there would be no slabs to support, and no slab edges to prop.

Future-proofed
Flexibility of the floorplates would be uninhibited by existing column arrangements. The column grid could be optimised to best suit the floor layouts, leading to clear spans that enable flexible layouts.

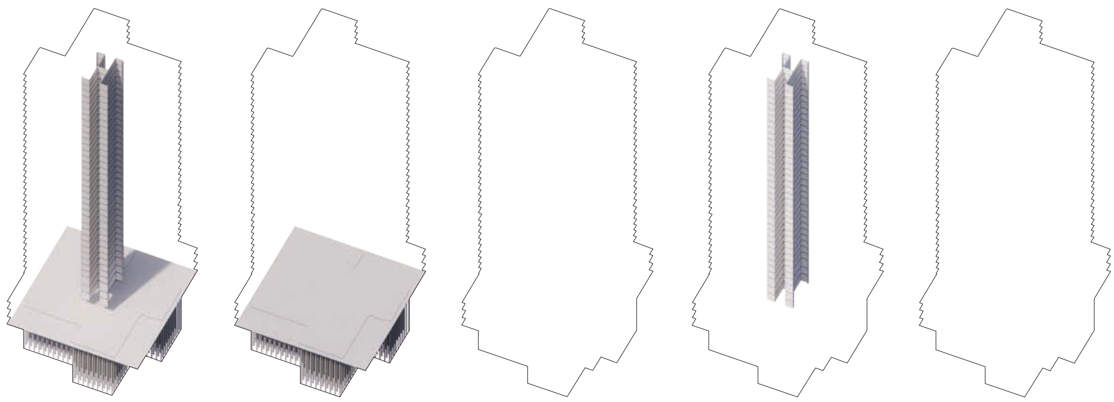
While the lower stack is enabled for lab space, it would be suitable for use as office space if desired. With its floor to floor height of 4,100mm, it is not over-dimensioned for an office, so this flexibility comes at little cost to efficiency.

From an adaptability perspective, all floor structure would be new build, so all areas would present the opportunity to design in double-height amenity spaces, or additional soft spots.

Unlike the options that retain interstitial slabs, because the construction would occur in a "blue sky" environment, there is no limitation on floor systems. Accordingly, pre-fabricated, "drop in" systems could be used which would enable the systems to be designed for disassembly at end of life.

This adaptability is a key value, as the aim with the structural system is to design something long-lasting, flexible, and adaptable to future trends, to reduce the risk of premature obsolescence and avoid waste in the future.

How adaptability and design for disassembly is imagined in the new structural system is shown in Section 18.



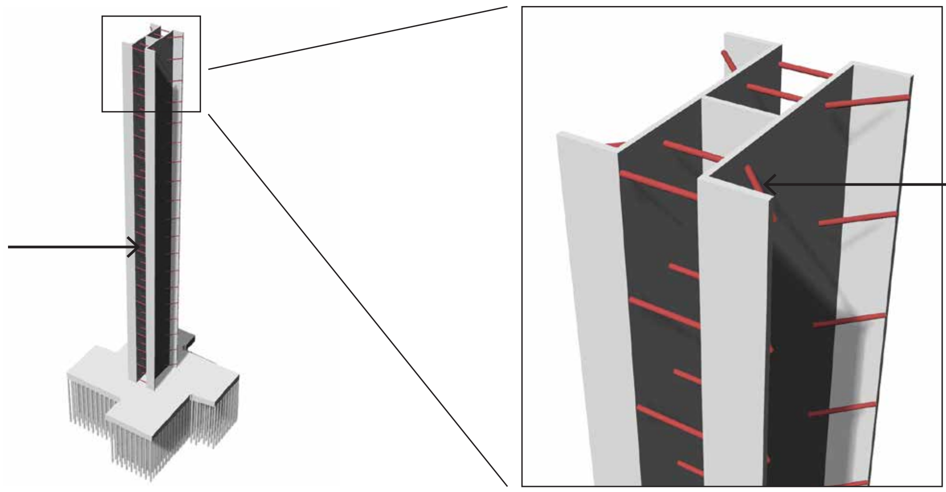
MAXIMUM POSSIBLE WITHOUT EXTENSION*
89 %

	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**2,235** tCO2e	**1,683** tCO2e	**0** tCO2e	**552** tCO2e	**0** tCO2e
Ratio of Carbon	**25** %	**19** %	**0** %	**6** %	**0** %

** Assumes no floorplate extension (i.e. working within the existing envelope), meaning new risers need to be cut out of the existing floorplate. Refer to Section 15. With extended floorplates, possibility exists to position risers outside of this existing footprint, resulting in potential higher degrees of retention.*

Figure 16.31 Embodied carbon and retention of structure broken down by structural element

Indicative temporary propping required to restrain retained core elements



Props shown are provisional to restrain the existing retained core walls assuming assumes front core walls and landing slabs are removed on demolition

Figure 16.32 Indicative temporary works required to brace retained core

Health & Safety and Buildability
Buildability in this option would be moderately complex due to retaining the unrestrained central core. Compared to all the other preceding options however, there would be a lower risk of unknowns in the existing structure affecting design or programme.

The construction sequence is shown schematically in Figure 16.33. Apart from retaining the core, this would be a more conventional demolition and construction sequence than the other options. Not having demo and new-build operatives working simultaneously and in close proximity would reduce the risks around health & safety.

Initially the slabs would be removed back to the core top down. To minimise the temporary works required to brace the core, it would be intended to leave the front walls of lift shafts in place during demolition to reduce temporary propping. Some propping would likely still be required, a provisional solution to restrain the existing front core walls against out of plane buckling is shown in Figure 16.32. These walls would be retained on the floors where the lifts do not stop. In addition to these temporary works, some back propping would be required to the below grade retaining walls where the ground floor slab would be removed.

Once the slabs are entirely removed, construction of the permanent steels could begin using conventional, "blue sky" methods. Working without overhead constraints, means pre-fabricated, "drop in" structural systems could be used, reducing time on site and the associated risks to heath & safety.

Efficiency and Viability
This option would deliver a solution that balances structural retention with construction complexity and its associated risks. It would provide efficient floorplates with regular inter-storey heights, meaning it works with a compact core based on a double-decker vertical transportation strategy.

With regards to volumetric efficiency, this option would generate as much area as possible within the massing envelope, while delivering the desired floor to floor heights for both lab and office spaces.

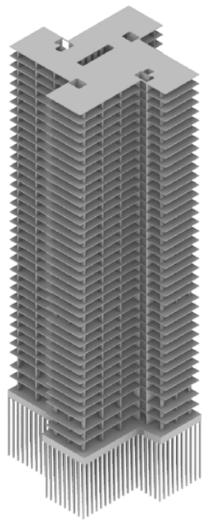
Accordingly, it is likely that this option would be viable.

Lab-enabled
This option delivers lab-enabled spaces in the lower portion of the stack with a floor to floor height of 4,100mm. This flexibility cannot be delivered with a lower floor to floor height without compromises.

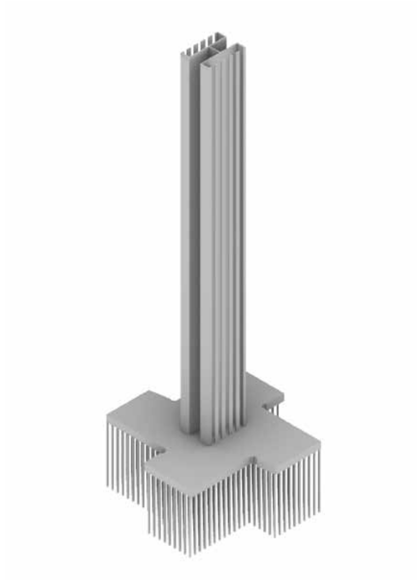
This floor to floor height is also suitable for use as office space, without the floors being over-dimensioned and volumetrically inefficient.

Site Capacity
This option significantly improves site capacity, and would have the capacity to provide widespread public realm upgrades due to its scale. Refer to Volume One Section 5.4. It provides the in-demand lab-enabled space required in London in way that is spatially efficient.

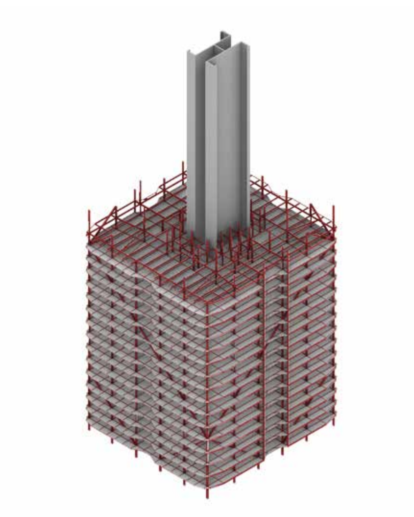
1. EXISTING BUILDING
Construction sequence is moderately complex due to the unrestrained core



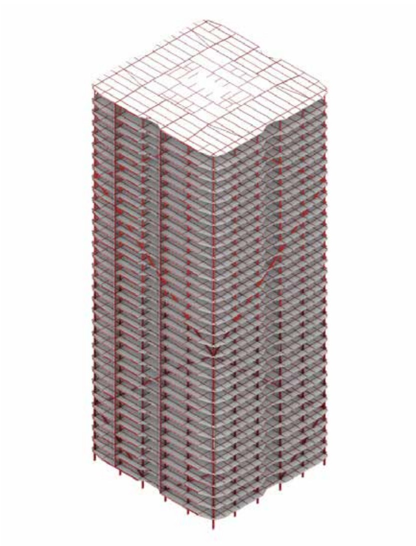
2. REMOVE FACADE
Existing facade carefully deconstructed and materials used in recycling and upcycling



3. REMOVE SLABS
Slabs are removed back to the core, further temporary works may be required to restrain the free-standing core



4 EXTEND FLOORPLATES
Construction of the permanent steels and floorplates can begin using conventional methods



5. COMPLETED STRUCTURE
The structure is completed and installation of facade, services, vertical transport, etc. can follow

Figure 16.33 Construction sequence diagram

16.3.7 New Build

Description
This option would demolish and recycle the full existing tower. No structure would be retained (including foundation and substructure). The floor footprint would be extended to deliver an expanded floorplate.

All cores, columns, and slabs would be built from new, enabling freedom to choose floor to floor heights for optimum efficiency.

The lower stack, up to and including Level 11, would comprise lab-enabled space with floor to floor height of 4,100mm in this example. All floors above would be office floors (Levels 12 - 29 inclusive) with a floor to floor height of 3,800mm.

The vertical transport strategy would be reliant on using double decker lifts (reducing the footprint of lifts required and therefore resulting in improved floorplate efficiency). All levels have the same inter-storey height, and are therefore appropriate for the vertical transportation strategy.

The section and floor slab retention diagrams are shown in Figure 16.34. The programme stack and room sections are the same as in the previous option (Section 16.3.6), and are shown in Figure 16.35 overleaf.

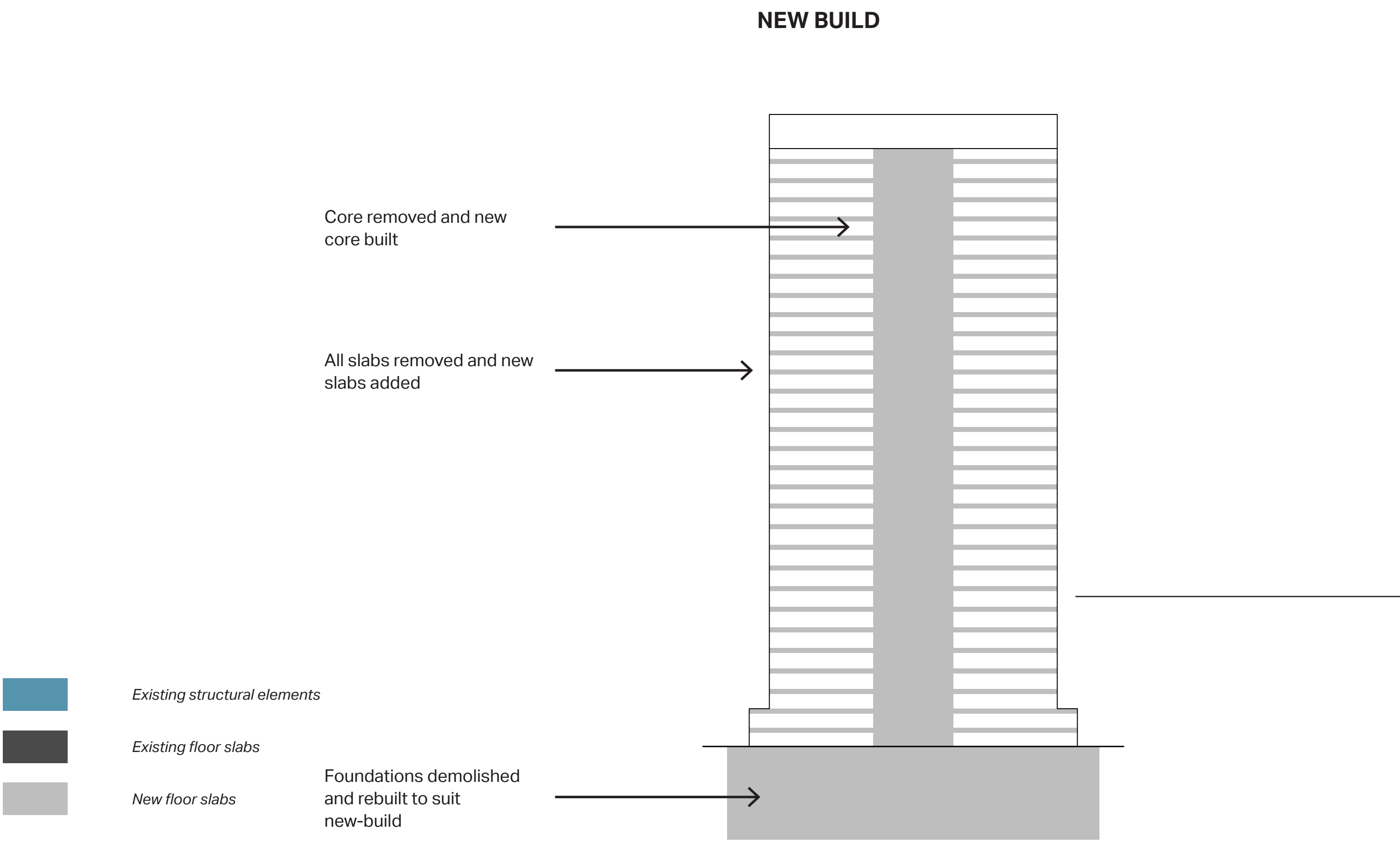
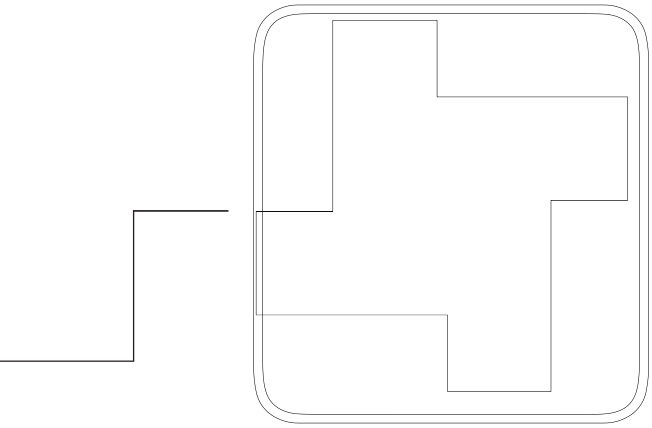
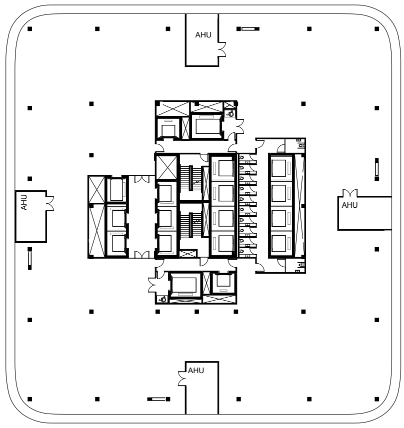


Figure 16.34 Diagram showing retained structural elements in this option (section above and slabs opposite)

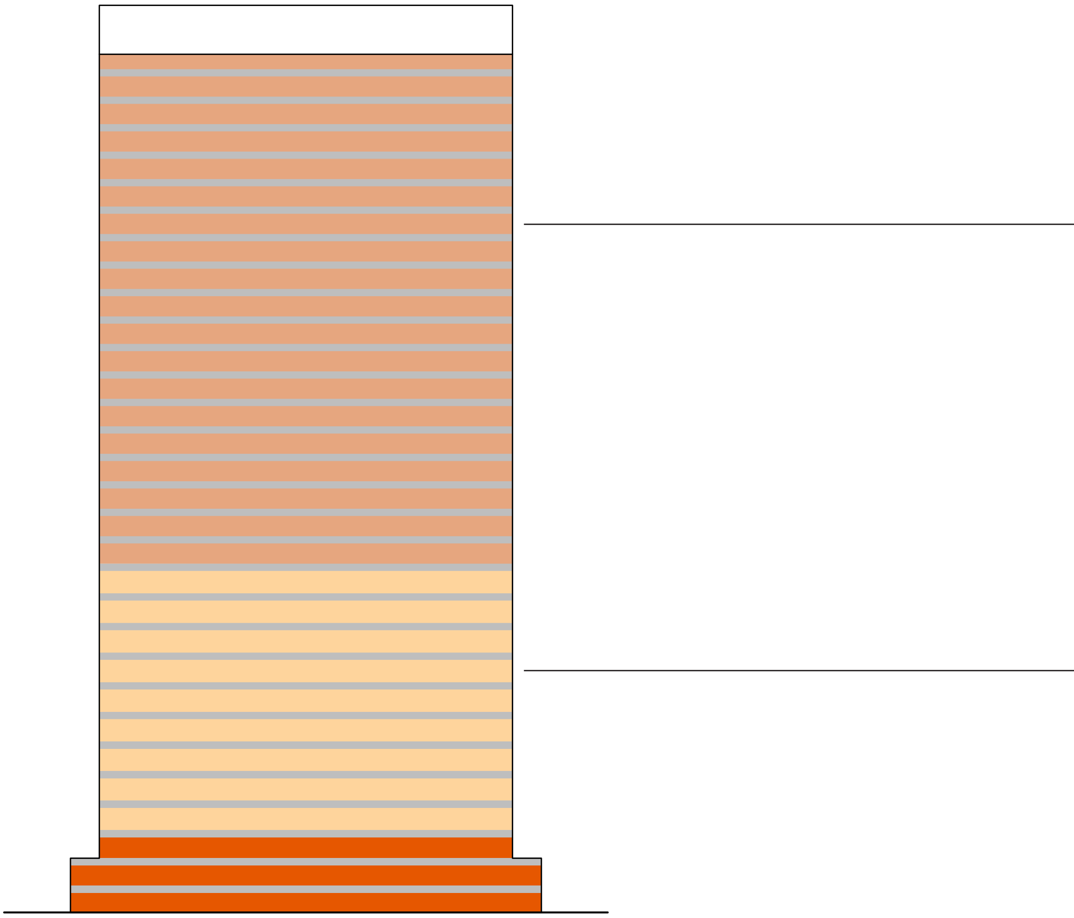
ALL LEVELS
Core removed, floorplates removed, all rebuilt



INDICATIVE CORE LAYOUT
Expanded Central Core



PROGRAMME AND SECTION STACK
New Build



3.8m floor to floor office

Potential to include lab-enabled space

Podium amenity

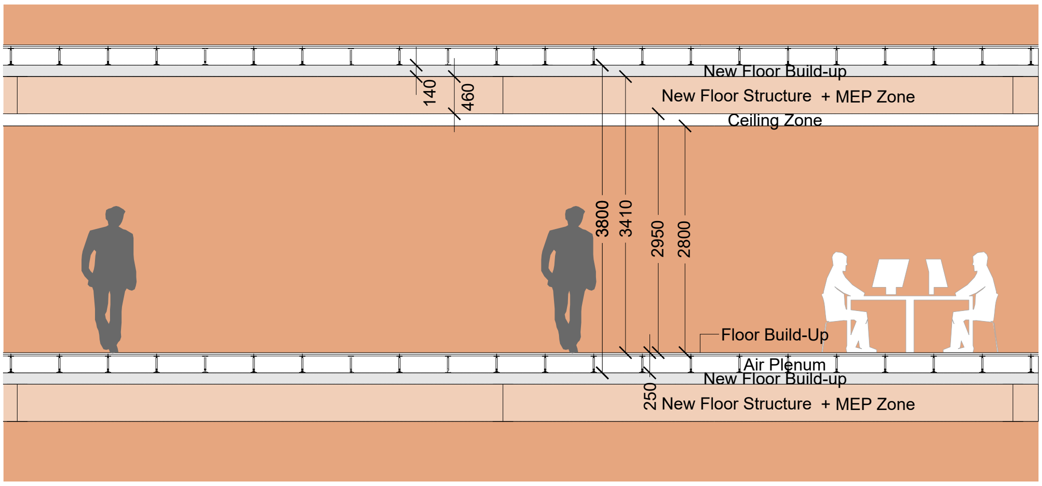
New-build floor slab

Retained floor slab

Figure 16.35 Programme stack diagram (above) and room sections (opposite)

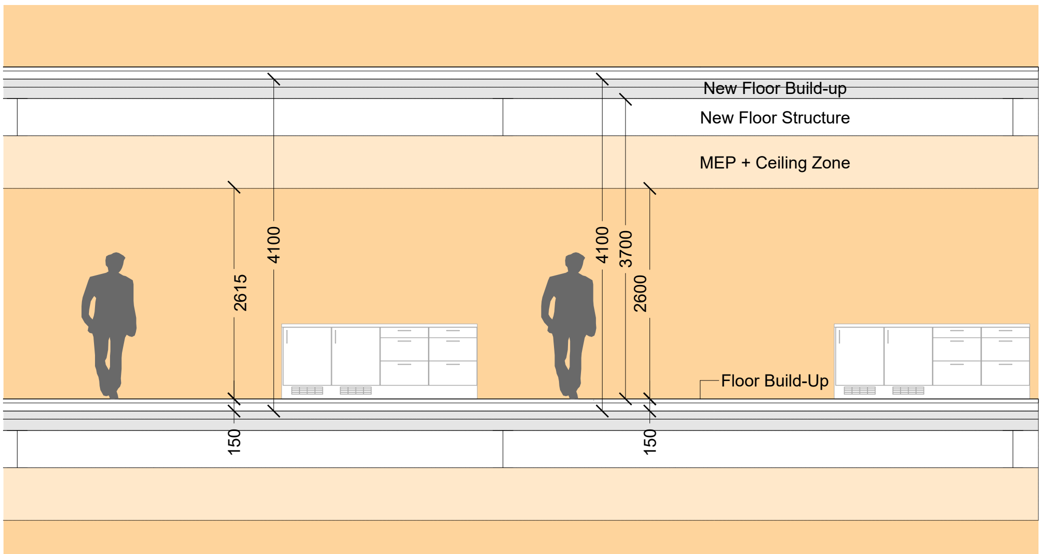
OFFICE SPACE

Floor to floor 3,800mm
Floor to ceiling 2,800mm



POTENTIAL LAB-ENABLED SPACE

Floor to floor 4,100mm
Floor to ceiling 2,600mm



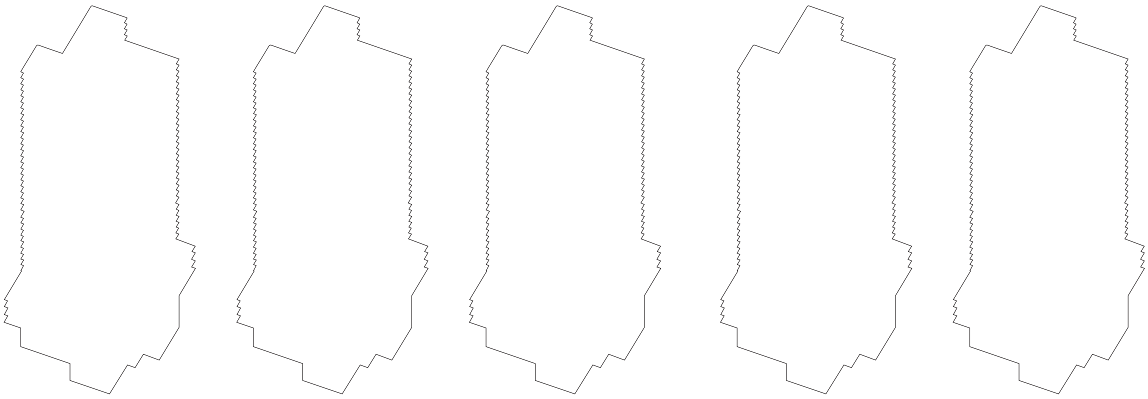
Structural Retention
This option would be a conventional demolition and re-build. No elements would be retained.

There would be 27 storeys in total above the podium, of which in this example 9 are lab-enabled, and 18 are office only, differentiated by their floor to floor heights. There would be 30 storeys in total.

For this option the expanded centralised core is proposed. In this case it would be an entirely new core. The floorplates, all built from new, would allow freedom to choose optimised grids which improves flexibility compared to the floorplates that retain grid elements.

This would result in 0% of the structure retained (by carbon or volume). This is shown schematically in Figure 16.36.

Future-proofed
Future proofing (flexibility and adaptability) is the same as the retain the core option in Section 16.3.6.



	OVERALL	FOUNDATION	SLAB	CORES	COLUMNS
Embodied Carbon	**0** tCO2e	**0** tCO2e	**0** tCO2e	**0** tCO2e	**0** tCO2e
Ratio of Carbon	**0** %	**0** %	**0** %	**0** %	**0** %

Figure 16.36 Embodied carbon and retention of structure broken down by structural element

Health & Safety and Buildability
Buildability would be the least complex of all the options, as it is a conventional demo and re-build. Compared to all the other options, there would be the lowest risk of unknowns in the existing structure affecting design or programme. However, coordination around the existing piles would still be required.

The construction sequence is shown schematically in Figure 16.37. The conventional demo and re-build means not having demo and new-build operatives working simultaneously and in close proximity, reducing the risks around health & safety.

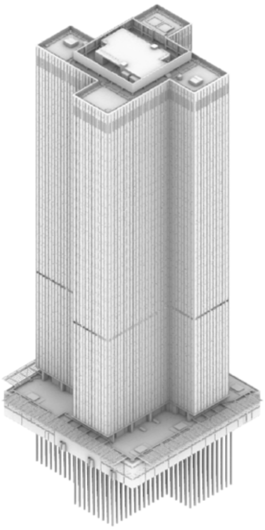
Compared to other options, the temporary works requirement would be significantly reduced with no above-ground structure to prop. Some temporary back propping would however be required for below grade retaining walls.

Once the building is demolished, construction of the new structure could begin using conventional, "blue sky" methods. Working without overhead constraints, means pre-fabricated, "drop in" structural systems could be used, reducing time on site and the associated risks to heath & safety.

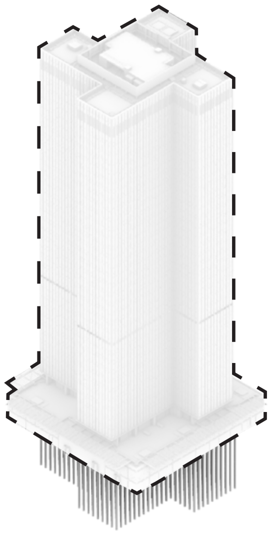
Efficiency and Viability
Considerations are the same as the core retention option in Section 16.3.6.

Lab-enabled
Considerations are the same as the core retention option in Section 16.3.6.

Site Capacity
Considerations are the same as the core retention option in Section 16.3.6.

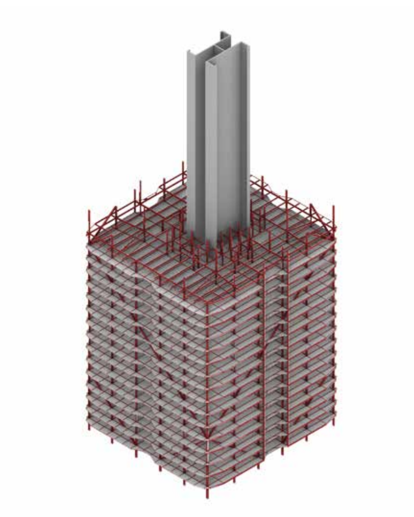


1. EXISTING BUILDING
Construction sequence is conventional demolition and rebuild

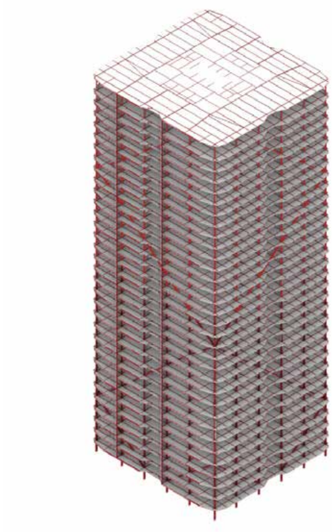


2. FULL DEMOLITION
Entire building is demolished including basement

3. NEW FOUNDATION
Dig new basement and foundation taking care to avoid existing piles



4 NEW PRIMARY STRUCTURE
Construction of new primary structure can begin using conventional methods

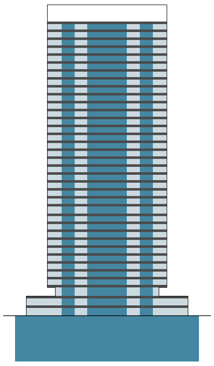
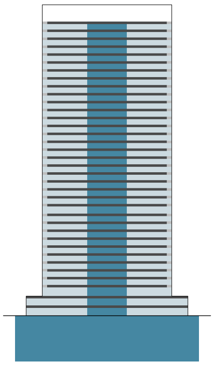
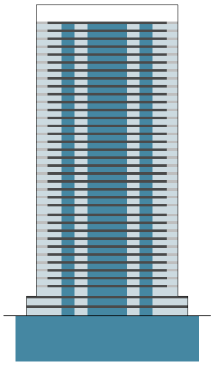
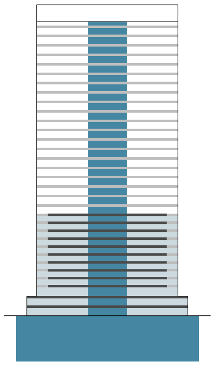


5. COMPLETED STRUCTURE
The structure is completed and installation of facade, services, vertical transport, etc. can follow

Figure 16.37 Construction sequence diagram

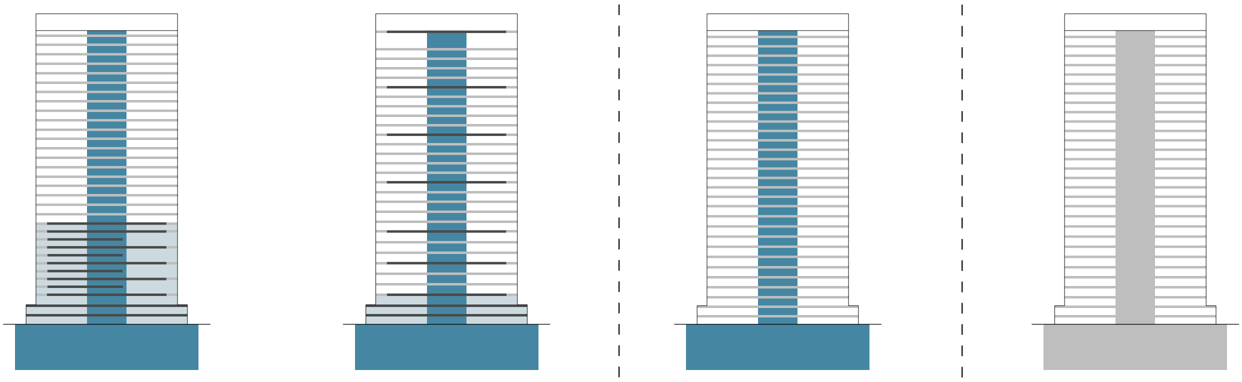
16.4 Summary and Comparison

The matrix on this page summarises and compares the options presented in this section. More detail against each of these considerations is contained within the respective sections.

	Major Refurbishment*	**Retention & Partial Extension - Max Retention**	**Retention & Extension - "Full" Retention**	**Partial Retention & Extension -** Retain Consecutive Slabs (Office)
				
	WLCA in Section 17	*WLCA in Section 17*	*WLCA in Section 17*	
Buildability and Temporary Works	Moderate. High risk of unknowns in using all existing structure. Complex but localised temporary works required to support unconstrained slab edges on all levels.	Moderate. High risk of unknowns in using all existing structure. Complex but localised temporary works required to support unconstrained slab edges on all levels.	Moderate. High risk of unknowns in using all existing structure. Complex but localised temporary works required to support unconstrained slab edges on all levels. Propping to below grade retaining walls required if ground slab is removed to facilitate new piling.	Moderate. High risk of unknowns in using all existing structure in lower stack and retaining unconstrained core. Complex but localised temporary works required to support unconstrained slab edges. Propping to below grade retaining walls required if ground slab is removed to facilitate new piling.
Floor to Ceiling Height	2,425-2,475mm (exposed services) 2,375-2,450mm (with ceiling)	2,425-2,475mm (exposed services) 2,375-2,450mm (with ceiling)	2,425-2,475mm (exposed services) 2,375-2,450mm (with ceiling)	2,425-2,475mm (lower stack, exposed services) 2,375-2,450mm (lower stack, w/ ceiling) 2,800mm (upper stack, with ceiling)
Structural Salvage	89% (by carbon) 90% (by volume)	93% (by carbon) 92% (by volume)	84% (by carbon) 85% (by volume)	41% (by carbon) 45% (by volume)
Flexibility in Use	Limited by existing grids. Existing loading capacity limits possible uses. No lab-enabled space.	Limited by existing grids. Existing loading capacity limits possible uses. No lab-enabled space.	Limited by existing grids. Existing loading capacity limits possible uses in areas of existing slabs. No lab-enabled space.	Limited by existing grids on retained floors. Grids above impacted by tying in to existing columns. Existing loading capacity limits possible uses in areas of existing slabs. No lab-enabled space.
Adaptability and Design for Disassembly	Limited. Opportunities for building in soft spots and design for disassembly limited by existing structure.	Limited. Opportunities for building in soft spots limited by existing structure. Design for disassembly limited to very small areas of new construction only.	Limited. Opportunities for building in soft spots limited by existing structure. Design for disassembly limited to areas of new construction only.	Limited. Opportunities for building in soft spots limited by existing structure in lower stack. In upper stack all areas offer opportunities for soft spots/amenity. Design for disassembly limited to areas of new construction only.

** Shown in Volume One not to be feasible.*

Best balance of structural retention and quality, flexibility, adaptability, and buildability.



Partial Retention & Extension - Retain Consecutive Slabs (Office and Lab)	Partial Retention & Extension - Retain Interstitial Slabs (Office / Office and Lab)	Partial Retention & Extension - Retain the Core	New Build
	WLCA in Section 17	*WLCA in Section 17*	*WLCA in Section 17*
Complex. High risk of unknowns in using existing structure in lower stack and retaining unconstrained core. Extensive temporary works required to support unconstrained slab edges especially at double-height lab-enabled levels. Propping to below grade retaining walls required if ground slab is removed to facilitate new piling.	Complex. Retaining unconstrained interstitial slabs and added H&S risk with simultaneous demolition and new construction. Strengthening required to unbraced columns spanning retained slabs. Extensive temporary works required for interstitial slabs and propping to below grade retaining walls required if ground slab is removed to facilitate new piling.	Moderate. Retaining unconstrained core but lower risk of unknowns. Bracing needed for core and propping to below grade retaining walls if ground floor slab is removed to facilitate new piling.	Good. Conventional demolition and rebuild minimises risk of unknowns, but coordination around existing piles required. No existing structure to be constrained but back propping required for below grade retaining walls where ground floor slab is removed to facilitate new piling.
2,375-2,450mm (retained office or lab-enabled write up, with ceiling) 4,925mm (lab-enabled, with ceiling) 2,800mm (new office, with ceiling)	2,840-2,980mm (office, with ceiling) 2,781mm (lab-enabled, with ceiling)	2,800mm (office, with ceiling) 2,600mm (lab-enabled, with ceiling)	2,800mm (office, with ceiling) 2,600mm (lab-enabled, with ceiling)
41% (by carbon) 45% (by volume)	38% (by carbon) 42% (by volume)	25% (by carbon) 31% (by volume)	0 % (by carbon or volume)
Limited by existing grids on retained floors. Grids above impacted by tying in to existing columns. Lab-enabled spaces can be double-height office or amenity, but would be inefficient.	Limited by existing grids on retained floors. All grids impacted by tying in to existing columns. Lab-enabled spaces can be used as offices, but would be inefficient.	Clear spans enable flexible layouts. Lab-enabled spaces can be used as offices.	Clear spans enable flexible layouts. Lab-enabled spaces can be used as offices.
Limited. Opportunities for building in soft spots limited by existing structure in lower stack. In upper stack all areas offer opportunities for soft spots/amenity. Design for disassembly limited to areas of new construction only.	Limited to soft spots only by having to use in-situ concrete slabs. Design for disassembly limited by existing floor structure and in-situ options for new build floorplates due to coordination with bracing structure.	Good. All areas offer opportunities for soft spots/amenity. All floor structure is new so can be designed for disassembly.	Good. All areas offer opportunities for soft spots/amenity. All floor structure is new so can be designed for disassembly.