Pell Frischmann

Homebase - O2 Finchley Road

Pre-demolition audit

Report Ref.	**4602_001-Pef-Xxx-Xxx-Rp-S-000002**
File Path	**https://pellf.sharepoint.com/sites/104878/Shared Documents/General/01 - WIP/Documents/Structural Engineer/Reports/Homebase - Pre-demo audit/4602_001-PEF-XXX-XXX-RP-S-000002.docx**

Rev	Suit	Description	Date	Originator	Checker	Approver
01	S2	First issue	02-08-22	RP	MH	MH
02	S2	Minor amendments to address comments	18-11-22	RP	MH	MH

Ref. reference. Rev revision. Suit suitability.

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Executive Summary	
Site Name	Homebase - Homebase - O2 Finchley Road
Location	London
Summary	This report is a pre-demolition audit for the Homebase building located at 255 Finchley Rd, O2, London. Documentation research was completed, complemented by a site visit. The audit lists the key demolition products (KDPs) likely to arise from demolition and end-of-life waste management options for each one of those products. An embodied carbon assessment of the KDPs was also completed within the scope of the audit. Opportunities to reuse some of the KDPS were identified, and reuse targets were proposed. Recycling targets were also set for the project, and landfill waste was estimated.

1 Introduction

Landsec has engaged Pell Frischmann (PF) to complete a pre-demolition audit of the Homebase building located at 255 Finchley Rd, O2, London NW3 6LU.

The building owner (Landsec) owns the materials and components arising from demolition and is typically responsible for adequately managing such components. The owner is also entitled to receive any profit related to the materials and components arising from the demolition process unless the ownership is transferred to another party (e.g. a demolition contractor).

Generally, the pre-demolition audit aims to inform the building owner of the materials and components arising from the demolition process and guide on the appropriate end-of-life scenario (management, recovery or reuse) for each material and component.

The following objectives were set for this audit:

- Describe the investigations that have been carried out to evaluate the potential reusability of the existing building and building components;
- Identify and quantify the key demolition products (KDP) likely to be generated from the demolition/deconstruction works;
- The associated embodied carbon of the key components and materials and whether they are suitable for reclamation;
- Identify opportunities in line with the waste hierarchy to maximize reuse and recycling and minimize waste to landfills;
- Optimize the management of products and provide recommendations to the project actors on how to process such products after demolition;
- Provide advice on the reuse of products and recycling of material on-site, focusing on products with better chances of being reintegrated into the supply chain;
- Facilitate better communication between the supply chain by providing a list of relevant organizations and/or companies who may be able to deal with the products;
- Provide data to help with populating the Resource Management Plan in support of the BREEAM assessment and the Greater London Authority Circular Economy Statement;
- Estimate overall reuse and recycling rate for all key materials, on- and offsite, and suggest targets where appropriate;
- Estimate the overall landfill diversion rate for all key materials.

The first step of the audit covered documentation research, which is summarized in section 2.1

The available information and documentation on the building were limited. PF contacted the original civil and structural designers to access relevant documentation but was unsuccessful (the building was designed in the mid-nineties).

To aid the demolition audit, a site investigation was carried out by PF. A comprehensive site survey was not completed, as this was not covered by the PF proposal nor the purpose of this audit. The audit was therefore completed based on the visual inspection considering typical industry practice. The photos presented throughout the report were taken during the site visit.

Sections 2.2 provide relevant building data, while section 2.3 evaluates opportunities to retain or reuse the existing building or building components within the new O2 Finchley Road development.

Section 2.4 lists the assumption considered to complete the audit based on the documentation research and typical industry practice.

The key demolition products (KDP) are summarized in section 2.5. Detail on each KDP, including end-of-life management options, are given in 3.

An embodied carbon assessment is completed in section 4, based on the KDP volumes assessed on this audit.

Guidance to maximize reuse and recycling, as well as reuse and recycling targets for the KDPs, are proposed in sections 5 and 6, respectively.

Appendix A includes a schematic representation of the steel structure based on the site visit.

2 Pre-demolition audit

2.1 Documentation research

PF completed documentation research to gather all relevant building information for the audit. A summary of the documentation research is presented in Table 1.

Table 1 Documentation research summary

Item	PF Notes
Site location	255 Finchley Rd, O2, London NW3 6L
Approximate National Grid Reference	525650, 184730
Construction date	1996-1997
Structure	Streel frame supported by concrete pad and strip footings. Mezzanine floor in the north area of the building.
Building Description	Single-storey industrial shed of approximately 48m x 72m plan with a GIA of 3851 m^2.
Building layers	Primary hot-rolled frame, secondary cold-formed steel structure, sandwich panel cladding with brickwork at ground floor level
Architects – original building	HOK, formerly Hellmuth, Obata + Kassabaum (1996-1997)
Structural Engineering – original building	Clarke Bond Partnership (1996-1997)
Developers outline specification - Sainsbury's Homebase – July 8 1996	Architectural drawings are included. A list of project actors can be retrieved, including Clarke Bond Partnership as the structural engineers.
The foundation plan of the existing structure is available in DWG format. The existing brick sewer below the building is represented.	Drawing originator: Clarke Bond Partnership: Project no. 14500 H. B. Drawing No. 01 (Nov 96)
PW9702660 - Planning permission for the erection of a sprinkler tank and pump house	August 1997
PW9802219 - Planning permission for a free-standing grazed canopy within the proposed garden centre area	March 1998
PW9802758 - Planning permission for a free-standing fabric-covered canopy within the proposed garden centre area	September 1998
2004-4639-A - Display of 4 high-level internally illuminated signs together with 4 street level non-illuminated poster panels	December 2004
2014-4395-P - Planning permission for a mezzanine extension **Note**: this extension was not completed.	August 2014. Ground floor and mezzanine level plans are available for the existing and proposed new layout. Drawings originator: pmm – architecture planning and construction 4027 P02 May 27 - Existing ground floor & site plan 4027 P03 May 27 - Existing first floor & south elevation 4027 P04 May 27 - Proposed ground floor & site plan 4027 P05 May 27 - Proposed first floor & south elevation
Homebase – Rack depth plan (24/09/2019)	Ground floor and mezzanines existing layouts

2.2 Building data

The building is located at 255 Finchley Rd, O2, London NW3 6L. The red hatch in Figure 1 identifies the building area covered by the pre-demolition audit.

Figure 1 Homebase - 255 Finchley Rd, O2, London NW3 6LU

The Homebase is a single-storey building erected in 1996-1997 (Figure 2). The building has external canopies (Figure 3) and interior mezzanines (Figure 4).

Figure 2 Homebase building

The primary structure is a hit-and-miss portal frame (Figure 5) supported by mass concrete pad and strip footings. The cladding is likely to be a 100mm sandwich panel (according to the Developers outline specification - Sainsbury's Homebase – July 8 1996) supported by cold-formed secondary steelwork with stays/rods (a structural sketch is shown in Appendix A, based on the site visit).

The building has a clear height of approximately 6m at the underside of the hunch. The primary frames are spaced by approximately 8m and span about 35m (2x35m, with an interior row of columns).

The ground floor is believed to be a 200mm power float monolithic concrete slab (according to Clarke Bond Partnership: Project no. 14500 H. B. Drawing No. 01 - Nov 96) with a surface hardener. Other finishes may have been applied in subsequent refurbishments.

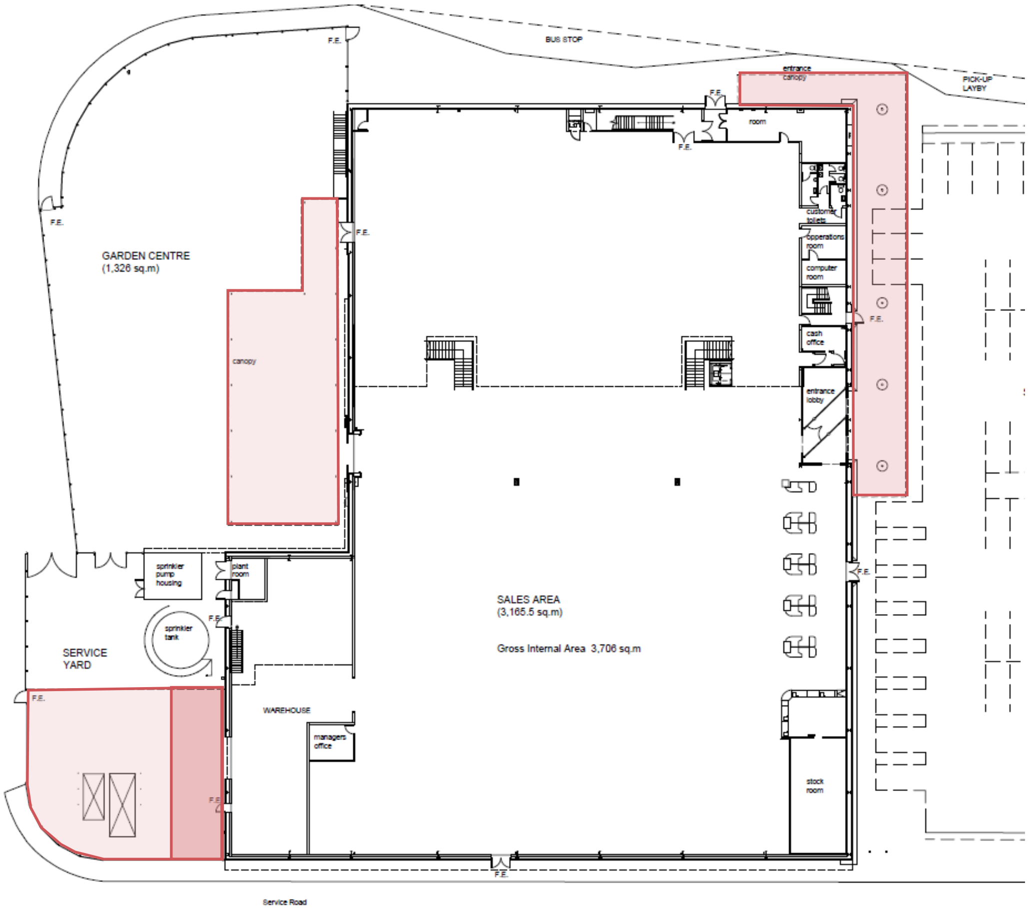


Figure 3 Ground floor plan identifying external canopies

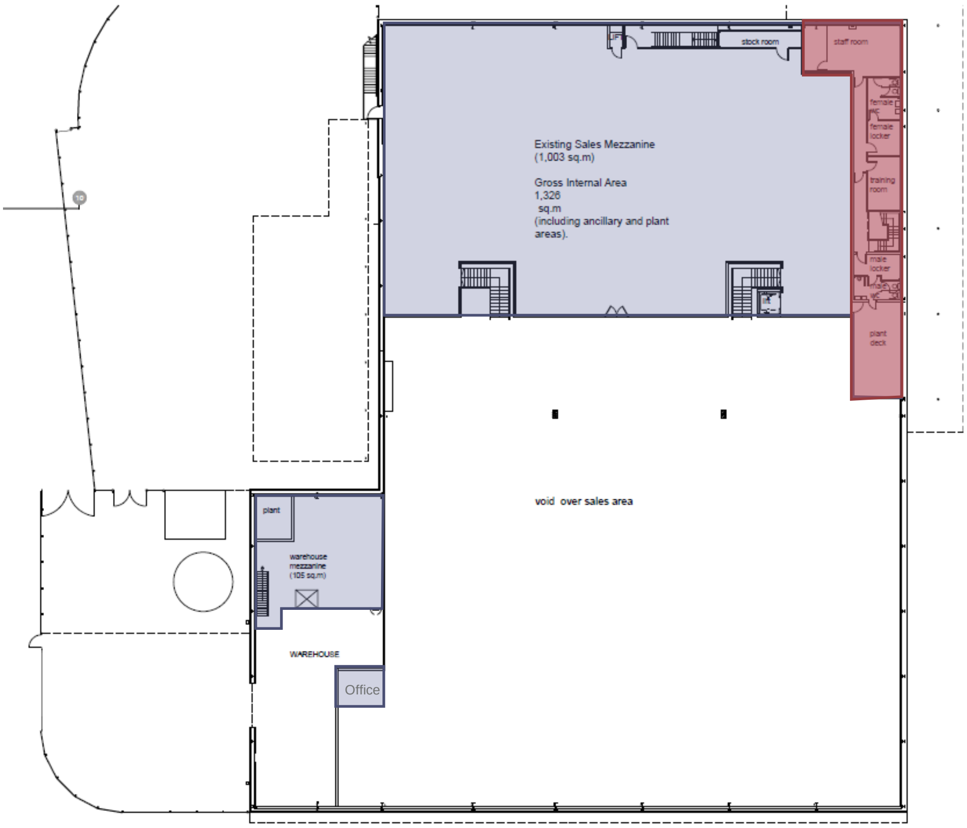


Figure 4 First floor plan mezzanines (red: concrete with metal decking; purple: cold-formed joists with OSB)

The building has an external cavity wall likely to be constituted by (according to the "Developers outline specification - Sainsbury's Homebase – July 8 1996"):

- Outer leaf – 103mm dark blue/grey facing brick;
- Cavity – 75mm, with 75mm Rockwool insulation;
- Inner leaf - medium density non-loadbearing concrete blockwork.

Figure 5 Typical steel frame

Most of the partitions over and below the mezzanine with metal decking (red area in Figure 4) are blockwork. Lightweight partitions are also used in some areas, assumed made by timber studs with plasterboards.

2.3 Potential for refurbishment and reuse

The Homebase building is in good condition, and there are opportunities to reclaim and reuse some components arising from demolition (or deconstruction). Section 5 discusses such opportunities, proposing reclamation and reuse targets for some key demolition products.

In general, the components arising from demolition (or deconstruction) do not fit the purpose of the new scheme (Figure 6). Opportunities to reuse the components on-site may involve using crushed concrete aggregate (recycled aggregate) as a sub-base or repurposing bricks or concrete pavers.

The existing building is a low-rise steel shed with large open spaces, while the proposed new building is a multi-storey residential building up to 16 storeys. The proposed solution for the new building is a concrete superstructure, which also hinders possible opportunities to repurpose the elements arising from the Homebase building into the new building structure.

Figure 6 O2 Finchley Road proposed new scheme

A preliminary study proved that the existing foundations are unsuitable for the new development (pad footings, while pile foundations are required for the new building - Figure 7). The loads transmitted to the new building are much higher than those currently transmitted by the Homebase building.

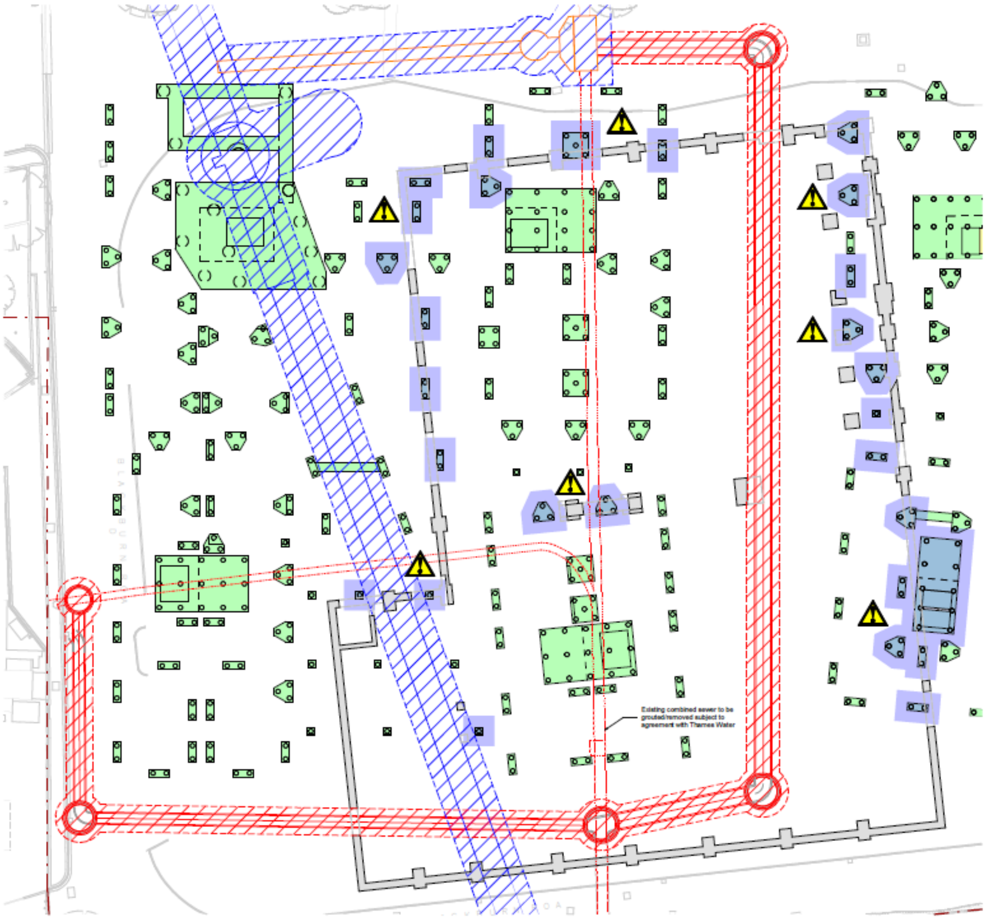


Figure 7 Homebase foundations (grey) and foundations of the new building (green and purple).

However, there are opportunities to reclaim and reuse key demolition (or deconstruction) products. Such opportunities are discussed in sections 3 and 5. The primary structure is the key demolition product with greater chances of being reclaimed and reused in a new structural application (possible as a building relocation or as individual elements).

2.4 Assumptions of the assessment

Key building areas and dimensions:

- Main building ground floor area: 3851 m^2
- Mezzanine with concrete and metal decking (staff area): 189 m^2
- Mezzanine with cold-formed joists – sales area: 1096 m^2
- Mezzanine with cold-formed joists – warehouse: 124 m^2
- Garden area canopy: 286 m^2
- Canopy over main building entrance: 238 m^2
- Canopy over service yeard entrance: 87 m^2
- Canopy over service yeard area: 216 m^2
- Service yeard ground floor area: 248 m^2
- Garden area ground floor area: 1324 m^2
- Main building roof area: 3875 m^2
- Office near warehouse: 17 m^2
- Main building façade area: 2715 m^2
- Service yard unit façade: 60 m^2
- Service yard unit roof: 25 m^2
- Building perimeter: 266m
- Timber fence length: 130m
- External ground floor area adjacent to the building: 630 m^2 (from a 2.5m strip around the building)
- Bitumen area adjacent to the building: 70 m^2 (from a 2.5m strip around the building)
- Areas with lightweight partitions: 230 m^2

The assessment was completed based on the following assumptions:

- Primary steelwork – main building: 40 kg/m^2
- Primary steelwork – mezzanine with concrete and metal decking: 45 kg/m^2
- Primary steelwork – mezzanine with cold formed joists and hot rolled steel framing: 35 kg/m^2
- Primary steelwork – canopy in the garden area: 30 kg/m^2 (galvanized)
- Primary steelwork – main building canopies: 40 kg/m^2
- Primary steelwork – service yeard canopy: 30 kg/m^2
- Cold-formed steelwork tonnage per m^2 of clad area: 5 kg/m^2
- Steel plates: 10% of the hot-rolled steelwork weight
- Steel plates: 5% of the cold-formed steelwork weight
- Metal decking – composite floors: 15 kg/m^2
- Sandwich panels: 15 kg/m^2
- Reinforcement rates: ~ 67 kg/m^3 of concrete (blended ratio for ground floors and foundations)
- Reinforcement for composite floor: A242 mesh plus edge bars (~ 4 kg/m^2)
- OSB panels thickness: 18mm
- Timber fence: 19mm boards with 100 x100 mm posts and beams
- Steel posts and framing – fence: SHS 100x100x4
- Steel posts and framing – razor fence support SHS 50x50x4 (galvanized)
- Ground floor thickness: 200 mm, as per Clark Bond Partnership: Project no. 14500 H. B. Drawing 01
- Foundations: as per Clark Bond Partnership: Project no. 14500 H. B. Drawing 01
- Rockwool insulation: 50 kg/m^3, 75mm thick, 3m height
- Blockwork: 3m height (building perimeter), assumed 440x215x215 blocks
- Brickwork: 1m height (building perimeter), 215x103x65 bricks
- Pavement blocks: 50mm thick
- Bitumen thickness: 35mm (which may arise close to the building edge)
- Ceilings – staff area: 3cm thick polystyrene ceiling tiles with framing (2 kg/m^2 for frame)
- Ceilings – sales mezzanine: 12.5mm plasterboard tiles with framing (2 kg/m^2 for frame)
- Lightweight partitions: timber studs and plasterboards – staff and storage/sales areas (50 kg /m^2)
- Polycarbonate – main building (10% of the roof area): 5 kg/m^2
- Polycarbonate – canopy garden area: 3 kg/m^2
- GRP roofing sheets – canopy service yeard area: 3 kg/m^2
- Glass balustrades: 15mm thick; height: 900mm
- Windows and doors glazings: 2 x 4mm

2.5 Key Demolition Products (KDPs)

Table 2 provides the key demolition products relevant for the assessment and indicates others expected to be found on site. Although some KDP quantities were not assessed, the report will provide advice on the end-of-life option of all products.

Table 2 Weight (tonnes), volume (m^3) and European Waste Codes for each KDP

Item	Volume (m^3)		Mass (tonnes)		EWC[(1)]
Concrete	1515.77	62.17%	3316.33	84.87%	17 01 01
Metals	49.20	2.02%	386.21	9.88%	17 04 05
Cladding	692.77	28.41%	103.92	2.66%	17 06 03 (hazardous) 17 06 04 (non-hazardous)
Bricks	23.24	0.95%	44.16	1.13%	17 01 01
Timber	50.6	2.08%	22.3	0.57%	17 02 01
Plaster and plasterboards	22.34	0.92%	17.87	0.46%	17 08 02
Glass	1.89	0.08%	4.72	0.12%	17 02 02
Plastics	18.86	0.77%	3.53	0.09%	17 02 03
Ceramics	1.40	0.06%	3.20	0.08%	17 01 03
Insulation	59.74	2.45%	2.99	0.08%	17 06 04
Bitumen	2.45	0.10%	2.55	0.07%	17 03 01
WEEE (electrical/electronic waste)	-	-	-	-	16 02 14
Total	**2438.26**	**100%**	**3907.74**	**100%**	-
(1) – https://www.gov.uk/how-to-classify-different-types-of-waste/construction-and-demolition-waste					

The information in Table 2 is represented graphically in Figure 8 and Figure 9.

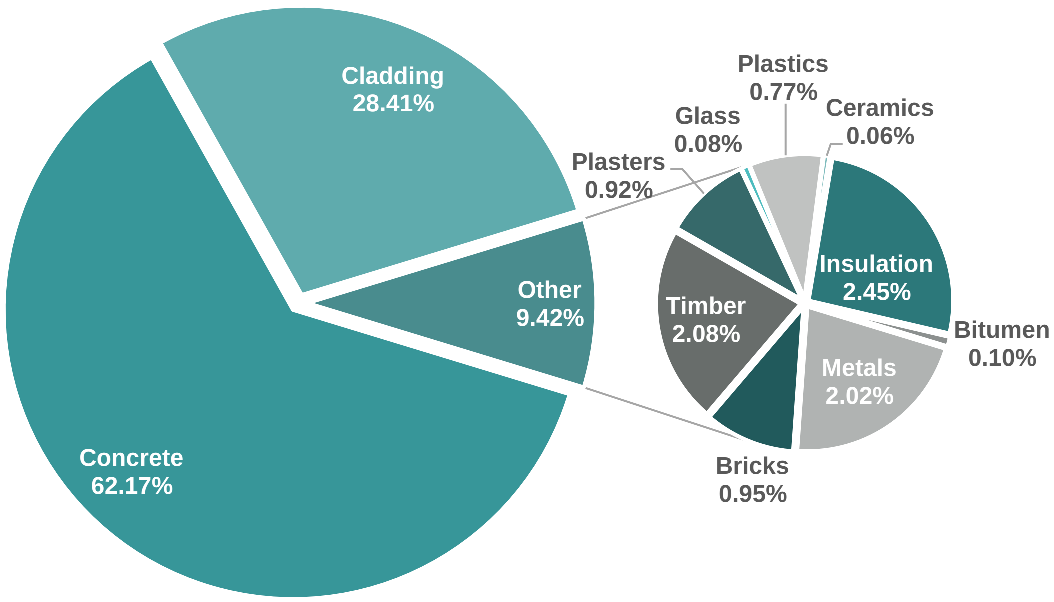


Figure 8 Key demolition products by volume (m^3)

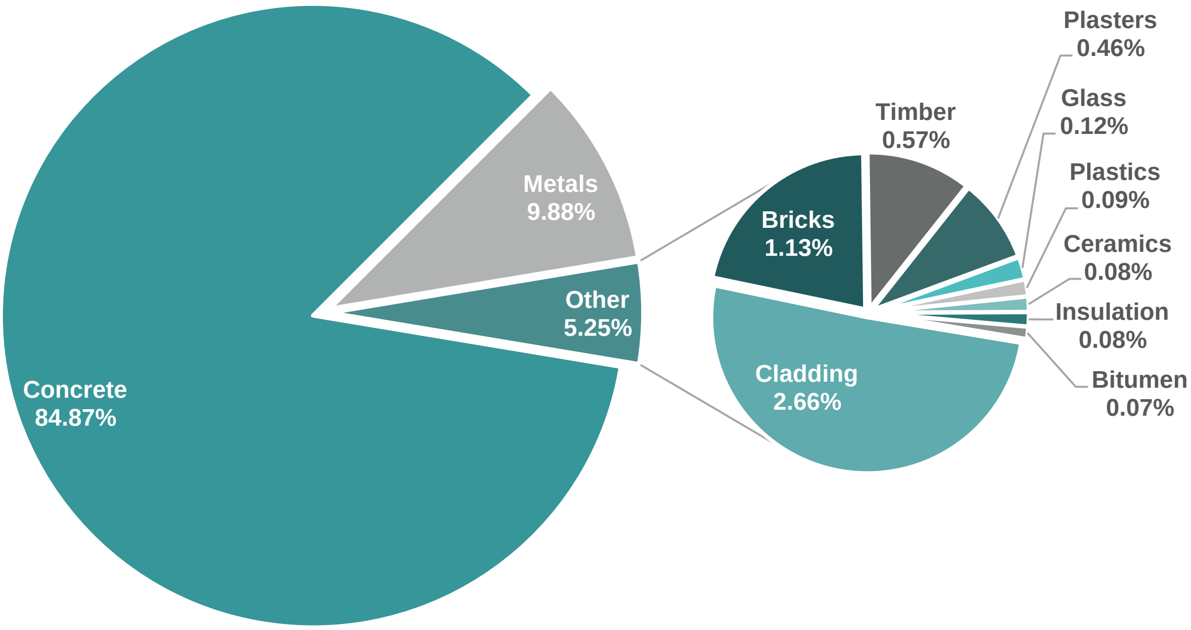


Figure 9 Key demolition products by weight (tonnes)

Section 3 details the sources and end-of-life management options for the KDPs in Table 2.

3 KDPs data and End-of-life management options

3.1 Concrete

Concrete is the largest KDP identified, estimated to be approximately 3,316 tonnes (about 84% of the total KDPs by Weight), as shown in Table 2, Figure 8 and Figure 9. The sources of the concrete-based products are shown in Table 3. The ground floor and foundations are more significant concrete sources (84% of the concrete-based products).

Table 3 Weight (tonnes), volume (m³) – KDP: concrete, EWC: 17 01 01

Item	Volume (m³)	Mass (tonnes)	%
Ground floors	819.74	1967.38	59.32%
Foundations	310.43	745.03	22.47%
Concrete blocks - walls	250.06	300.07	9.05%
Pavement blocks – external areas (potentially reusable)	97.65	214.83	6.48%
Mezzanine with metal decking	28.35	68.04	2.05%
Mortar (brickwork and blockwork)	9.21	20.25	0.61%
Grout	0.34	0.74	0.02%
Total	**1515.77**	**3316.33**	**100%**

The existing cast-in concrete and blockwork are unsuitable for reuse (ground slabs, foundations and mezzanine composite floor, block walls, mortar and grout). The pavement blocks can be reclaimed and reused (representing approximately 215 tonnes; about 6.5% of the concrete-based products' tonnage). Table 4 lists potential companies, institutions or platforms which can be considered to maximize the reuse potential of the pavement blocks.

Table 4 Examples of platforms and companies to enable the reuse of components – pavement blocks

Company	Website	Comments
Salvo	https://www.salvoweb.com	Generic platform (pavers can be found)
Watling Reclamation	https://watlingreclamation.co.uk	The company buys pavers across the UK
London Reclaimed Brick Merchants	www.lrbm.com	Advice may be sought

It is recommended that the concrete-based elements should be segregated either on-site or at a waste facility and crushed to produce recycled concrete aggregate (RCA), which s covered by BS8500-1 (see note 1). The production of RCA shall follow the recommendation of the WRAP Quality Protocol for aggregates from inert waste (see note 2).

The existing concrete can also be used for lower-value end-of-life applications such as piling mats or as a temporary or permanent filler. If reprocessed, stored or used on-site, appropriate permits or exemptions will be required (see note 3). Alternative options to utilize RCA are presented below.

Notes:

1. Recycled concrete aggregate is aggregate resulting from the processing of inorganic material previously used in construction and principally comprising crushed concrete (BS 8500-1: 2015)
2. https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-frominert-waste
3. https://www.gov.uk/guidance/waste-environmental-permits

Options to reutilise RCAs:

- **Bitumen-bound materials:** can be used may be used in a variety of base course and binder course mixtures.

- **Concrete:** recycled concrete aggregate is permitted for use in specific grades of concrete. It is generally acknowledged that RCA can potentially be used to replace 20% of the coarse aggregate in concrete up to Grade 50.
- **Pipe bedding:** suitably graded recycled concrete aggregate can be used in pipe bedding.
- **Hydraulically bound mixtures (HBM) for subbase and base:** recycled concrete aggregate can be suitable for use in HBMs. These can be used in constructing car parks, estate/minor roads and hard standing.
- **Unbound mixtures for subbase:** suitably graded recycled concrete aggregate can be used as a sub-base.
- **Capping:** recycled concrete aggregate is suitable for general capping applications.
- **Opportunity to reuse concrete-based paving elements which may arise from the demolition process**

Table 5 shows examples of waste management companies which may be able to manage concrete waste. Alternatively, licensed waste management contractors should be able to reprocess concrete waste into aggregates.

Table 5 Examples of waste management companies – concrete

Company	Website
Powerday	https://powerday.co.uk
Norris Skips	https://norriskips.co.uk
RTS Waste	www.rtswaste.co.uk
Days Group	http://www.daygroup.co.uk
O'Donovan	https://www.odonovan.co.uk
SRC Group	https://www.srcaggregates.co.uk
Sivyer	http://www.hsivyer.com
Hinton's	https://www.hintonswaste.co.uk

The following figures illustrate the concrete-based KDP found in the building.

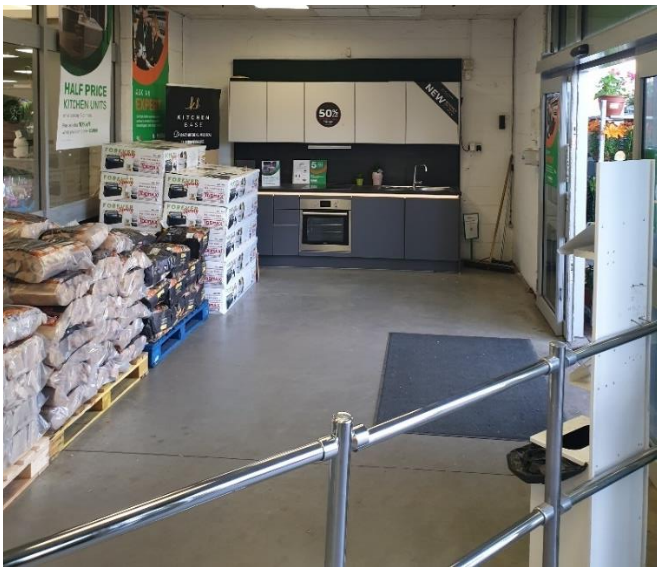


Figure 10 Concrete ground floor

Figure 11 Pavement blocks around the building

Figure 12 Service yard ground floor

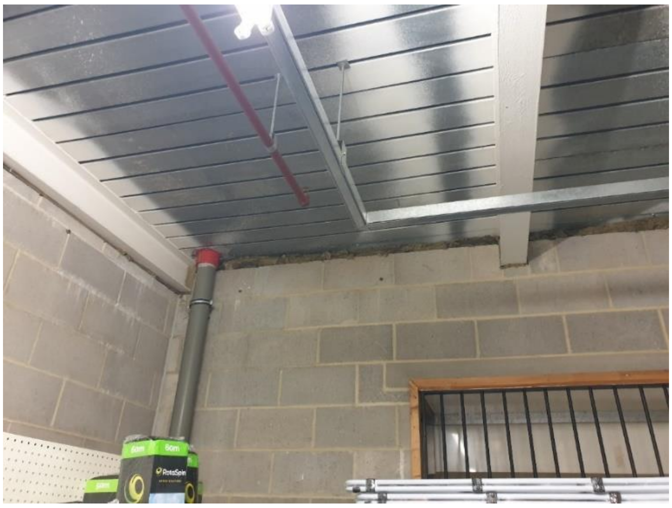


Figure 13 Brickwork and concrete on metal decking

3.2 Metals

Metals are the second largest KDP identified, estimated to be approximately 431 tonnes (about 11% of the total KDPs by Weight), as shown in Table 2, Figure 8 and Figure 9. The sources of the metals are shown in Table 3. A degree of reusability was established for each metal source. The primary steel structure (primary frames, bracings, and plate) and the reinforcement cast in the concrete elements are the two most significant sources of metals, with about 47% and 20% of the total metals, respectively.

Table 6 Weight (tonnes), volume (m^3) – KDP: metals, EWC: 17 04 05

Item	Volume (m^3)	Mass (tonnes)	%	Reusability
Painted I/H hot-rolled profiles (primary structure)	18.34	143.94	37.27%	
Reinforcement	9.82	77.07	19.95%	
Galvanized cold-formed steel	6.78	53.20	13.78%	
Painted I/H (other)	3.00	23.54	6.09%	
Painted CHS & SHS (primary structure)	2.94	23.11	5.98%	
Plate (primary structure)	1.96	15.40	3.99%	
Painted CHS & SHS (other)	1.30	10.21	2.64%	
Plate (other)	1.12	8.76	2.27%	
Galvanized CHS - garden area canopy	1.09	8.58	2.22%	
Painted I/H hot-rolled profiles with welded studs	0.84	6.62	1.71%	
Painted I/H - Canopy over service yard	0.82	6.47	1.67%	
Galvanized plate	0.65	5.08	1.32%	
Galvanized metal decking	0.36	2.84	0.73%	
Galvanized SHS (fence)	0.18	1.41	0.37%	
Sprinklers tank (galvanized)	-	-	-	
Streetlights posts (garden area and service yard)	-	-	-	
Other sources include railings, sheeting, roller shutters, handrails, gates, doors, window frames, racks, shelves, stairs, sprinklers systems, pipes, etc.	-	-	-	-
Total	**49.20**	**356.21**	**100%**	
Green: reusable, easy to segregate; **Amber:** reusable, but damage may occur during segregation**; Red**: suitable for recycling				

Particular attention should be paid to the bolted primary steel structure (heavy steelwork; 182 tonnes, 47% of the total metals) as it offers good reuse opportunities. The structure exhibits long spans with a considerable degree of repetition and standardization, which are favourable to reclaiming and reusing the structural components. One of the possible end-of-life scenarios is to deconstruct the structure and re-erected it elsewhere. Some remedial work will be required before the new life cycle (re-coating at least since the steelwork is likely to be stored outdoors before the new life cycle). The next best alternative is to reuse individual frames, possibly with a smaller frame spacing, to comply with new design requirements. Alternatively, individual components can be reclaimed and reused for different structural applications. The end of the beams, columns and bracings can be cut off and the steelwork re-fabricated to suit the new life cycle requirements.

The galvanized canopy in the garden area (green area in Figure 14; 8.6 tonnes, about 2.2% of the metals) is also suitable to be reclaimed and erected elsewhere. The canopy at the service yard area (red area in Figure 14) shows signs of corrosion and bad workmanship, for which the reclamation of individual components to be used in different structural applications is recommended.

The beams supporting the composite floor with metal decking (blue area in Figure 14; 6.6 tonnes, about 1.7% of the total metals) have welded studs cast in the concrete element. Careful demolition is required to reclaim the steel beams without significant damage, which would hinder their reusability.

The secondary structure (cold-formed elements to support cladding or used as a flooring plate in the mezzanines) also offers some opportunities to be reused. However, because the cladding or chipboards are connected to the secondary structure by self-drilling/tapping screws or shot-fired nails, the deconstruction is more laborious (and less attractive). Damage may occur during the deconstruction process.

The steel reinforcement (about 20% of the metals) should be segregated by a specialist contractor from the concrete elements and sent to recycling.

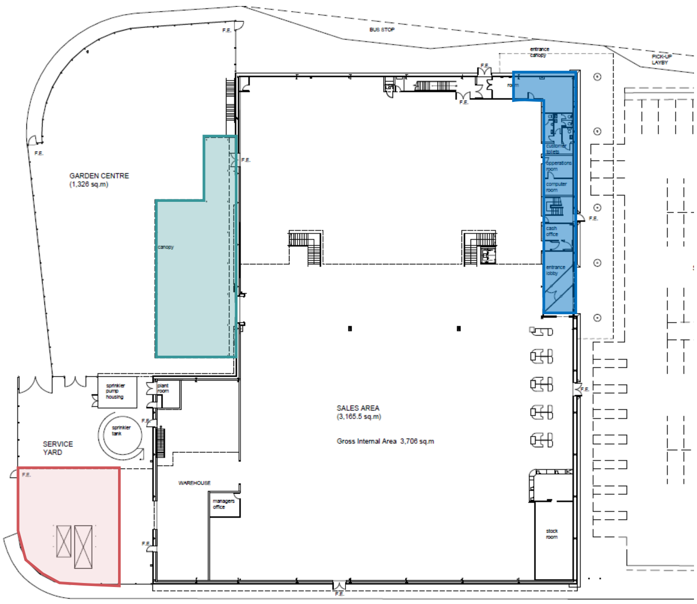


Figure 14 External canopies: garden area (green), service yard (red), mezzanine with metal decking (blue)

Guidance on reusing steel structures can be found in the references given in Table 7.

Table 7 Guidance on the reuse of structural steelwork

Company	Website
ECCS - Progress	https://www.steelconstruct.com/eu-projects/progress
ECCS – Progress design guide	https://www.steelconstruct.com/eu-projects/progress/design-guide
SCI P427	https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/SCI_P427.pdf

The SCI P427 guides on assessment and testing of existing steelwork to comply with the execution and erection standard (EN 1090-2). Even if detailed building documentation is unavailable, the steelwork can be tested, re-certified and reintegrated into the market. Table 8 lists potential companies, institutions or platforms which can be considered to maximize the reuse potential of the reclaimed steelwork.

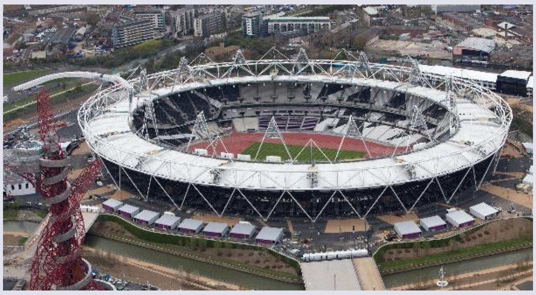
Table 8 Potential companies, institutions or portals capable of enabling the reuse of steel products

Company name	Website	Brief description
Cleveland Steel & Tubes Ltd.	https://cleveland-steel.com	Steelwork stockist with interest in promoting the structural steel reuse practice.
John Lawrie Tubulars	https://www.johnlawrietubulars.com	John Lawrie Tubulars sources decommissioned oil and gas pipelines and repurpose them for use as driven steel piles for civil and structural engineering purposes.
BCSA	https://steelconstruction.org/	The national organization for the steel construction industry in the UK, may be able to advise on market opportunities for repurposing existing steelwork.
SCI	https://www.steel-sci.com/	SCI (Steel Construction Institute) has been a trusted, independent source of information and engineering expertise in the UK. Advice may be sought to assess the reusability of reclaimed steelwork.
Ainscough Metals	https://www.ainscoughmetals.co.uk	New and used steel suppliers and fabricators.
Salvo	https://www.salvoweb.com	Salvo is the marketplace for architectural antiques, gardens, decorative, salvage and reclaimed building materials.

Although the steel reuse practice of an entire structure or individual components may be considered pioneering, Table 9 shows projects with ties to the UK market where such practice was successfully implemented.

Table 9 Steel reuse case studies (https://www.steelconstruct.com/eu-projects/progress/)

Building	Description
 SEGRO warehouse, Slough, UK	The warehouse building built in 2000 was relocated in a different layout in 2015 to enable the construction of a new road bridge. A new composite panel wall system replaced the original brick cladding.
 Bus station Schiphol – Nord, Amsterdam, Netherlands	The original building was constructed in 1958 and was used as a hangar by the Rotterdam Airport until the late 1990s. In 2003, the structure was reused as a hangar for seven years by the Rotterdam Detention Center. In 2015, it was reused again as a bus station in Schiphol.
 BRE test facility, Cardington, UK	Two sheds in Cardington in the midlands of England were converted from hangars for building zeppelins in wartime. No. 2 shed owned by BRE was initially erected in Pulham, but was moved to Cardington in 1928. The entire 3270-tonne steel structure was dismantled and reassembled.
 NTS building, Thirsk, UK	The original building order was cancelled in 2008, after which the fabricated steelwork was stored. Later the steelwork was divided into four parts and sold in an auction. The new building was erected in 2017 by reusing one of the lots from the original building.

Building	Description
 Kingsize Academy, Bradford, UK	Two long-span portal frames from existing industrial buildings were used as part of this new secondary school.
 The London Olympic Stadium, London, UK	2500 tonnes of surplus oil and gas pipeline tube material was used to build major stadia projects, including the London Olympic Stadium, Old Trafford North & South Stands in Manchester, Emirates Stadium, London and the Reebok Stadium in Bolton.
 Bedzed, London, UK	Temporary steelwork used at Brighton railway station was later used in the permanent structure of this award-winning, environmentally designed mixed-use development in 2002.
 Blue Steel Building, Leeds, UK	The existing warehouse structure was refurbished. Its portal frame was raised by 3 m, the existing purlins, bracing and rafters were reused, and a new office block was added with composite decking.

The structural steel reuse process can be summarized as follows (based on SCI P427):

- A building is flanged for deconstruction/demolition;
- A team of qualified professionals should assess the structure's condition and degree of Demountability. PF completed this assessment, and recommendations were given in this section. Discussions with demolition contractors at early project stages are required to exploit the steel reuse opportunities;
- A business case is established between the holder of stock (Landsec), market players interested in the steelwork (fabricators, stockholders, steelwork contractors or clients) and the company responsible for the deconstruction;
- Essential details of the reclaimed steel are recorded as described in the document;
- The new stockholder receives the reclaimed steelwork, grouped and listed as described in SCI P427. The necessary grouping impacts the extent of testing that may be required and should be treated carefully;
- If documentation is unavailable, members are inspected and tested according to the publication;
- The testing protocol involves a combination of non-destructive and destructive testing, with the opportunity to make conservative assumptions about certain material characteristics (such as toughness);
- The stockholder may complete testing. The stockholder is responsible for declaring the necessary characteristics as the material is sold (this would substitute the typical material certificate, based on the guidance given by EN 1990-2 section 5.1 for non-constituent products);
- The tests should be completed by an accredited laboratory (destructive tests) and trained personnel (non-destructive testing).
- Structural design and member verification are completed with modifications for member stability, as described in the document.

A model specification for the purchase of reclaimed steel sections has recently been published by the British Constructional Steelwork Association (BCSA):

https://steelconstruction.org/wp-content/uploads/2022/04/ModelSpecReclaimedSteel_Issue-1_Final-Rev.pdf

The environmental benefit that is obtained through the reuse of reclaimed steel sections comes from avoiding the energy needed to produce new steel and the associated carbon emissions. However, the most significant carbon emissions from the steelmaking industry are currently associated with the chemical reduction of iron ore in primary steel production. Every tonne of scrap steel makes a valuable contribution to reducing the demand for primary steel and, therefore, it is essential to make efficient use of all reclaimed steel, whether this is to be reused or recycled as scrap.

As a rule of thumb, if the reuse of reclaimed sections involves an increase of steel weight of more than 20% compared to an efficient solution using new steel, then any benefit in terms of global carbon emissions could be lost (Annex J to the National Steelwork Specification for Building Construction - NSSS).

The following keynotes can be listed:

- The building was erected in the late nineties (1996-1997), which indicates premium opportunities to reuse the structural components;
- The steelwork fits the scope set by SCI P427
- The first edition of the National Steelwork Specification was issued in 1989, which suggests that the fabrication and erection tolerances and comparable to those required for new structures (CE marking and Declaration of Performance of harmonized construction products were introduced after 2000);
- The site inspection completed by PF confirms that most of the steelwork is in good condition and fit for reuse (primary structure (more than 50% of the metals can be reclaimed and reused);

The following figures illustrate the steel work arising from demolition/deconstruction.

Figure 15 Primary structure

Figure 16 Typical detail of a primary frame

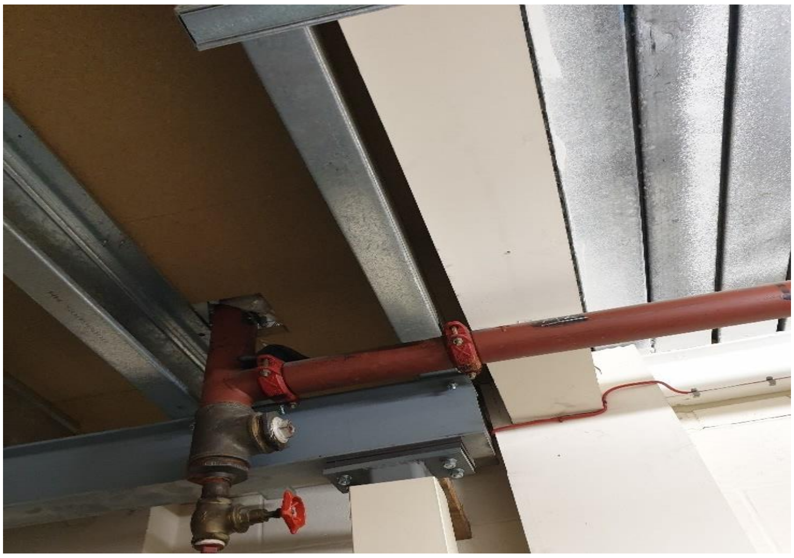


Figure 17 Transition between the composite floor and sales mezzanine with cold-formed joists (left)

Figure 18 Service yard entrance canopy and service yard area canopy

Figure 19 Flower garden canopy

Figure 20 Canopy over main shop entrance

Figure 21 Posts, framing and razor wire fence

Figure 22 Galvanized posts over the garden centre fence and streetlights

It is common practice for demolition contractors to reduce their contract value by allowing for income from recycling metals during demolition. Standard skip-hire companies will likely charge for transport costs only and may deduct a small allowance on the metals. Deconstructing the building in opposition to demolition will change the typical end-of-life programme of a building and should be planned in advance with the relevant actors/contractors.

If the metal components can't be reused, the companies listed in Table 10 may be considered to manage the metal waste.

Table 10 Local waste management companies - Metals

Company	Website
Capital Metal Recycling	http://capitalmetalrecycling.co.uk
London Scrap Metal Recycling	http://www.londonscrapmetalrecycling.com
EMR Group	http://www.emrgroup.com

Figure 23 Sprinkler tank

Figure 24 Steel stairs and handrails (warehouse)

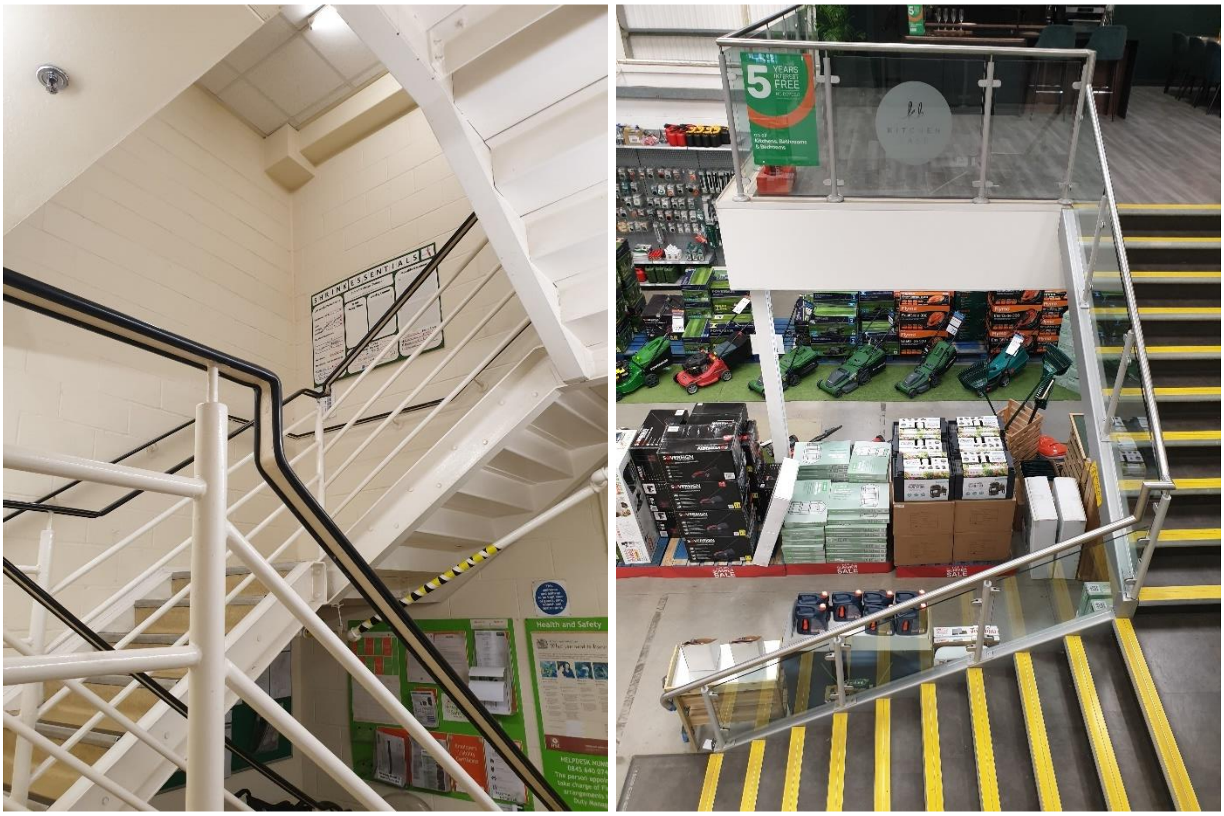


Figure 25 Steel stairs and handrails (Left: staff area mezzanine; Right: sales area mezzanine)

Figure 26 External stairs (fire exit) near the flower garden

3.3 Sandwich panels

The cladding elements are the third largest KDP identified, estimated to be approximately 104 tonnes (about 2.7% of the total KDPs by Weight). The EWC codes are 17 06 03 for hazardous cladding and 17 06 04 for non-hazardous cladding.

The sandwich panels are typically connected to the cold-formed secondary steel structure with self-drilling/tapping screws, which places barriers to the deconstruction and reclamation of such products. However, considering the good condition of the primary steelwork, the deconstruction of the building is encouraged, which may allow for the reclamation of the sandwich panels. Most of the panels also appear in good condition (Figure 27). Some cladding elements may be damaged (possible close to the building edges and apex, where the density of the connection elements and flashing is more significant), but a percentage can be successfully reclaimed and fit for reuse. The panels can be reused in different applications as the final cladding element or as an internal cladding element to be over-clad by a new cladding component (to suit the new construction requirements).

Figure 27 Sandwich panels

Insulated panels that contain ODS (Ozone Depleting Substances) in the form of blowing agents (gases trapped within the closed-cell structure) are subject to additional hazardous waste requirements, which stipulate the recovery process and requirements of ODS. Such panels would be classified as hazardous waste and therefore subject to transportation and dismantling restrictions (no crushing on-site, for example, and processing only through ODS recovery plants such as fridge recycling facilities).

Based on guidance from the EPIC (Engineered Panels in Construction), approximately 40% of panels in use are not subject to hazardous waste restrictions. These include all pentane-blown PIR Insulated Panels produced in the UK after 2004, including all current production. These panels do not contain any ODS and are classed as non-hazardous. Pentane-blown panels are also not classified as hazardous under any other existing legislation.

The older PUR insulated panels used CFCs or HCFCs, which are Ozone Depleting Substances and are subject to regulatory requirements. CFCs blowing agents were used generally until 1994, after which they have rapidly phased out in favour of HCFC blown panels which reduced the ODP content by 90%. CFC panels account for about 20% of the existing panel building stock and HCFC panels for a further 40%. From 2000 the industry gradually changed to pentane or HFCs and o PIR panels. These are both non-ODP panels. HFC-blown panels are not classified as hazardous waste but are subject to F-Gas regulation restrictions.

The following end-of-life options are possible for the sandwich panels based on the EPIC recommendations (applicable to insulated panels that are classified as both hazardous and non-hazardous):

- **Maintaining** insulated panels in position unless damaged, even during refits – not feasible for the current project;
- **Reuse**: panels can be reused if not damaged (a careful deconstruction is required);
- **Recycling**: recycling options exist for panels classified as both non-hazardous and hazardous;
- **Other**: metal facings can be recycled and sold (after either non-hazardous or hazardous panels processing has taken place). The foam element of the panels can be used as a fuel source within cement kilns;
- **Recovery**: The foam element of the panels can also be incinerated (with energy recovery) at various locations across the UK. The typical method of disposal has been to cut the panels up with a reciprocating saw into maximum 2m x 1m sections and dispose of them in one of the four domestic refrigerator recycling plants in the UK;
- **Disposal**: as a last resort, panels and/or individual constituents (after either non-hazardous or hazardous panels processing has taken place) can be disposed of at landfill **(**after ODS processing, the metal facings and foam are no longer classified as hazardous waste).

The building was erected in the late nineties, but there is no information on the cladding type. The sandwich panels may generate hazardous waste (the building was erected after 2004).

Recommendations on the assessment, reclamation, waste management and reuse of engineered panels can be found in the publications given in Table 11.

Table 11 Guidance on existing engineered panels assessment, reclamation, waste management and reuse

Company	Website
EPIC	https://www.epic.uk.com/wp-content/uploads/2016/10/Insulated-Panels-Identification-and-end-of-life-options-2017.pdf
EPIC	https://www.epic.uk.com/wp-content/uploads/2016/10/epic_identification_and_disposal-original.pdf
ECCS	https://www.steelconstruct.com/wp-content/uploads/PROGRESS_Design_guide_final-version.pdf
RFCS/SCI	https://steel-sci.com/assets/downloads/steel-reuse-event-8th-october-2019/5_reuse_of_steel_cladding_systems.pdf
RFCS/SCI	https://www.steelconstruct.com/wp-content/uploads/Webinar-1-4-Reusing-existing-envelopes.pdf

The platform Panel Sell (https://www.panelsell.co.uk/) may be considered to enable the reuse of reclaimed sandwich panels (Figure 28).

Figure 28 Reclaimed sandwich panels advertised by https://www.panelsell.co.uk/

A possible way forward of reusing the reclaimed sandwich panels is shown in Figure 29. The reclaimed panels are used as an internal layer of a cladding system, which is over-clad with a new element to comply with the new building requirements.

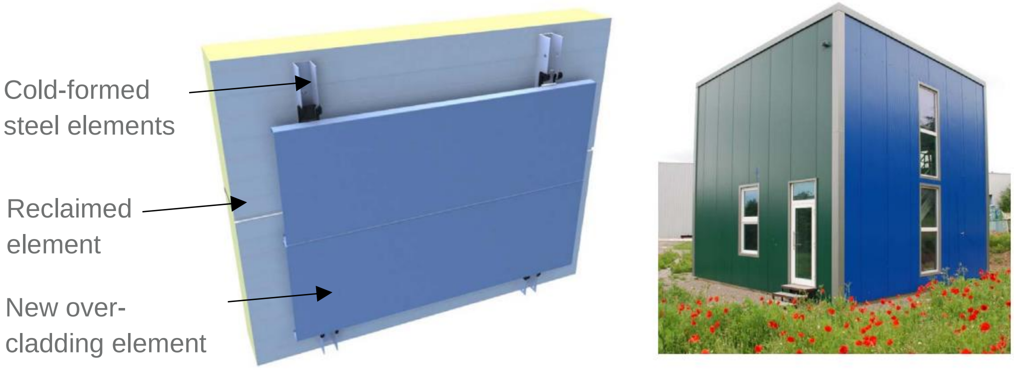


Figure 29 Over-cladding sandwich panel construction (RWTH Aachen)

3.4 Bricks

There is an estimated 44 tonnes of bricks (EWC: 17 01 01) arising from demolition (approximately 1.1% of the KDPs by Weight). The brick source is the brick walls around the main building (Figure 30).

Figure 30 Brick wall

Bricks should be segregated on-site and reclaimed for future applications whenever possible. Figure 31 shows a reclaimed brick stock from a UK merchant. The reusability of the bricks is related to the type of bonding agent used. If mortar has been used, it will be harder to reuse the bricks.

If bricks can't be reused, they can be segregated either on-site or at a waste facility and crushed to produce recycled aggregate (RA), which can be used as fill material. The Quality Protocol for inert materials should be followed.

Suppose any of the bricks are suitable for reclamation. In that case, local reclamation companies can be contacted about reclaiming the bricks and the value of such a process (this will be influenced by the amount of bricks that can be reclaimed for reuse). Possible platforms are presented in Table 12.

Figure 31 Stock of reclaimed bricks (https://www.lrbm.com/)

Table 12 Examples of platforms to enable the reuse of components - bricks

Company	Website
London Reclaimed Brick Merchants	www.lrbm.com
Salvo	https://www.salvoweb.com

Table 13 shows examples of waste management companies which may be able to manage brick waste. Alternatively, licensed waste management contractors should be able to reprocess concrete waste into aggregates.

Table 13 Examples of waste management companies - bricks

Company	Website
Brewsters Waste	https://brewsterswaste.co.uk
Ohara Bros	http://oharabros.co.uk
RTS Waste	www.rtswaste.co.uk
Days Group	http://www.daygroup.co.uk

3.5 Timber

There are an estimated 22 tonnes of timber-based components arising from demolition (<1% of the KDPs by Weight). The timber sources are detailed in Table 14.

Table 14 Weight (tonnes), volume (m^3) – KDP: timber, EWC: 17 02 01

Item	Volume (m^3)	Mass (tonnes)	%
OSB panels	21.96	9.66	43.39%
Timber studs	10.47	4.61	20.69%
Timber fence boards	7.41	3.26	14.64%
Timber fence posts and beams 100x100	7.22	3.18	14.27%
Timber plywood	3.55	1.56	7.01%
Other sources include doors, laminate worktops, timber doors frame, cupboards, desks, tables, etc.	-	-	-
Total	**50.61**	**22.27**	**100%**

Most of the solid timber can be recycled, usually into chipboard. The panel-based products will be suitable for energy recovery. Some timber may be hazardous due to the coatings and preservatives used (for example, in the external timber fences). It is recommended that local wood recycling organizations are contacted to see what timber items (if any) are suitable for reclamation and reuse.

Where reclamation is impossible, the timber should be segregated on-site or offsite and sent to a licensed waste management contractor for recycling. For the current building, the amount of timber which can be reclaimed and reused is expected to be small (these may include fit-out items).

Local waste management companies or platforms to pursue the reclamation and reuse of the timber components are given in Table 15. Guidance on wood waste assessment is also provided.

Table 15 Waste management guidance and companies - Timber

Company	Website
Waste Wood Assessment Guidance	https://condemwaste.org/wp-content/uploads/2021/07/CIWM-CD-Waste-Wood-Guide-v1.0.pdf
Community Wood Recycling	https://communitywoodrecycling.org.uk
Solo Wood Recycling	www.solowoodrecycling.co.uk
Salvo	https://www.salvoweb.com

The figures below illustrate the timber sources.

Figure 32 Timber-based panels covering the plant room

Figure 33 Timber-based panels and framing covering the stock room

Figure 34 Timber-based panels on mezzanine floors

Figure 35 Exterior wood fence

Figure 36 Timber cupboards

3.6 Plaster and plasterboards

Approximately 18 tonnes of plasters are expected to arise from demolition (<1% of the KDPs by Weight; EWC: 17 08 02). The plaster sources are mainly the sales mezzanine ceiling (Figure 37, 11 tonnes) and walls/partitions throughout the building (7 tonnes).

The sales mezzanine area ceiling boards may be reclaimed and repurposed. The platform Salvo (https://www.salvoweb.com) may be considered for trading the reclaimed panels.

If possible, plasterboards should be segregated on-site or alternatively at a waste transfer station. Several companies within the London area offer recycling services for plasterboards as long as the plasterboards are relatively free from contamination. Some recycling routes can include being used in the plasterboard manufacturing process (check with the waste/recycling company for their recycling routes). If it is sent to disposal, it should be landfilled separately from the other waste. Waste management companies/platforms for plaster products are given in Table 16.

Table 16 Local waste management companies – Plaster products

Company	Website
Powerday	https://www.powerday.co.uk
Plasterboard Recycling Solutions	http://www.plasterboardrecyclingsolutions.co.uk
Hinton's Waste	https://www.hintonswaste.co.uk/recycling-facilities/plasterboardrecycling
Hippo Waste (collected in bags)	https://www.hippowaste.co.uk/blog/plasterboardrecycling-removal
RTS Waste Management	https://www.rtswaste.co.uk/plasterboard-mobilecompaction-service

Figure 37 Sales mezzanine ceilings – opening found on site

3.7 Glass

The glass will arise from windows, shopfront doors, lobby partitions, controls room glazed partitions and balustrades in the sales mezzanines area. The total amount of glass is estimated to be about 4.7 tonnes (<1% of the KDPs by Weight), being about 4 tonnes attributed to the glazed balustrades (EWC: 17 02 02).

Whilst some schemes will take back flat glass for recycling unless the glass is reclaimed as part of components (say external glazing or doors), it is recommended to be crushed into aggregate with the other inert waste. If it is to be segregated on-site for reuse/recycling, health and safety considerations are required for the workforce as it needs to be handled carefully.

The glazed balustrades are in good condition and relatively easy to deconstruct and reclaim. The platform Salvo (https://www.salvoweb.com) may be considered to trade the reclaimed components.

Table 17 Local waste management and recycling companies – Glass

Company	Website
May Glass Recycling	https://mayglassrecycling.co.uk
Viridor	https://www.viridor.co.uk
RTS Waste	https://www.rtswaste.co.uk
Berryman Glass Recycling	https://www.urmgroup.co.uk

The figures below illustrate the glass sources.

Figure 38 Sales mezzanine – glazed balustrades

Figure 39 Kitchen window

Figure 40 Glazed wall in the controls room

Figure 41 Glazed doors and entrance lobby glazed partitions

3.8 Plastics

The amount of plastic arising from demolition is expected to be about 3.5 tonnes (<1% of the KDPs by Weight; EWC 17 02 03). The sources of the plastic are roofing and ceiling elements, as illustrated in the figures below.

Other sources of plastic may include uPVC windows/doors, pipework, guttering, cabling, etc. Plastic is likely to be sent for sorting at a waste transfer station and later for incineration.

If any uPVC windows or doors are reclaimed, the initiative included in Table 18 may be considered:

Table 18 Platform for trading existing ceramics

Company	Website
axiongroup	https://axiongroup.co.uk/services/specialist-collection-schemes/recovinyl

The polycarbonate roofing panels may be reclaimed and repurposed (approximately 2 tonnes, Figure 42). The roofing elements of the garden and service yard canopies appear in bad condition and are unsuitable for reuse (Figure 43 and Figure 44). The platform Salvo (https://www.salvoweb.com) may be considered to trade any reclaimed components suitable for reuse.

The figures below illustrate the plastic sources.

Figure 42 Main building roof – polycarbonate panels


Figure 43 Garden area canopy – polycarbonate sheets

Figure 44 Service yard roofing – GRP panels


Figure 45 Staff areas and entrance lobby ceilings – polystyrene ceiling tiles

3.9 Ceramics

An estimated 3.2 tonnes of ceramics (<1% of the KDPs by Weight; EWC: 17 01 03) is expected to arise from demolition. The ceramic sources include ceramic tiles, basins, toilet pans and urinals.

Ceramic materials such as tiles are unlikely to be reusable. It is recommended that these are crushed with the inert waste on-site and used to produce recycled aggregate.

Depending on their conditions, toilet pans, urinals, and basins (approximately 0.5 tonnes of ceramics) may be reclaimed and repurposed. The platform Salvo (https://www.salvoweb.com) may be considered to trade any reclaimed components suitable for reuse.

The figures below illustrate the ceramic sources.

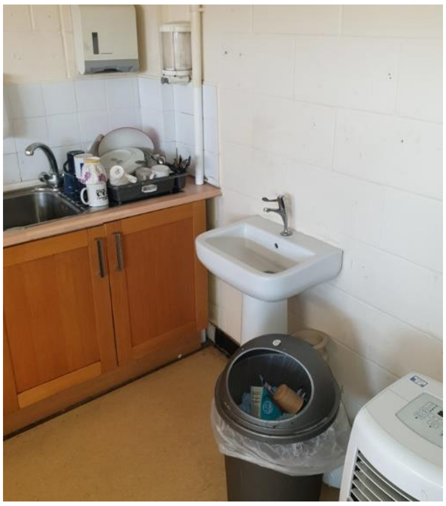



Figure 46 Ceramics – kitchen


Figure 47 Ceramics – Toilets

Figure 48 Ceramics – Toilets

3.10 Insulation

It is expected that approximately 3 tonnes of insulation will arise from the brick walls and phenolic insulation on the pipework of foams to complete local remediations throughout the building (<1% of the KDPs by Weight; EWC: 17 06 04).

Recovery of insulation material is unlikely to be possible if it is bonded to the substrate. If the insulation panels can be segregated on-site, they may be reclaimed for future use. Second-hand Rockwool panels have been found in the market (https://www.claddingwarehouse.co.uk/products/100mm-rockwool-second-use).

Typically, insulation is disposed of at a landfill via a licensed waste management contractor or could be sent for energy recovery if foam-based insulants can be successfully disaggregated. Care should be taken to ensure that insulation containing ozone-depleting substances is removed and handled carefully.

The options for recycling insulation arising from a construction site include:

- returning materials through take-back schemes offered by manufacturers;
- compressed stone wool ceiling tile manufacture;
- reclamation and reprocessing after removing impurities such as screws and nails;

However, the process still faces some barriers, such as:

- insulation arising from demolition can be contaminated (e.g., by mortar, wood, bitumen or asbestos);
- greenhouse gas emissions generated from breaking rigid urethane insulation;
- lack of specialised recycling facilities;
- lack of end markets;
- the low value of insulation material;
- due to the low density of the panels, large storage areas are needed;

Table 19 proposes some pioneering projects to recycle insulation materials.

Table 19 Pioneering projects to recycle insulation materials

Company	Website
Knauf	https://www.knaufinsulation.com/news/how-knauf-insulation-driving-recycling-for-a-better-world
Rockwool	https://www.rockwool.co.uk/about/sustainability/recycling
Kingspan	https://www.kingspan.com/gb/en-gb/products/insulation-boards/resources/sustainability-and-responsibility/waste-take-back-scheme

Local waste management companies shall be consulted. Two examples are given in Table 20.

Table 20 Examples of waste management companies - Insulation

Company	Website
londonwastemanagement	https://www.londonwastemanagement.com/product/insulation
businesswaste	https://www.businesswaste.co.uk/plastic-recycling/foam-waste-disposal

The figure below illustrates the insulation behind the block wall.

Figure 49 Insulation behind the concrete block wall

3.11 Bitumen

Bitumen or asphalt account for an estimated 2.6 tonnes of KDP (<1% of the KDPs by weight; EWC: 17 03 01). The bitumen arises from the car park and accesses near the building (Figure 50). This does not account for the road accesses nor the broader car park. The bitumen should be suitable for reprocessing into new surfacing material. Samples can be taken to determine any coal tar content, which might result in it being deemed hazardous waste.

Guidance on Managing Reclaimed Asphalt can be found in the following ADEPT publication:

https://adeptnet.org.uk/system/files/documents/ADEPT%20Guide%20to%20Managing%20Reclaimed%20Asphalt%20Version%202019%20Rev%201.pdf

Bitumen should be processed aligned with the Quality Protocol for inert waste. Potential recycling routes include sub-base, capping or used in hot-mix asphalt (dependent upon the amount of coal tar) and other bituminous mixes. The waste management companies suggested for concrete and bricks (Table 5 and Table 13, respectively) should be able to manage the bitumen waste.

Figure 50 Bitumen close to the building

3.12 WEEE

A number of Waste Electrical and Electronic Waste Equipment (WEEE; EWC 16 02 14) will arise from demolition, mainly lights and other equipment from the plant rooms, pump house, control room and kitchen.

Any fluorescent lighting should be segregated on-site, collected and disposed of by a licensed hazardous waste contractor. Any waste electrical and electronic equipment should be separated on-site and sent to a specialist recycling facility. Alternatively, schemes like those presented in Table 21 may be considered.

Table 21 Local waste management and recycling companies – WEEE

Company	Website
Pure Planet Recycling	https://www.pureplanetrecycling.co.uk/WEEEe-recycling-london
Junkwize	https://junkwize.com/commercial/WEEEe-recycling-disposal-london/
Recolight	https://www.recolight.co.uk

If items are in good condition, they could be donated or advertised on suitable platforms (Table 22).

Table 22 Platform for trading existing WEEE

Company	Website
London Reuse	https://www.reusefuluk.org/
Salvo	https://www.salvoweb.com

The figures below illustrate the WEEE sources and estimate the number of units arising from demolition.

Figure 51 Main building WEEE lights (approximately 220 units)

Figure 52 Mezzanine – sales area WEEE lights (approximately 175 units)

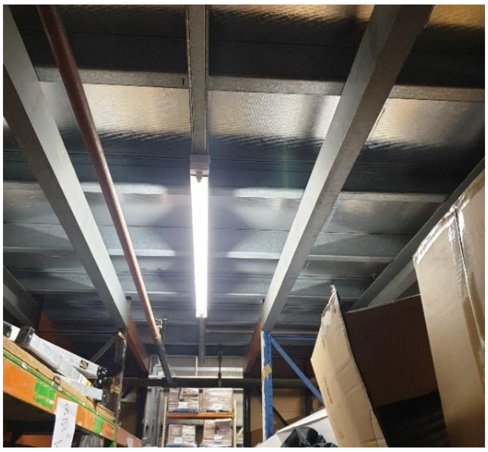
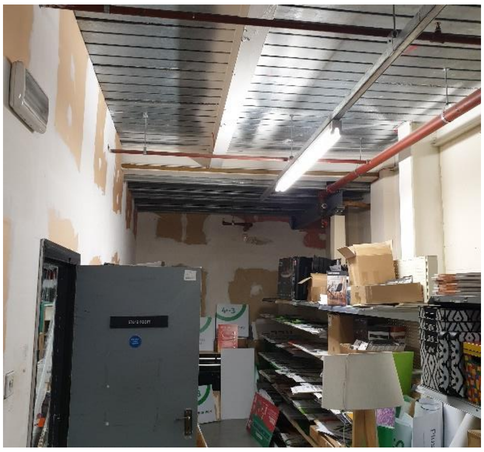



Figure 53 WEEE lights – Warehouse and storage rooms (30 units)

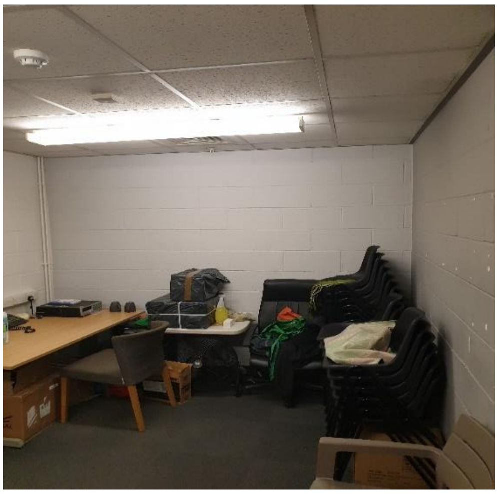



Figure 54 WEEE lights – Staff rooms – typical WEEE (approximately 30 units)

Figure 55 Potential WEEE from the operations room

Note: plant room and pump house were not inspected.

4 Embodied carbon assessment of the KDPs

The embodied carbon calculation was completed following the guidelines proposed by the Institution of Structural Engineers[1]. The following assumptions were considered for the embodied carbon assessment:

- GIA: 5762 m^2 (including mezzanines and external canopies)
- Approximate construction value: 3M

The construction value and GIA are considered to assess the carbon burdens for modules A5 and C1 of the whole project, respectively. The carbon burdens of such modules were distributed proportionally to the weight of each product listed in Table 24.

The assessment considered the following EPDs for the hot-rolled steelwork and cladding:

- British Steel EPD: https://britishsteel.co.uk/media/342251/british-steel-rails-sections-epd.pdf
- European Association for Panels and Profiles (PPA-Europe): https://www.ppa-europe.eu/db/docs/181203_EPD_panels_PU_final.pdf

The British Steel EPD represents a typical UK-sourced Blast Furnace steel, likely to be the provenance of the existing hot rolled steelwork.

The PPA EPD provides data on a generic 100mm sandwich panel with a PUR core. The EPD data was converted to account for the sandwich panel weight assumed in the assessment.

The embodied carbon factors considered in the assessment are detailed in Table 23.

Table 24 presents the results of an embodied carbon assessment for the key demolition products. Although the assessment does not account for all materials listed in Table 2, approximately 99% of the KDPs by weight are covered. The carbon breakdown is illustrated graphically in Figure 56.

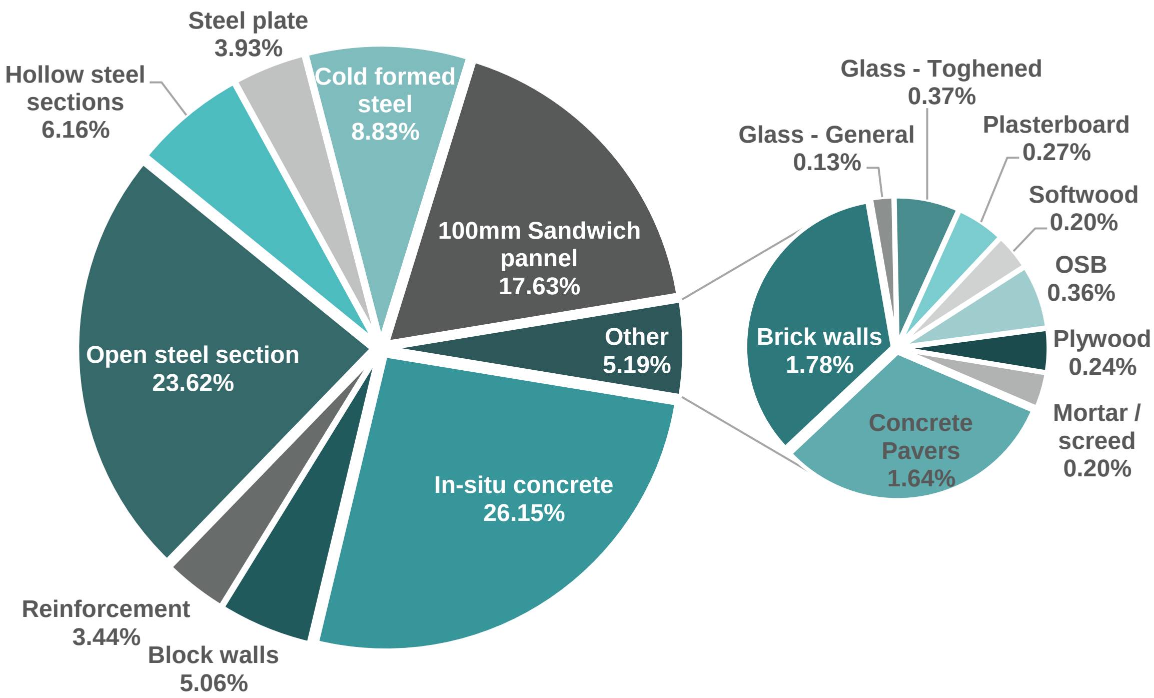


Figure 56 Embodied carbon breakdown of the KDPs.

[1] "How to Calculate Embodied Carbon", Second Edition, IStructE, 2022

Table 23 Embodied carbon factors considered in the assessment

Material Type	Material Specification	Embodied carbon – [tCO_{2e}/t]								
		Production	Construction			Use	End-of-life		Recycling & Reuse	Biogenic Carbon
		A1-A3	A4	A5w	A5a	B1-5	C1	C2-C4	D	
In-situ concrete	UK C32/40 (25% GGBS)	120	5	8	15	NA	14	18	0	0
Mortar / screed	1:4 cement: sand mix avg UK cement mix	149	5	9	0		0	18	0	0
Concrete Pavers	UK C16/20 (0% SCM)	113	5	7	1		1	18	0	0
Block walls	PCC Lightweight (AAC) blocks	280	11	77	0		2	18	0	0
Reinforcement	UK 97% recycled EAF production	760	32	43	1		0	18	351	0
Open steel section	UK open rolled sections (British steel EPD)	2450	32	18	0		1	9	-1600	0
Hollow steel sections	Global closed sections	2500	183	27	0		0	18	-1530	0
Steel plate	Plate	2460	32	25	0		0	18	-1160	0
Cold-formed steel	Global hot dip galvanised	2760	183	30	0		0	18	-1320	0
Brick walls	UK: BDA generic brick	213	11	61	2		0	18	-16	0
Glass	General	1440	32	79	0		0	18	0	0
Glass	Toughened	1670	32	91	0		0	18	0	0
Plasterboard	Partitioning / ceilings (min 60% recycled content)	390	32	128	0		0	18	0	0
Softwood	Softwood, 100% FSC/PEFC	263	161	50	0		0	1667	-524	-1640
OSB	OSB 100% FSC/PEFC	455	161	71	0		0	1667	0	-1640
Plywood	Plywood 100% FSC/PEFC	681	161	96	0		0	1667	-524	-1640
100mm Sandwich panel	EPD - www.ppa-europe.eu	2510	10	0	1		1	720	-1310	0
Whole project burdens: A5a: 21 tCO_{2e}, C1: 19.59 tCO_{2e}										

The embodied carbon values associated with the substructure and superstructure are given in Table 25 and Table 26. Figure 57 provides some relevant carbon breakdowns involving the substructure, superstructure and other KDPs.

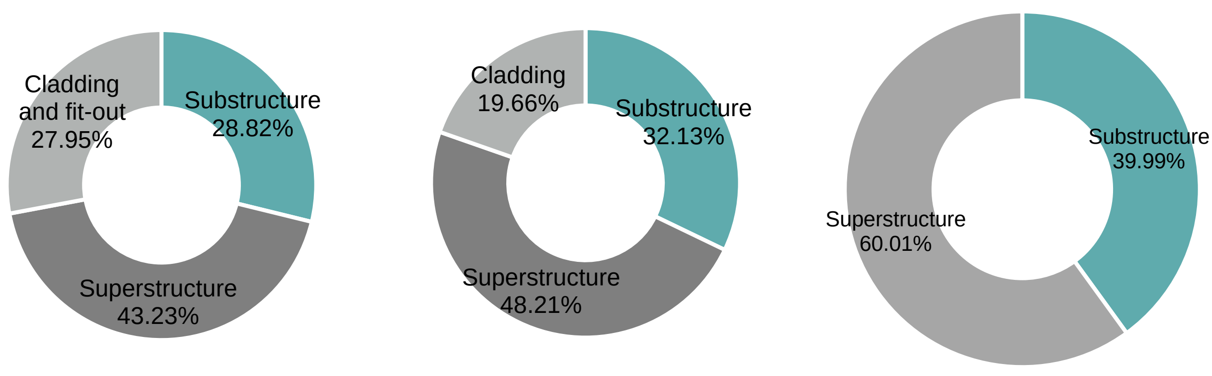


Figure 57 Embodied carbon breakdown between substructure, superstructure and other KDPs

Table 24 Embodied carbon assessment of the KDPs

Material Type	Material Specification	Material Quantity [kg]	Embodied carbon – [tCO_{2e}]								Embodied Carbon [tCO_{2e}]	% - Embodied carbon breakdown
			Production	Construction		Use	End-of-life		Recycling & Reuse	Biogenic Carbon		
			A1-A3	A4	A5	B1-B5	C1	C2-C4	D			
In-situ concrete	UK C32/40 (25% GGBS)	2780443	333.65	13.90	62.83	NA	38.95	50.14	0.00	0.00	499.47	26.15%
Mortar / screed	1:4 cement: sand mix avg. UK cement mix	20991	3.13	0.10	0.19		0.00	0.38	0.00	0.00	3.81	0.20%
Concrete Pavers	UK C16/20 (0% SCM)	214830	24.28	1.07	1.80		0.23	3.87	0.00	0.00	31.25	1.64%
Block walls	PCC Lightweight (AAC) blocks	300071	84.02	3.30	3.43		0.45	5.40	0.00	0.00	96.61	5.06%
Reinforcement	UK 97% recycled EAF production	77069	58.57	2.47	3.31		0.03	1.39	27.05	0.00	65.77	3.44%
Open steel section	UK open rolled sections (British steel EPD)	180554	442.36	5.78	1.21		0.16	1.65	-288.89	0.00	451.16	23.62%
Hollow steel sections	Global closed sections	43306	108.27	7.93	0.74		0.01	0.78	-66.26	0.00	117.72	6.16%
Steel plate	Plate	29247	71.95	0.94	1.67		0.00	0.53	-33.93	0.00	75.08	3.93%
Cold-formed steel	Global hot dip galvanised	56038	154.66	10.25	2.69		0.02	1.01	-73.97	0.00	168.63	8.83%
Brick walls	UK: BDA generic brick	44165	9.41	0.49	23.25		0.01	0.79	-0.71	0.00	33.95	1.78%
Glass	General	673	0.97	0.02	1.40		0.00	0.01	0.00	0.00	2.40	0.13%
Glass	Toughened	4043	6.75	0.13	0.05		0.00	0.07	0.00	0.00	7.01	0.37%
Plasterboard	Partitioning / ceilings (min 60% recycled content)	10960	4.27	0.35	0.37		0.00	0.20	0.00	0.00	5.19	0.27%
Softwood	Softwood, 100% FSC/PEFC	7784	2.05	1.25	0.39		0.00	12.98	-4.08	-12.77	3.90	0.20%
OSB	OSB 100% FSC/PEFC	9662	4.40	1.56	0.69		0.00	16.11	0.00	-15.85	6.90	0.36%
Plywood	Plywood 100% FSC/PEFC	4821	3.28	0.78	0.47		0.00	8.04	-2.53	-7.91	4.66	0.24%
100mm Sandwich panel	EPD - www.ppa-europe.eu	103916	260.83	1.04	0.06		0.05	74.82	-136.13	0.00	336.80	17.63%
Totals:		**3888572**	1572.84	51.35	104.54	0.00	39.93	178.16	-579.43	-36.52	1910.31	100%
% - Modules:			82.33%	2.69%	5.47%	0%	2.09%	9.33%	-	-1.91%	100%	-

Table 25 Embodied carbon assessment of the substructure KDPs

Material Type	Material Specification	Material Quantity [kg]	Embodied carbon – [tCO_{2e}]								Embodied Carbon [tCO_{2e}]	% - Embodied carbon breakdown
			Production	Construction		Use	End-of-life		Recycling & Reuse	Biogenic Carbon		
			A1-A3	A4	A5	B1-B5	C1	C2-C4	D			
In-situ concrete	UK C32/40 (25% GGBS)	2712403	325.49	13.56	60.29	NA	37.07	48.91	0.00	0.00	485.32	88.16%
Reinforcement	UK 97% recycled EAF production	76313	58.00	2.44	3.31		0.03	1.38	26.79	0.00	65.15	11.84%
Totals:		**2788716**	383.49	16.00	63.60	0.00	37.09	50.29	26.79	0.00	550.47	100%
% - Modules:			76.28%	3.18%	7.74%	0%	2.79%	10.00%	-	0%	100%	-

Table 26 Embodied carbon assessment of the superstructure KDPs

Material Type	Material Specification	Material Quantity [kg]	Embodied carbon – [tCO_{2e}]								Embodied Carbon [tCO_{2e}]	% - Embodied carbon breakdown
			Production	Construction		Use	End-of-life		Recycling & Reuse	Biogenic Carbon		
			A1-A3	A4	A5	B1-B5	C1	C2-C4	D			
Reinforcement	UK 97% recycled EAF production	756	0.57	0.02	0.03		0.00	0.01	0.27	0.00	0.65	0.08%
Open steel section	UK open rolled sections (British steel EPD)	180554	442.36	5.78	3.41		0.91	1.65	-288.89	0.00	454.10	54.98%
Hollow steel sections	Global closed sections	43306	108.27	7.93	1.18		0.22	0.78	-66.26	0.00	118.37	14.33%
Steel plate	Plate	29247	71.95	0.94	0.74		0.15	0.53	-33.93	0.00	74.30	9.00%
Cold-formed steel	Global hot dip galvanised	56038	154.66	10.25	1.68		0.28	1.01	-73.97	0.00	167.89	20.33%
In-situ concrete	UK C32/40 (25% GGBS)	68040	8.16	0.34	0.54		0.34	1.23	0.00	0.00	10.62	1.29%
	Totals:	**377941**	785.97	25.26	7.58	0	1.90	5.21	-462.78	0.00	825.92	100%
		% - Modules:	95.16%	3.06%	0.92%	0%	0.23%	0.63%	-56.03%	0.00%	100.00%	-

5 Guidance to maximize reuse and proposed reuse targets

Careful planning is required to maximize the reuse of products reclaimed from the existing building. Typically, the opportunities to reuse reclaimed elements are increased if the elements are reused on the same site or by the same owner. Alternatively, the reclaimed components may be sold or given away locally to minimize transportation costs. For components with increased value (such as a steel frame or structure), the opportunities may arise from specialist stockists/dealers across the country.

Table 27 lists items that may be suitable for reuse and proposed reclamation targets. Setting aside storage on site for segregation of salvage items may increase their reuse opportunities. The recommendations given in section 3 shall be considered.

Table 27 Propose reuse targets

Items	Volume (m^3)	Mass (tonnes)	Reuse	Reused Volume (m^3)	Reused weight (tonnes)
Primary steelwork – main building	23.24	182.45	100%	23.24	182.45
Primary steelwork – garden area canopy	1.09	8.58	100%	1.09	8.58
Primary steelwork – service yard canopy	0.82	6.47	100%	0.82	6.47
Primary steelwork – beams with welded studs (mezzanine)	0.84	6.62	50%	0.42	3.31
Primary steelwork – I/H and SHS	4.30	33.75	100%	4.30	33.75
Plate (welded to primary elements)	1.12	8.76	100%	1.12	8.76
Secondary steelwork (cold-formed elements)	6.78	53.20	50%	3.39	26.60
Plate (cold-formed elements cleats)	0.65	5.08	50%	0.32	2.54
Cladding (sandwich panels)	692.77	103.92	50%	346.39	51.96
Glazed balustrades and railing	1.62	4.04	70%	1.13	2.83
Bricks	23.24	44.16	50%	11.62	22.08
Paving concrete elements	97.65	214.83	50%	48.83	107.42
Timber framing	17.69	7.78	30%	5.31	2.34
Plaster ceiling boards (sales mezzanine)	13.70	10.96	75%	10.28	8.22
Sprinkler's water tank	-	-	Yes	-	-
Streetlights posts	-	-	Yes	-	-
WEEE – lights	-	-	50%	-	-
Roller shutters	-	-	Yes	-	-
Doors and fire doors	-	-	50%	-	-
Timber cupboards, desks and tables	-	-	25%	-	-
Total	**885.51**	**690.60**	**-**	**458.25**	**467.29**

Table 23 shows an opportunity to reclaim and reuse approximately 458 tonnes of materials (about 12% of the KDPs by weight). These figures do not include reusing inert waste as fill on site.

The information in Table 27 is represented graphically in Figure 58 and Figure 59.

Table 28 lists examples of organizations and platforms which may be considered to maximize the reuse potential of the KDPs.

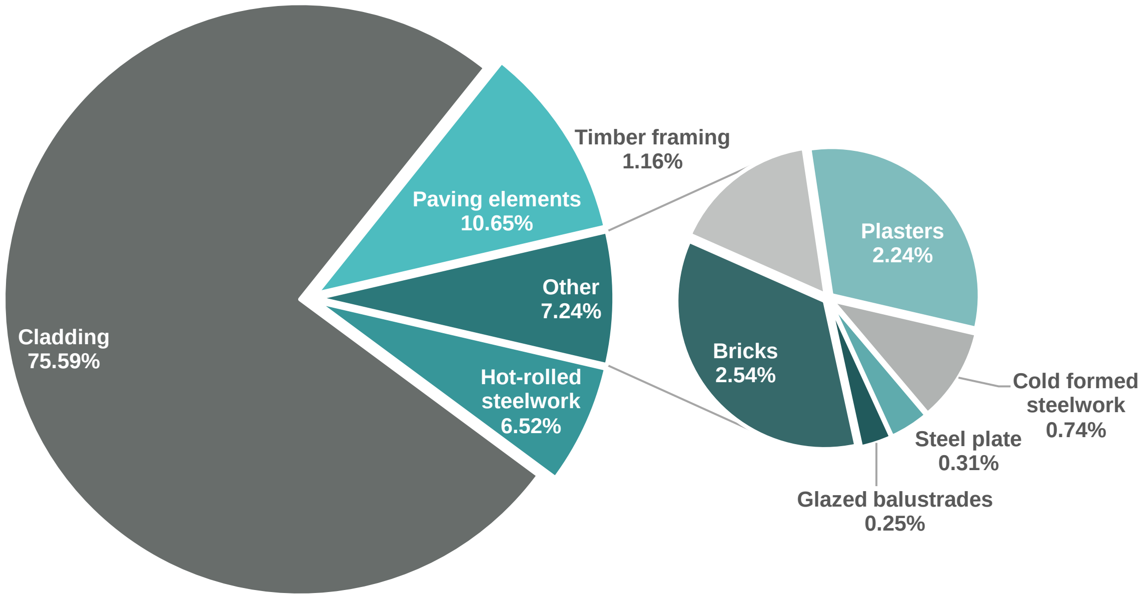


Figure 58 Proposed reusable KDP breakdown by volume (m^3)

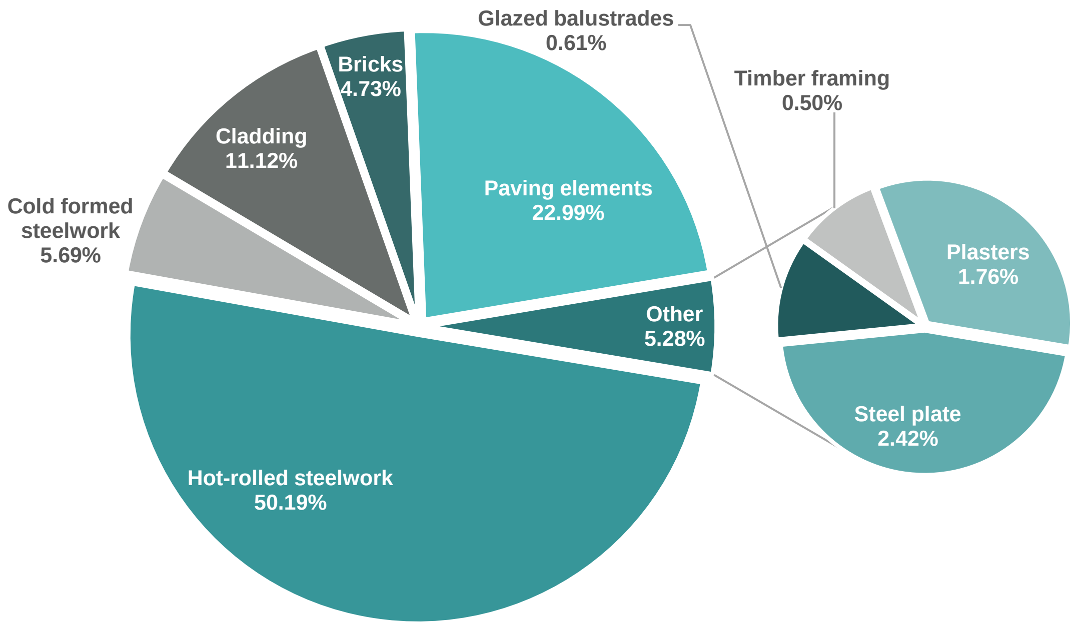


Figure 59 Proposed reusable KDP breakdown by weight (tonnes)

Table 28 Examples of organizations and platforms to maximize the reuse potential of the KDPs

Company name	Website	Brief description
Salvo	https://www.salvoweb.com/	Salvo is the marketplace for architectural antiques, gardens, decorative, salvage and reclaimed building materials.
Reuse Network	https://reuse-network.org.uk	Supports reuse charities across the UK to help them alleviate poverty, reduce waste and tackle climate change
Cleveland Steel & Tubes Ltd.	https://cleveland-steel.com/	Steelwork stockist with interest in promoting the structural steel reuse practice.
Ainscough Metals	https://www.ainscoughmetals.co.uk/	New and used steel suppliers and fabricators.
Supply Chain Sustainability School	https://www.supplychainschool.co.uk	An interactive map showing the different platforms available for a material exchange geographically.
Reyooz	https://www.reyooz.com	Offer a service to collect surplus and distribute to charities, schools and small businesses.
Globechain	https://globechain.com	A reuse marketplace that donates to charities, schools and small businesses
Collecteco	https://www.collecteco.co.uk	Donation of furniture and equipment to charities, schools and small businesses.
Scrapstores	https://www.workandplayscrapstore.org.uk/	Scrapstore repurposes waste and surplus goods as arts and crafts materials
Reuseful UK	https://www.reusefuluk.org/	ReusefulUK is a national network of scrap stores, resources and creative reuse centres
panel sell	https://www.panelsell.co.uk/	Reseller of reclaimed sandwich panels
London Reclaimed Brick Merchants	www.lrbm.com	Reseller of reclaimed bricks
Cladding Warehouse	https://www.claddingwarehouse.co.uk	The platform may be considered to trade cladding or insulation components. Second-hand components are advertised.

6 Guidance to maximize recycling and proposed recycling targets

It is recommended that to maximise the recycling opportunities of the KDPs that the following materials are segregated on site:

- Concrete
- Metals
- Sandwich panels - cladding
- Bricks
- Plasterboards
- Timber
- Plastics
- Insulation
- Bitumen
- Glass
- Ceramics
- Hazardous waste

The project may follow the recycling rates proposed in Table 29. These should be discussed with relevant actors before the demolition/deconstruction works begin. **The estimated percentage of waste materials that can be recycled and diverted from landfill is 96% by volume and 98% by weight**. However, it should be possible to reach a figure close to 100% diversion by weight from landfill if the inert waste (concrete, brick, blockwork – almost 85% of the waste likely to be sent to landfill) is all recycled.

Table 29 Proposed recycling rates

KDPs	Volume (m^3)		Mass (tonnes)		EWC	Recycling Rate %	Landfill Volume (m^3)	Landfill Weight (tonnes)
Concrete	1515.77	62.02%	3316.33	83.90%	17 01 01	98	30.32	66.33
Metals	54.94	2.25%	431.30	10.91%	17 04 05	100	0.00	0.00
Cladding	692.77	28.35%	103.92	2.63%	17 06 03 (hazardous) 17 06 04 (non-hazardous)	100	0.00	0.00
Bricks	23.24	0.95%	44.16	1.12%	17 01 01	98	0.46	0.88
Timber	50.6	2.07%	22.3	0.56%	17 02 01	90	5.06	2.23
Plasters	22.34	0.91%	17.87	0.45%	17 08 02	75	5.58	4.47
Glass	1.89	0.08%	4.72	0.12%	17 02 02	100	0.00	0.00
Plastics	18.86	0.77%	3.53	0.09%	17 02 03	50	9.43	1.76
Ceramics	1.40	0.06%	3.20	0.08%	17 01 03	98	0.03	0.06
Insulation	59.74	2.44%	2.99	0.08%	17 06 04	25	44.80	2.24
Bitumen	2.45	0.10%	2.55	0.06%	17 03 01	50	1.23	1.27
Total	**2444.01**	**100%**	**3952.83**	**100%**	-	-	**96.91** (4% of the total KDPs)	**79.25** (2% of the total KDPs)

During the demolition, details of the materials arisings and the waste management methods used should be recorded to compare actual with forecast and assess performance against the proposed targets. Following completion of the project, any barriers to achieving the targets should be reviewed to ensure that these barriers can be overcome in future projects.

The information in Table 29 is represented graphically in Figure 60 and Figure 61.

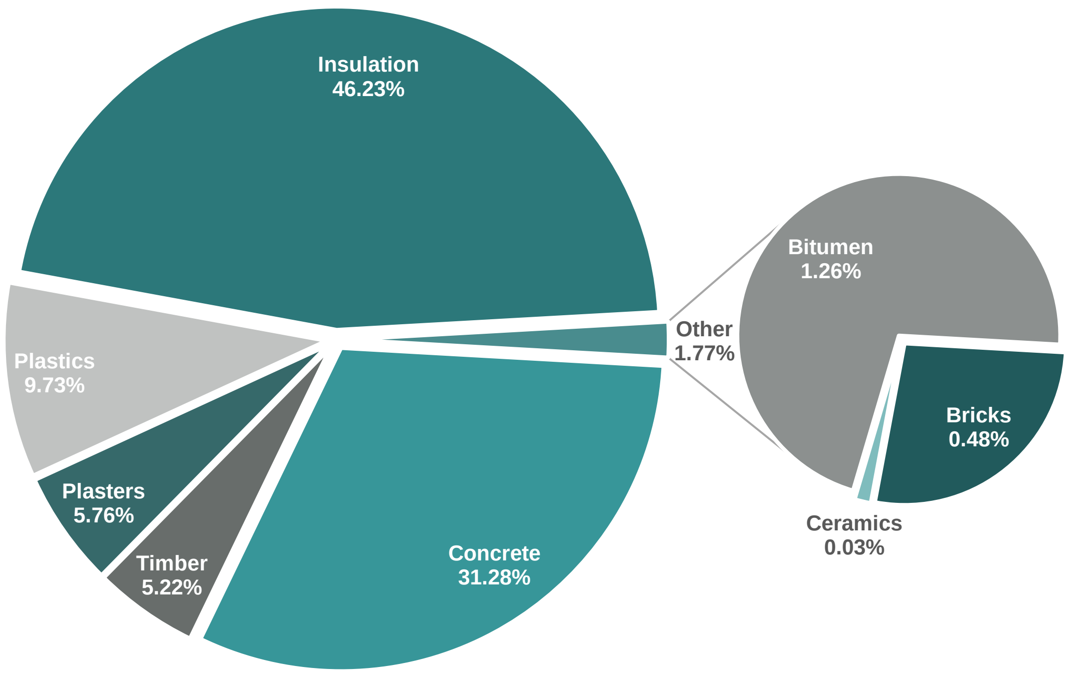


Figure 60 Estimated landfill waste breakdown by volume (m^3)

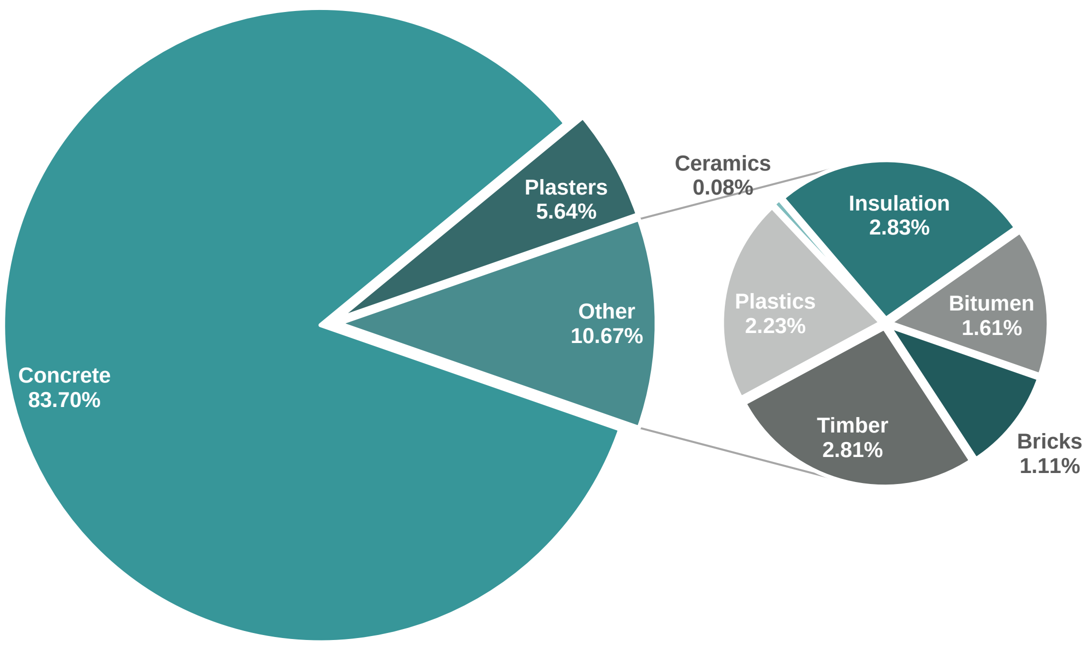
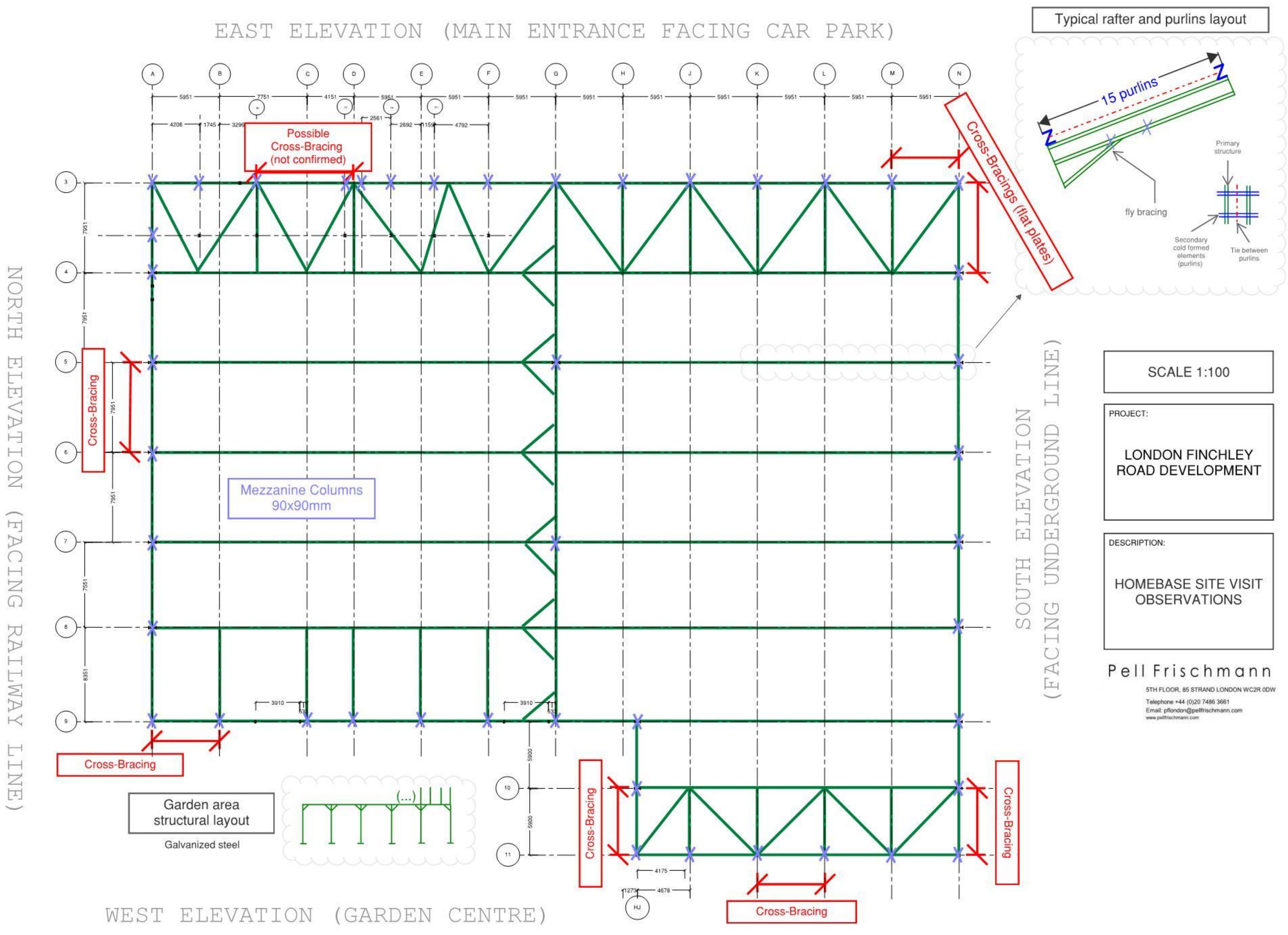
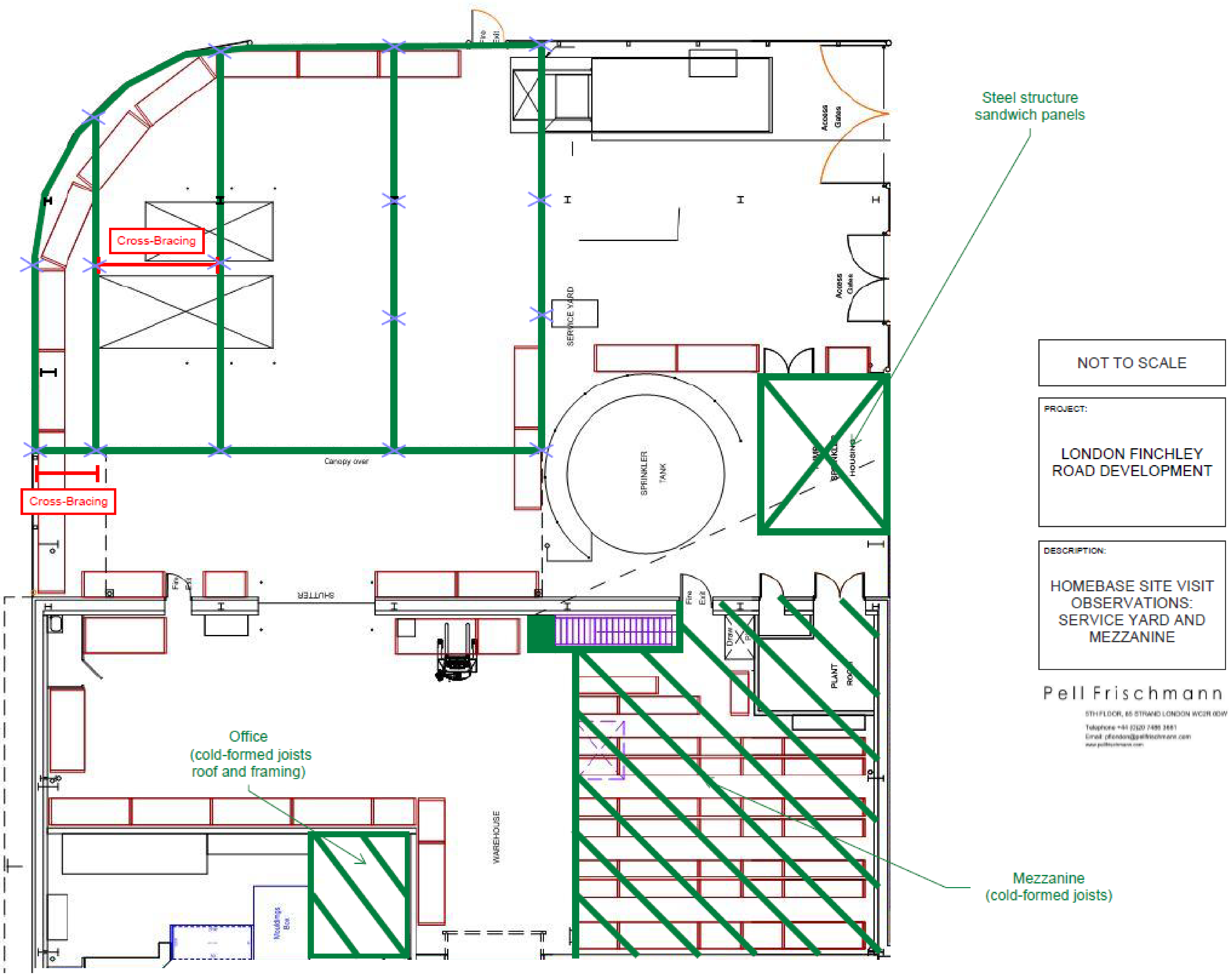


Figure 61 Estimated landfill waste breakdown by weight (tonnes)

Appendix A Site visit sketches




Steel structure
sandwich panels
Cross-Bracing
Cross-Bracing
Canopy over
SERVICE YARD
SPRINKLER
TANK
Access
Gates
Access
Gates
Fire
Exit
PLANT
ROOM
WAREHOUSE
Office
(cold-formed joists
roof and framing)
Mezzanine
(cold-formed joists)
NOT TO SCALE
PROJECT:
LONDON FINCHLEY
ROAD DEVELOPMENT
DESCRIPTION:
HOMEBASE SITE VISIT
OBSERVATIONS:
SERVICE YARD AND
MEZZANINE
Pell Frischmann