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Structural Statement

of

Tobacco Warehouse
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Client name: Abercorn Construction

Our ref: SCK/LW/LM27586

Date: July 2015

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STRUCTURAL STATEMENT

DOCUMENT VERIFICATION

Report Reference: LM27646 Issue: 0 Date: 29th May 2015

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Revision History:

Rev	Date	Description	Prepared	Checked	Approved
Rev 0	**29.05.15**	**Issued for comment**	**LW**	**SCK**	**SCK**
Rev A	**17.06.15**	**Revised after comments**	**LW**	**JAS**	**SCK**
Rev B	**03.07.15**	**Revised after comments**	**LW**	**SCK**	**SCK**

Contents

1.0 Clients Brief

1.1 We have been instructed by Abercorn Construction, to prepare a structural statement on the proposed alterations to the existing structure of The Tobacco Warehouse, Stanley Dock, Liverpool.

1.2 The primary purpose of this report is to allow the Local Authority to understand how the building structurally performs as part of the planning permission.

1.3 This report is to be included within other supporting documents to submit to the local planning authority, in support of the planning application for the refurbishment of the building into apartments.

1.4 We have been provided with copies of the existing planning documents and this report is intended to be read in conjunction with this information.

1.5 A visual assessment has been carried out on the Tobacco Warehouse to inspect the internal and the external fabric of the building.

1.6 Our inspection was undertaken on the 30th April 2015.

1.7 The contents of this report is to comment concerning those terms outlined in this brief.

1.8 The views expressed in this report are based upon a visual appraisal of the structure, carried out on the 30th April 2015, the proposals provided by the architect, Darmondy Architecture and previous structural drawings of the building.

1.9 The statement is intended to comment on the structural feasibility of the alterations proposed for the refurbishment of the building. The key alterations to affect the existing structure are:

- Creating new stair and lift cores to gain suitable access throughout the building to meet current building regulations.
- Creation of three light wells to provide light to the interior parts of the building, without which the space would be un-usable.

- Formation of openings through the existing floors to create dual aspect split level duplex apartments.
- Removal of a large section of the existing roof, to replace with a new lightweight roof and construction of an additional floor to create penthouse apartments at new level 13.
- Removal of existing lift shafts and infilling of the associated voids.
- Providing underground parking in the existing basement.
- Ensuring each change of use from tobacco storage is acceptable in terms of the allowable live loads throughout the building.

1.10 Further surveys and investigative work will be required as part of the refurbishment process. This will be dealt with upon the course of the redevelopment and through the Building Regulations process.

2.0 Executive Summary

2.1 Tobacco Warehouse was conceived, designed and built as a dedicated tobacco warehouse at the nineteenth-century Stanley Dock complex. Construction of the warehouse was underway in January 1898 and the building was completed by March 1901, it is listed Grade II.

2.2 The ground conditions at the site have been found to comprise made ground over glacial till on sandstone bedrock. Tobacco Warehouse itself lies within ground reclaimed inside the original dock. Archive drawings show that it is built off piled foundations founded on the underlying sandstone.

2.3 The warehouse comprises basement, ground and twelve upper floors with brick-masonry load bearing external and internal cross walls.

2.4 The roof structures comprise steel ‘angle-iron’ roof trusses spanning between the load-bearing walls and intermediate rows of columns. The roof envelope is either of traditional hipped or ‘north light’ geometry.

2.5 The floors comprise steel filler-joist structures with concrete infill panels spanning between primary steel beams. These beams are supported on cast-iron columns or the loadbearing brick walls. The details and arrangements of these floors appears to be identical throughout the building, however the steel beams and filler joists are larger in section at ground floor level than elsewhere.

2.6 The cast-iron columns from basement to roof level are of circular hollow section, with their diameter reducing at each floor level up the building. The column shafts are cased in some form of fire-proof cladding. Each column slots into the head of the columns below. The incoming primary floor beams sit on brackets cast into the base of each column and are bolted in place.

2.7 Rainwater from the roofs is carried down to ground level in externally mounted downpipes.

2.8 There does not appear to have been any significant alterations to the structure.

2.9 The warehouse is a well-proportioned and generally robust building. However, the specific use for which it was designed has resulted in a building that does not have the same degree of flexibility either geometrically or in terms of its load-carrying capacity that other, more general-purpose buildings have.

2.10 The building has suffered from a lack of maintenance for many years. This has led to significant local problems, particularly with water ingress through failed roof finishes, blocked gutters and rainwater goods causing damage to the structure. This has lead to the building being in poor condition locally and in need of a major overhaul.

2.11 The approach to any structural repairs will be to mitigate known problems and any defects that are encountered during the course of the works. In dealing with these repairs and the proposed alterations, solutions will be adopted that are compatible with the nature and form of the existing structure. A programme of regular inspection and maintenance will be required to safeguard the future of the structure.

2.12 The roof finishes are generally in poor condition, and rainwater ingress into the building is widespread. The gutters appear to be blocked and vegetation is growing in abundance. This has lead to the corrosion of the roof structure where it is exposed to water, particularly the steel beams below valley gutters and potentially where they bear onto the external walls. This water ingress reaches all the way down to the basement.

2.13 Extensive cracking was recorded within the concrete floors throughout the building. It is not clear what has caused this cracking but it does not, at this stage, appear to be as a result of the water ingress through the building and floors. The actual extent and causes of the cracking, and the resulting structural implications, will be investigated as the design progresses.

2.14 In general, the steelwork embedded in the floors appears to be in a reasonable condition with only surface corrosion seen on exposed steelwork. There are instances, however, where laminated corrosion seems to be beginning, and it is possible that some floor beams and/or joists will need to be replaced as part of the works.

2.15 The condition of the cast-iron columns seems to be reasonable with only surface corrosion seen. As with all cast iron members a detailed crack survey is necessary at the next stage.

2.16 The extent and severity of corrosion to all the steel and cast-iron structural elements to that part of the warehouse that is to be retained will need to be established at the next stage of the design by physical investigation and perhaps material testing. Allowance should be made at this stage for repairs to the local structure.

2.17 Vegetation around the rainwater downpipes at the top floor suggests that the pipes are leaking and, in all probability, corroding. Similar vegetation growth and staining of the wall heads is visible below the gutters to the hipped roofs, suggesting the water is getting into brickwork. The condition of beam and joist ends where they bear into the external walls needs to be checked, particularly around leaking downpipes. It is possible that the brickwork in some areas will need to be broken out to allow treatment to affected joist/beam ends.

2.18 The existing framing to the ground floor north elevation seems to be in a reasonable condition however there are signs that laminated corrosion has set in externally where the existing paintwork has been lost. This will require further investigation but it is likely that remedial works can be limited to wire brushing affected areas and treating with a corrosion inhibitor.

2.19 The principle structural alterations affecting the warehouse are as follows:

- Creating new stair and lift cores to gain suitable access throughout the building to meet current building regulations.
- Creation of three light wells to provide light to the interior parts of the building, without which the space would be un-usable.
- Formation of openings through the existing floors to create dual aspect split level duplex apartments.
- Removal of a large section of the existing roof, to replace with a new lightweight roof and construction of an additional floor to create penthouse apartments at new level 13.
- Removal of existing lift shafts and infilling of their associated voids.
- Providing underground parking in the existing basement.

- Ensuring each change of use from tobacco storage is acceptable in terms of the allowable live loads throughout the building.

2.20 The retained part of the warehouse has been proportioned to be self-stable. This means that there are no significant or complicated construction sequences to follow that are dictated by structural considerations.

2.21 An initial assessment of the existing floor structures suggest that an imposed load capacity of around $3kN/m^2$ may be justified to current standards although it is likely that the structure has sustained higher loads in the past (and this is backed up by original design drawings for the building).

2.22 Naturally, further detailed investigations and appraisals are required to confirm the actual capacity of the key structural elements of the existing floor structures. At this stage, however, and based on all the information available to date, it is reasonable to assume that there is more than adequate capacity in the existing floors to carry the loads to which they will be subjected. For residential use.

2.23 The addition of the new penthouse storey on the north, east and west sides of the building means that some of the existing cast-iron columns across the upper floor levels below this extension will need to be replaced or strengthened. At this stage, it is envisaged that this strengthening will take the form of thin concrete casing to the columns. This casing will also serve to improve the robustness of the columns and their resistance to disproportionate collapse and act as the fire protection to the columns.

2.24 The new openings required by the formation of the duplex apartments are arranged to fit within the existing grillage of steelwork to the floors. Their size and extent has been limited in such a way as to maintain the ability of each floor to span between the retained cross walls. This will allow each floor to contribute to the overall stability of the retained structure. The only trimming that is required is to re-case the existing steelwork in new reinforced concrete.

2.25 The other local alterations to the existing structure (removal lift risers and installation of new stair and lift cores) are to be arranged and constructed to respect the existing structure and its structural action.

2.26 It is proposed to improve the overall robustness of the retained structure and its resistance to possible disproportionate collapse (for example, if a column were to fail). The general principles at this conceptual stage behind these proposals are: to improve the robustness of the columns by casing in a thin cladding of reinforced concrete, thus replacing the existing casing. This needs to be done in conjunction with the fire engineer's requirements to cap the existing cross walls with a reinforced concrete beam that will be able to span over or around local voids created (accidentally) within the wall.

2.27 The approach needs to be verified as will all of the structural engineering when more detailed survey work is available at the next stage in the design process.

2.28 It is envisaged that the car park will be in the existing basement and the removal of existing columns will be kept to a minimum as far as practical.

3.0 Site Information

3.1 The historical development of the Stanley Dock site is described in detail in the Conservation Statement prepared by Hinchliffe Heritage for Abercorn Construction.This section summarises the Site Information and the key steps in the historical development from a structural engineering viewpoint.

3.2 Stanley Dock was constructed to the design of Jesse Hartley as part of the general expansion of the North Liverpool docks in 1845-48. The dock linked Collingwood Dock (to the west) with a new branch of the Leeds and Liverpool Canal (to the east). An opening was formed in the north wall of the dock and a short navigation channel constructed below the North Warehouse apparently to allow a connection to future dock developments to the north.

3.3 The first two warehouses at the dock – now known as the North and South Warehouses – were completed by 1855 to a design very similar to that of Jesse Hartley's Albert Dock warehouses completed a few years earlier. These buildings were general-purpose warehouses. Tobacco Warehouse (Photos 1 and 2) was conceived designed and built as a dedicated tobacco warehouse. Construction was underway in January 1898 and the building was completed by March 1901. Refer to appendix A.

3.4 In order to build this new warehouse, it was necessary to infill the southern part of the original dock. The building is therefore founded on piled foundations taken down to the load-bearing strata below.

3.5 The geological map of Liverpool (Appendix A) shows the site to be founded on recent drift deposits (alluvium and blown sand) over Upper Mottled Sandstone, part of the Bunter Sandstone strata.

3.6 A site investigation carried out by Soil Mechanics in February 2004 (Report No.F4031) revealed the ground conditions to comprise Made Ground over Glacial Till on Sandstone bedrock.

4.0 Property Descriptions

Summary

4.1 The Tobacco Warehouse is a thirteen storey masonry building with a basement which extends along the south front of Stanley Dock in Liverpool. The warehouse measures approximately 205m by 50m.

4.2 The warehouse was constructed in 1901 and is grade 2 listed.

4.3 The building is of loadbearing (red and blue brick) masonry construction which is typical of its age. Steel filler joist floors with unreinforced concrete infill panels spanning between primary beams support the upper floors, they are supported by a grid of cast-iron columns and loadbearing masonry exterior and cross walls.

4.4 On plan the large masonry structure is divided up into six sections, where each section was originally called a ‘cell’. Within each cell, the cast-iron columns are arranged on a grid of approximately 4.9m by 3.8m. The north elevation is built directly off the dock wall and the warehouse itself is built off ground reclaimed from the original dock.

4.5 Access to the upper floors was by three staircases and the tobacco was transferred between floors by load bearing masonry lift shafts, where there is one lift in each ‘cell’ of the building.

4.6 Appendix D contains copies of some of those drawings that have been located from the archives of the Mersey Dock and Harbour Board held at the Mersey Maritime Museum. The drawings include original contract drawings and some supporting ‘design’ drawings. These design drawings include calculations for various key elements, for example bending moments in the steel joists and beams, loads in the cast-iron columns and stresses in the main walls.

4.4 The findings of the visual investigation carried out so far generally match the information contained in these archive drawings.

Foundations

4.5 As noted in Section 3, Stanley Dock is founded on Bunter Sandstone between 3.5 and 5.0m below ground level.

4.6 The Tobacco Warehouse is built off land reclaimed from the original dock, comprising of, recent drift deposits of alluvium and blown sand, over Upper Molted Sandstone over Sandstone strata. The cast iron columns are built off piled foundations taken down to load bearing strata.

4.7 Local investigative excavations in the basement of the structure have been carried out, showing that the pile caps are approximately 1.4m by 1.4m wide.

4.8 The north (dockside) wall appears to have been built off the new dockwall, itself founded on the underlying sandstone. Further foundation details will be investigated as part of the next phase of design process.

Basement

4.9 The basement has load bearing cross walls with a grid of circular cast iron columns and beams supporting the concrete floor over.

Superstructure

4.10 The upper floors are currently unused and also consist of load bearing masonry cross walls spanning front to back and a grid of cast iron columns and beams supporting steel filler joist floors with unreinforced concrete infill panels. Appendix D shows details of this structure, also photo 3 and 11, Appendix E shows photographs of the floor structure.

4.11 The details and arrangements of the filler joist floors appear to be identical throughout the building, however the steel beams and filler joists are larger in section at ground floor level then elsewhere.

4.12 The concrete infill panels are unreinforced and contain crushed brick as the aggregate. There is a granolithic screed topping to the floors. The top flanges of the steel joists and beams are encompassed within the infill panels and their bottom flanges (which are downstand from the main) are cased in a clinker concrete (see photo 4). This clinker concrete is largely unreinforced apart from widely spaced metal straps (as can be seen in photo 3).

4.13 The filler joists are cleated to the side of the primary floor beams. These primary beams span between the cast-iron columns and sit on brackets cast into the bases of these columns.

4.14 The circular hollow cast iron columns from basement to roof level reduce in diameter at each level up through the building. Each column slots into the head of the columns below with a spigot for locating purposes. The incoming primary floor beams sit on brackets cast into the base of each column. The beams are bolted in place.

4.15 The cast iron columns are cased in fire-proof cladding.

4.16 The load bearing masonry external and cross walls also reduce in thickness up the building. At ground level on the end elevations the walls are faced externally with rusticated stonework bonded into the brickwork.

4.17 The primary beams span between the column grid and the masonry exterior and cross walls.

4.18 The Tobacco Warehouse is connected to the adjacent South Warehouse by steel bridges at first floor level. These bridges sit within purpose-built openings in the south wall of the warehouse, and openings that were enlarged within the north wall of the South Warehouse.

4.19 Openings typically have brick-arched heads. The exception to this is larger window openings in the external elevations. These openings have concrete encased steel beams as lintels on the inside face of the opening (being part of the floor structures) and reinforced, reconstituted-stone lintels on the external faces of the walls.

4.20 The north (dock) side elevation is supported at ground level by compound steel girders rigidly connected to compound steel columns. To the east end of this elevation, this frame has been infilled with brickwork. This infill brickwork is not original and unlikely to contribute to the lateral stability of the building.

Roof Structure

4.21 The roof is constructed in an arrangement of light weight steel ‘angle iron’ trusses spanning between the cast iron columns and load bearing masonry walls below.

4.22 The roof geometry over four of the cells of the building (refs Bays 1, 2, 4 and 5 and see photo 6 Appendix E) is traditional, with hipped ends. In these roofs, the trusses span onto steel valley beams that span over the intermediate columns – see photo 6.

4.23 The roof geometry to the remaining two cells (refs. Bays 2 and 6) comprise of ‘north light’ roof trusses (Photo 10, Appendix E). These trusses span north – south, onto steel valley beams that collect rainwater into gutters that lie along the lines of the roof valley beams. These gutters run into channels that carry the rainwater to downpipes built into the cross walls by the stair cores. In the north light roofs these channels are fixed to the sides of the cross walls.

4.24 Rainwater from the roofs is carried down to ground level in externally mounted downpipes. These downpipes receive water from the roof from downpipes that are built into the cross walls at level twelve and which feed into hoppers at the twelfth floor level.

Lateral Stability

4.25 The Tobacco warehouse is split into six cells, provided by the masonry cross walls. This means the building is well proportioned and creates a robust structure.

4.26 The lateral stability is achieved by the diaphragm action of the concrete filler joist floors acting as plates to transfer the loads the masonry cross walls.

4.27 The external masonry walls span vertically.

4.28 Lateral stability is not gained through the existing stair or lift cores.

Stairs and Lifts

4.29 Each cell of the warehouse is served by its own lift. The lift shafts are formed out of brick masonry and form part of the original fabric of the building. The floor structures bear onto these lift shaft walls (see photo 5).

4.30 There are three stair cores, in cells 1, 4 and 6. The landings to the stairs appear to be a continuation of the filler joist floor construction of the typical floors, whilst the stair flights themselves appear to be stone 'cantilevered' (hanging) construction.

5.0 Current Structural Condition

General

5.1 The condition of a structure is dependent on three basic factors:

- The quality of its original design and construction;
- The extent and sensitivity of past alterations and
- The level of maintenance.

5.2 The Tobacco Warehouse appears to be a generally robust design. However, there appears to have been desire to build as economic a building as possible, and the resulting design is based around the specific requirements of tobacco storage as they were at the end of the nineteenth century. This has resulted in a building that does not have the same degree of flexibility either geometrically (the floor to ceiling heights are very mean) or in terms of load-carrying capacity of the floors (which were designed to cope with the loading requirement of the tobacco and no more) as more general-purpose buildings like the neighbouring North and South Warehouses.

5.3 In addition to this fundamental inflexibility of the structure, there exist some defects that may be as a result of the way in which the building was finally constructed, and these will be considered separately below.

5.4 There does not appear to have been any significant alterations to the structure.

5.5 The building has suffered from a lack of maintenance for many years. This has led to significant local problems, particularly with water ingress through failed roof finishes, blocked gutters and rainwater goods, causing damage to the structure. This is also discussed in more detail below.

5.6 Overall whilst the structure is robust in conceptual terms and in a reasonable condition, it is locally in a poor condition, and in need of a major overhaul.

Approach to repairs

5.7 Important historic structures such as these respond well to an approach that mitigates both known problems and defects that are encountered during the course of the works.

5.8 Without pulling the building apart, it is impossible to look at everything. The ongoing inspection and maintenance programme which needs to be put in place for the future care of the building should reflect this.

5.9 In dealing with the repairs, solutions will need to be developed which are compatible with the nature and form of the existing structure. This approach is different from the one taken on new buildings and cannot be judged by comparing the existing building with what would be achieved on totally new construction.

5.10 As noted above, a programme of regular maintenance is required once the current defects are remedied – the success of the overall approach relies on this.

Floor Structures

5.11 The existing floors comprise steel filler joists spanning between primary steel beams with unreinforced concrete infill floor panels.

5.12 Extensive cracking has been recorded within these panels throughout the building.

5.13 The presence of these cracks has allowed water to freely penetrate from the top floor all the way down to the basement. It is not clear at this stage exactly what has caused this cracking, or when it occurred, and this will be investigated as part of the next phase of the design. It is possible that the cracking developed very early in the life of the building as a result of drying shrinkage of the unreinforced concrete.

5.14 The water penetration through the building means that the moisture levels within the floors is quite high. This can be seen to be causing corrosion of the embedded steel beams and joists and, in a number of instances, the concrete casing to the bottom flanges has been blown off. Where the steelwork has been exposed in this way, or through opening up works, the corrosion generally seems to be limited to surface corrosion only. There are instances however, where laminated corrosion seems to be beginning, and it is possible that some of the joists and/or beams will need to be replaced where the extent of corrosion has significantly reduced the strength of the member.

5.15 It is significant to note that the cracks in the concrete panels do not, in general, coincide with the lines of the embedded steel beams or joists. This suggests that the cause of the cracking is not related to water ingress through the building.

5.16 The extent and severity of corrosion to all the steel and cast-iron structural elements to that part of the warehouse that is to be retained (see later) will need to be established at the next stage of the design by physical investigation and perhaps material testing, but it seems prudent to allow for the following structural repairs:

- Improvement of corrosion protection of exposed areas of steel.
- Replacement of steel elements where corrosion has significantly reduced their load-bearing capacity.
- Re-casing exposed steelwork with either in situ concrete or a proprietary concrete repair system.

5.17 The full extent of the cracking to the concrete floor panels needs to be investigated further as the design progresses. This will need to establish in detail the form of the cracks, their orientation and whether or not they are full developed, as this will dictate how the structural action of the floors is affected. It is likely that some of the cracks will need to be repaired in key locations using some form of proprietary repair system.

5.18 Our observations to date suggest that the corrosion of the steel floor joists and beams has not been exacerbated by the presence of the clinker concrete casing to the bottom flanges of these elements. This will need to be investigated further however the volume of clinker-concrete throughout the building as a whole is tiny and it is unlikely to prove a significant issue once the building is watertight.

Columns and Walls

5.19 In general, the cast-iron columns seem to be in reasonable condition. The water penetration that has occurred through the building seems only to have resulted in minor surface corrosion, although this will need to be confirmed as the design progresses.

5.20 In many instances, the fire-proof casing has been lost. This appears to be largely as a result of mechanical damage but in some cases could be as because of the surface corrosion of the cast iron. The load bearing brick walls generally appear to be robust and well-built but there are a number of local defects that have occurred as a result of corrosion to a number of steel elements built into the walls.

5.21 It is possible that the columns contain cracks that are hidden and a detailed survey at the next stage will establish whether or not any cracks exist and their structural implication.

5.22 Vegetation around the rainwater downpipes at the top floor suggest that the pipes are leaking and, in all probability, corroding. Similar vegetation growth and staining of the wall heads is visible below the gutters to the hipped roofs, suggesting the water is getting into brickwork.

5.23 The rainwater penetration through the floors and the ensuing corrosion of the embedded steelwork has been discussed previously. The condition of beam and joist ends where they bear into the external walls needs to be checked, particularly around leaking downpipes. It is possible that the brickwork in some areas will need to be broken out to allow treatment to affected joist/beam ends.

5.24 The defects in the brickwork that have arisen as a result of defective rainwater goods or corroding joist/beam ends will need to be addressed either by stitching in brickwork across any cracks or, in more extreme cases, by cutting out the deteriorating element (pipe, joist or beam) replacing as required and locally rebuilding the wall. It is likely that the existing downpipes will need to be replaced.

5.25 The condition of the parapets generally needs to be investigated further when better access is available. It is likely that some will need to be partially taken down and rebuilt.

5.26 Although largely non-structural, spalling of the reconstituted stone elements to the main elevation windows (cills, lintels) could be seen. This will need to be investigated further but it is likely that repair can be limited to treating the expose reinforcement and patch-repairing the stonework.

5.27 Given the age of the building, it is possible that metal ‘bond-bars’ or straps have been embedded in the masonry of the main walls. There are no obvious signs of any significant structural problems related to corrosion of such elements although horizontal staining of some bed joints internally suggest that thin strapping does exist, and that it has corroded. This issue will of course need to be investigated as the design progresses.

5.28 The existing framing to the ground floor north elevation seems to be in a reasonable condition however there are signs that laminated corrosion has set in externally where the existing paintwork has been lost. This will require further investigation however it is likely that remedial works can be limited to wire brushing affected areas and treating with a corrosion inhibitor.

Roof

5.29 The existing roof is generally in a poor condition, with substantial damage due to water ingress across the roof. In whole this roof is not structurally viable to be fully retained.

5.30 The gutters appear to be blocked and vegetation is growing in abundance. This has lead to the corrosion of the roof structure where it is exposed to water, particularly the steel beams below valley gutters (see photo 5).

5.31 It is likely that steelwork built into the walls under leaking gutters will have corroded more seriously. Although it is proposed to replace the existing roofs with an additional new floor and roof (Section 6.21) the extent of corrosion of the existing steel roof structure where it bears onto the existing walls will need to be investigated further as part of the next phase of the design process to establish how the wall heads (that are to be retained) have been affected by the deterioration of the roofs.

5.32 The penetration of water through the roof finishes is not confined to the top floor (See photo 7). Water ingress through the building continues through the floors all the way to the basement.

6.0 Structural proposals

General

6.1 The current proposals for the Tobacco Warehouse comprise its refurbishment and conversion to residential use, with provision for car parking and some retail, office and exhibition space at ground floor level.

6.2 The shear bulk of the building, and the bespoke nature of its design, mean that the level of intervention required to make sensible use of the building is higher than it might otherwise be for buildings of more modest scale and less closely-defined original design parameters.

6.3 The principle structural alterations affecting the warehouse are:

- Creating new stair and lift cores to gain suitable access throughout the building to meet current building regulations.
- Creation of three light wells to provide light to the interior parts of the building, without which the space would be un-usable.
- Formation of openings through the existing floors to create dual aspect split level duplex apartments.
- Removal of a large section of the existing roof, to replace with a new lightweight roof and construction of an additional floor to create penthouse apartments at new level 13.
- Removal of existing lift shafts and infilling of their associated voids.
- Providing underground parking in the existing basement.
- Ensuring each change of use from tobacco storage is acceptable in terms of the allowable live loads throughout the building.

Access

6.4 The three original staircases in building, which are of a cantilevered construction are to be retained. However to achieve the change of use of the building, further access is essential to meet current standards.

6.5 Two new staircases are required, this will mean cores to be cut through the filler joist floors in the building at all levels. This should be located adjacent to the existing grid.

6.6 New lift shafts are required, and as with the stair cores should be located adjacent to the existing grid.

6.7 A number of the existing lift shafts are proposed to be removed, however as they are not providing lateral stability to the structure this element of work should not affect the structure. Steel framing out will be required in these areas to support the filled in voids and existing floors.

Atriums

6.8 Three large light wells through the building are proposed.

6.9 The light wells will follow the original grid for the new cladding to connect back into it.

6.10 The purpose of the light wells is to ensure that both aspects of the new apartments have light. Without the removal of this element of the structure this area would be unusable.

Floors, Columns and Walls

6.11 Sections of the internal filler joist floors are to be removed to create split level duplex apartments. Shown on drawings in Appendix C.

6.12 The openings in the floors are to follow the existing column grid to minimise the effects on the structure. Further analysis on the impact of the lateral restraint of the columns and load bearing walls will be required and strengthening of those will also be needed.

6.13 Trimming out will be required to re-case the existing steelwork in new reinforced concrete.

6.14 Additional strengthening works due to deterioration and corrosion may be required on some of the columns. This is to be determined through further investigations of the structure.

6.15 In addition to strengthening works to the columns the same process of investigation and mitigation will be required in areas of the floor which are damaged. This is to be developed upon future investigations throughout the project.

6.16 Where the openings are larger or more complex (i.e. around the proposed lift and staircases) the existing floor structure between columns will be broken out and replaced with new reinforced concrete slabs cast in situ and tied back into the retained surrounding floors.

6.17 The size and extent of the openings has been limited in such a way as to maintain the ability of each floor to span between the retained cross walls, thus allowing each floor to contribute to the overall stability of the retained structure as described above. The holes for the vertical service risers are small and are limited and arranged so as not to compromise the structural principles already described.

Disproportionate Collapse

6.18 To follow the Building Regulations Part ‘A’ the buildings resistance to possible disproportionate collapse must be considered. As only a small proportion of the building is to be removed it will still retain its robustness. A number of similar buildings have been developed in this way in the Liverpool area and we do not see disproportionate collapse to be a problem.

6.19 However some areas will need to be improved by casing the columns in a thin cladding of reinforced concrete, thus replacing the existing casing; to cap the existing cross walls with a reinforced concrete beam that will be able to span over or around local voids created (accidentally) within the wall.

Roof

6.20 The existing roof is generally in a poor condition, with substantial damage due to water ingress across the roof. This roof is not structurally suitable to be fully retained.

6.21 The proposal is to remove the roof and the supporting trusses and build up a new two storey steel frame to create a penthouse level, which will be built off the columns on level 11.

6.22 A new level of columns is required on the twelfth floor as the water damage has also affected the columns on this level. Also as the columns reduce in size up the building the size of the columns needs to be increased at this level. A new floor will be provided to form the new level 13. Further columns will be built up off this floor to support the roof at penthouse level.

6.23 It is envisaged that the new storey will be of lightweight construction built off the existing internal columns and cross walls, using timber floors and steel framing, braced as required for lateral stability (see Appendix C). The new roof will be a lightweight construction. The use of lightweight construction will minimise the loads transferring through the building.

6.24 The new loads will be transferred down through the building through the existing walls and concrete grid, all the available load points will be utilised to spread the load. However, and because of the economic and efficient design principles followed when the warehouse was originally designed, it will still be necessary to strengthen some of the existing columns.

6.25 It is proposed at this stage that this strengthening will take the form of a thin concrete casing to the column. This casing will replace the existing and will improve (reduce) the slenderness of the column and enhance its load-carrying capacity. The new casing will improve the resistance of the columns to disproportionate collapse (considered in more detail below). The casing will also provide fire protection to the columns and this will need to be done in conjunction with the fire engineer's requirements.

6.26 The primary reason for removing the existing roof is to ensure the light wells and the adjacent construction can be achieved. We believe the removal of part of the roof will not be structurally viable adjacent to these light wells.

6.27 New walkways are proposed between the north and south sides of the penthouses. They will be built off the roof below. The existing grid will be taken into consideration to support the walkway.

6.28 A section of the existing roof is to be retained for two nesting Falcons. Repair works to the existing steel roof will be required and a suitable connection between the new floor and existing roof will need to be designed to keep the structural integrity of the roof intact.

Car Park

6.29 The car park will be designed to reach the appropriate level of parking and will be located in the basement.

6.30 Access to the car park will be via two concrete ramps, one to come into the building and one to exit.

6.31 There will be a minimal impact on the existing structure as we propose to design a structural system which retains the existing cast iron columns as far as practical. Refer to the car park layout in Appendix C.

Loadings

6.32 The Tobacco Warehouse was conceived, designed and built as a dedicated tobacco warehouse. Original drawings show that care was taken in the design of the floors and supporting cast iron columns to achieve an efficient and economic structural design. This refined design means that the building does not have the same flexibility in loading permutations as a general purpose warehouse would.

6.33 Drawings from the Mersey Dock and Harbour board suggest the existing live loadings on the building was only calculated to support 8cwt/sq.yard. This equates to approximately 5kN/m^2. Taken from existing drawings.

6.34 Records from the same source show how the warehouse was used to store tobacco, from either Kentucky or Virginia, in hogsheads stacked one high (hence the low floor – ceiling heights). The loading implications reveal a spread of likely imposed loadings of between 1.75 – 5.15kN/m^2.

6.35 It has not yet been possible to establish the actual material strength or properties of these primary beams. It appears that the construction of the warehouse made use of non-standard steelwork. A conservative estimate of an imposed load capacity of around 3kN/m^2 can be justified to current Codes of Practice. This is based on the section properties of the primary floor beams previously deduced from site measurements and an assumed material strength based on commonly practiced assumptions in place when the warehouse was built.

6.36 The change of use of the building, from storage of tobacco to office/retail and exhibition space for the ground floor, residential upper floors and car parking for the basement. The proposed live loadings are from BS 6399: Part 1:

- Residential upper floors - 3kN/m^2
- Ground floor office, retail and exhibition space - 4kN/m^2
- Basement car park - 2.5kN/m^2

6.37 The existing live load is suitable for the proposed changed of use throughout the building. The highest load on the ground floor is acceptable as noted previously the ground floor construction is thicker than the upper floors.

6.38 Additional further investigations will be required throughout the development to confirm this capacity of the structure. At this stage, however, and based on all the information available to date, it is reasonable to assume that there is more than adequate capacity in the existing floors to carry the loads to which they will be subjected.

Lateral Stability

6.39 How the existing building achieves its stability in its present form is described in section 4.0. In broad terms, the existing floors transmit lateral loads to the cross walls and hence down into to the ground. These same principles will be followed in the proposed scheme, with the result that the retained structure will be inherently stable.

6.40 The most significant of the new openings through the walls are at ground floor level, where the new car park entrance and exit openings are to be formed. These will need to be framed with new, probably steel, frames that will maintain the lateral stability of wall locally.

6.41 The removal of the existing infill wall panels between the existing steel frame at ground floor level to the north (dockside) elevation is unlikely to affect the lateral stability of the wall. This will need to be looked into in detail as the design progresses and there is therefore provision in the scheme for new walls or bracing along these existing wall lines should they prove necessary to maintain the local stability.

6.42 The new steel frame forming level 12 and 13 will be designed with bracing and moment frames to resist the lateral loads. The loads from this will then be distributed back into the existing building and transmitted through the floors and walls as above.

Signed: *Sean Keyes*

Sean Keyes
MEng CEng MStructE MICE MRICS MCIOB MaPS

Appendix A – Site Information

Figure 1: 1841 Site Plan

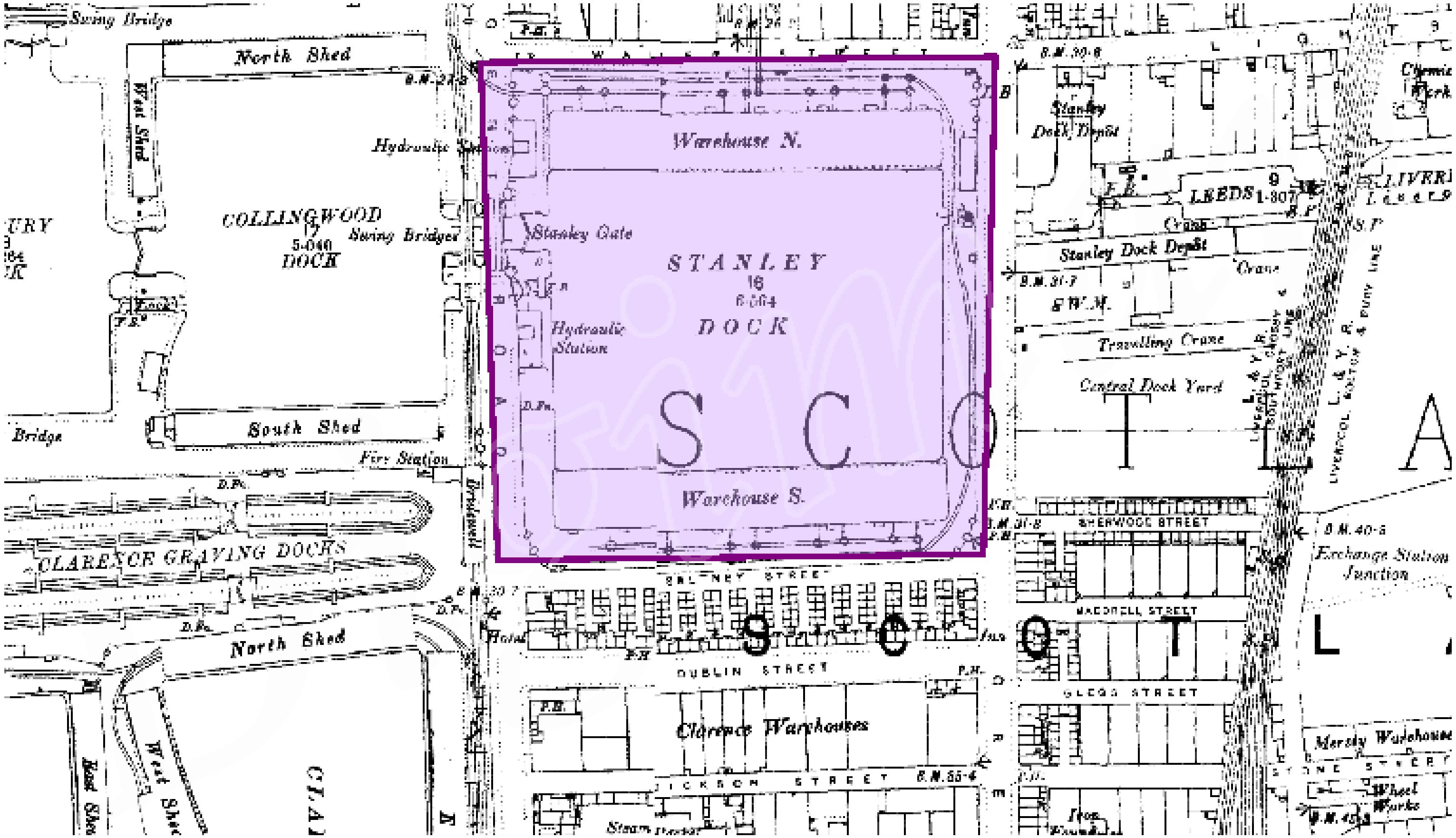


Figure 2: 1893 Site Plan

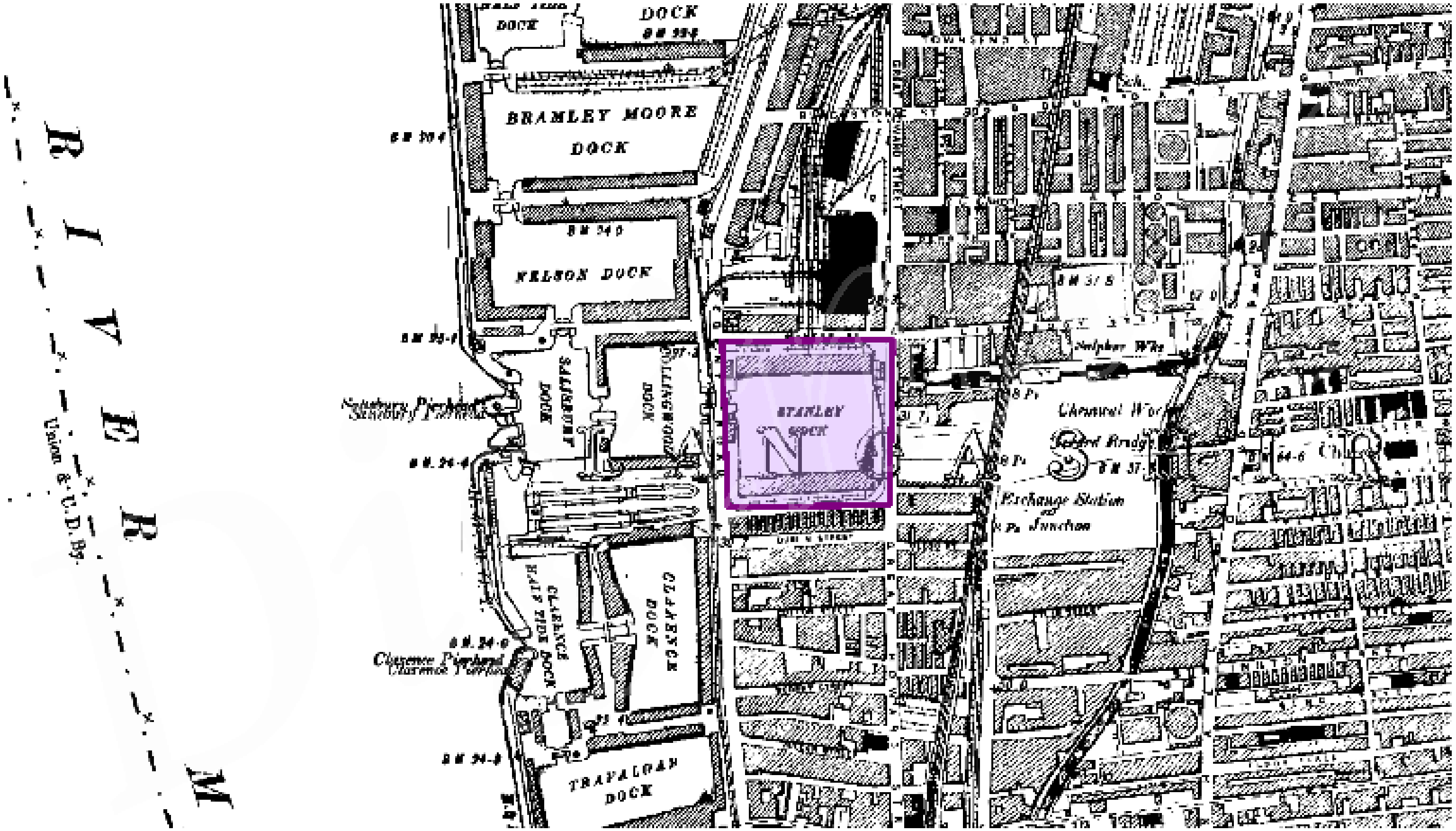


Figure 3: 1894 Site Plan

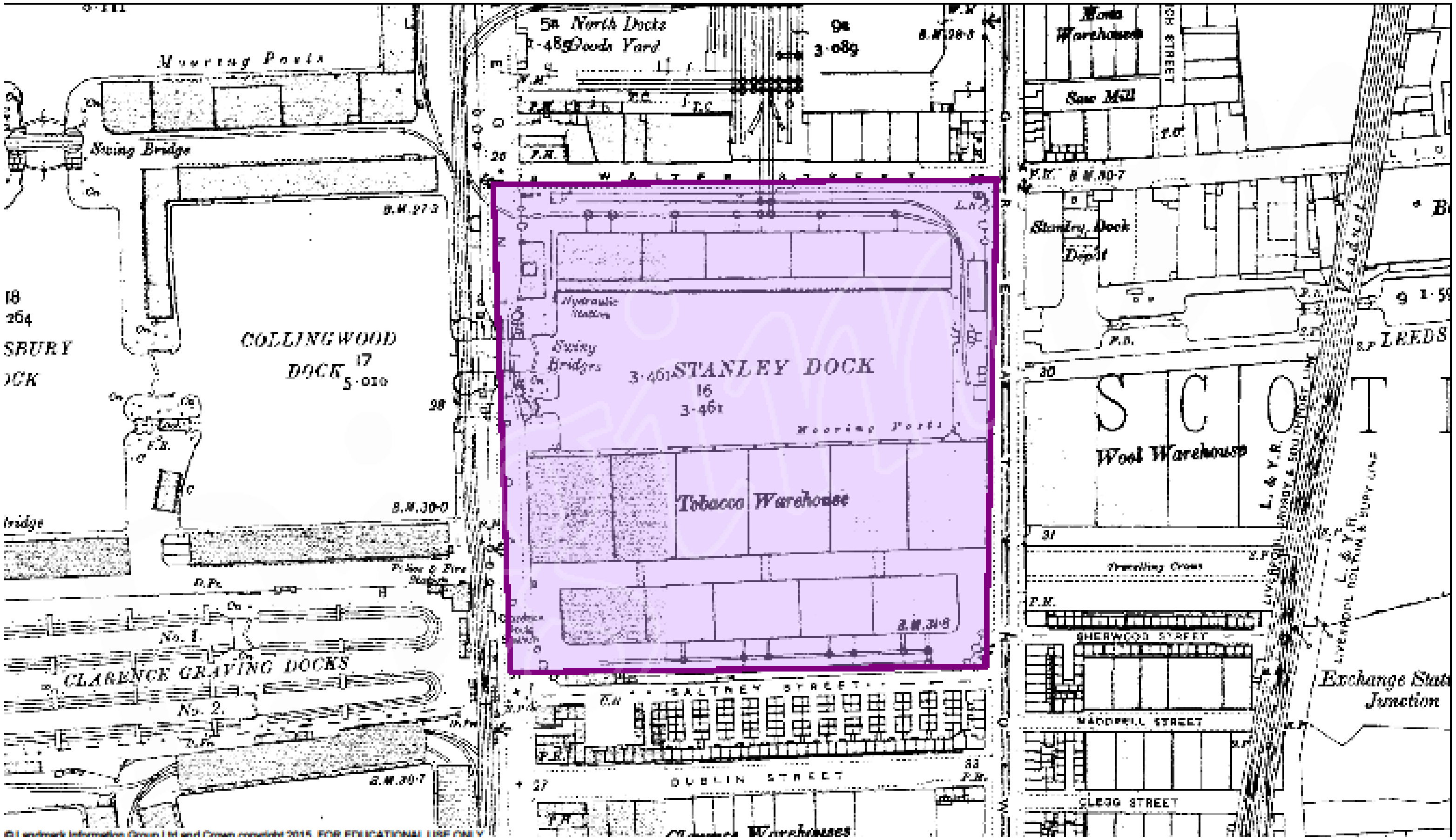


Figure 4: 1908 Site Plan

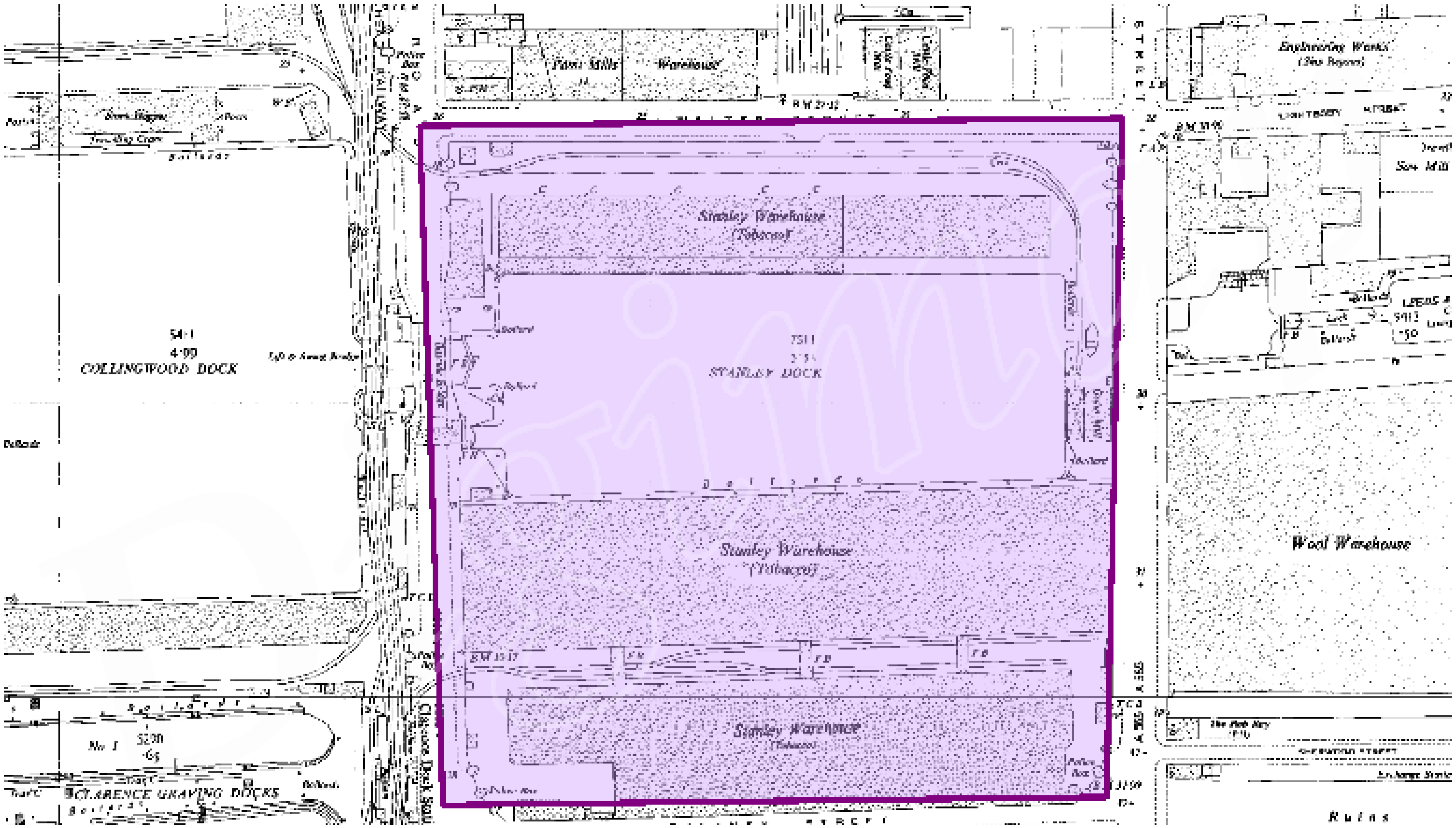


Figure 5: 1955 Site Plan

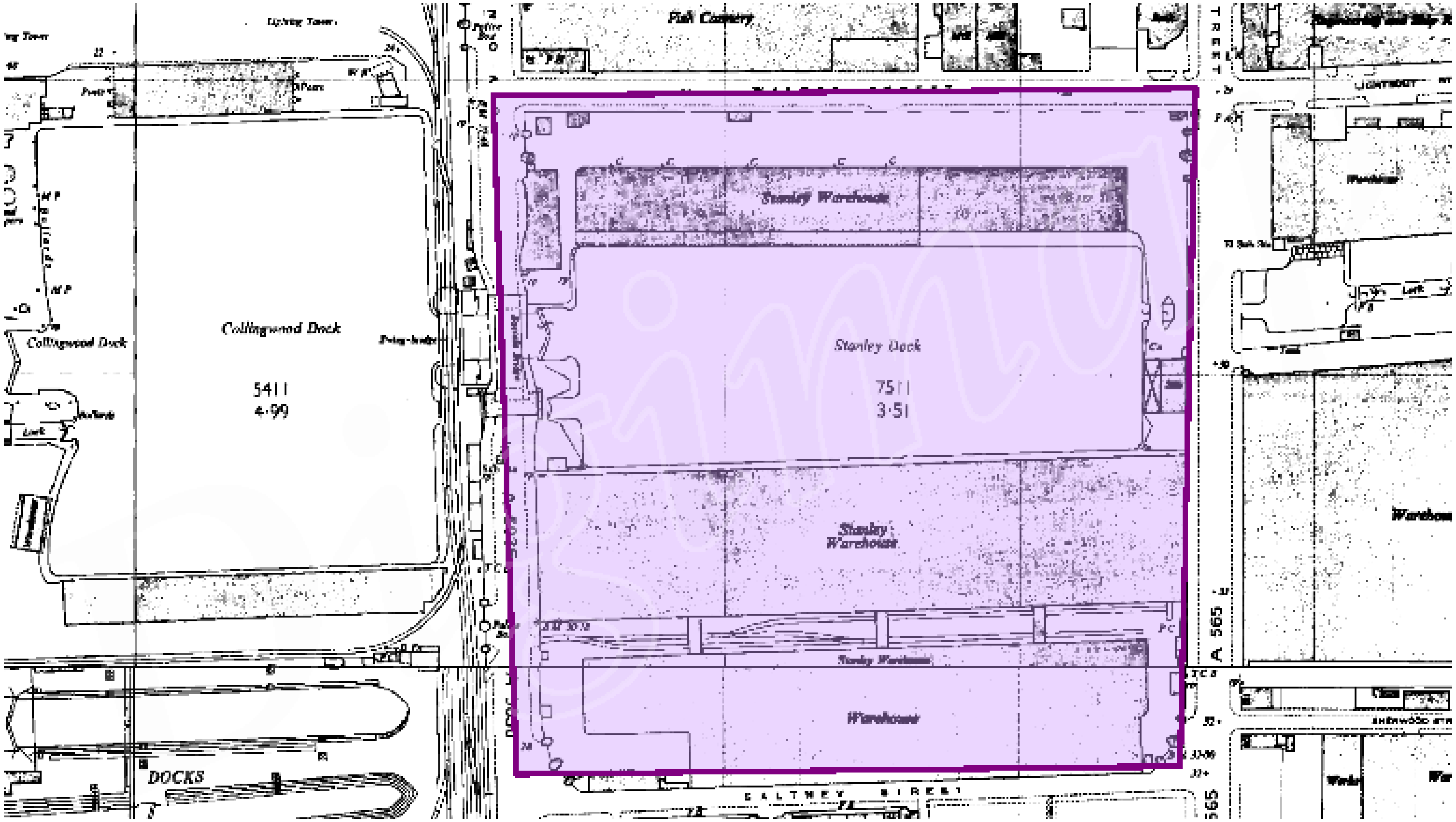


Figure 6: 1968 Site Plan

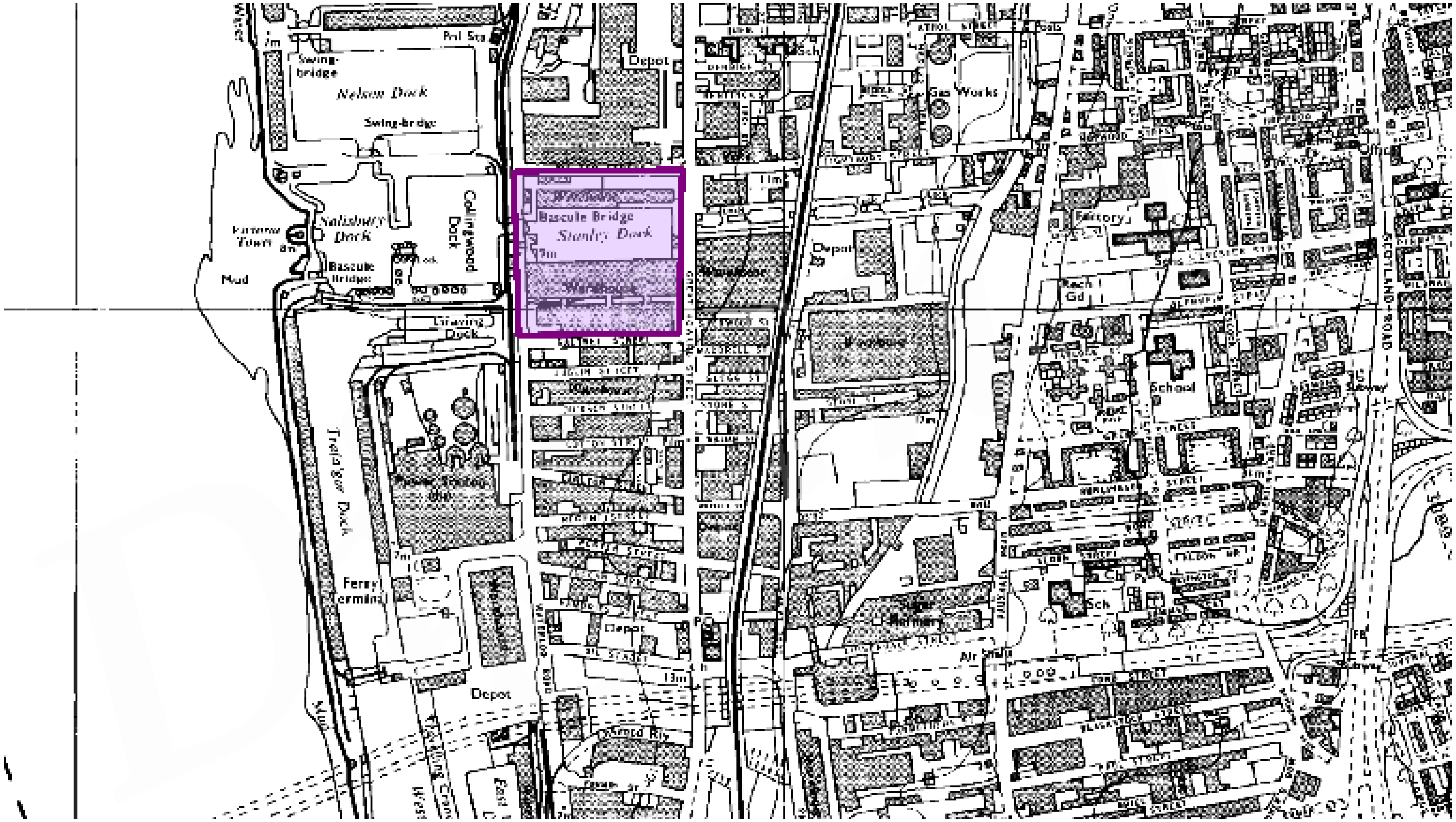


Figure 7: 1984 Site Plan

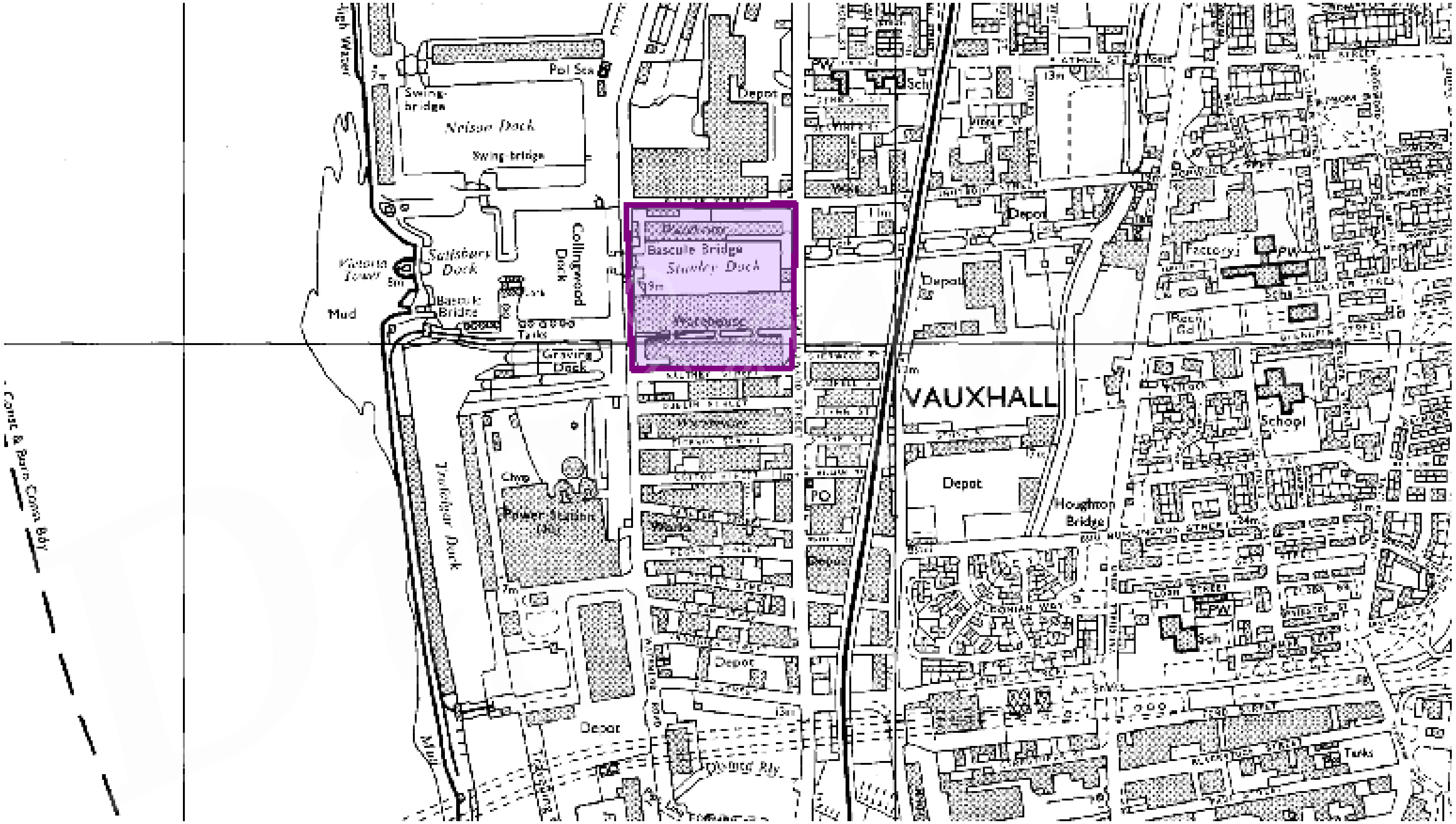
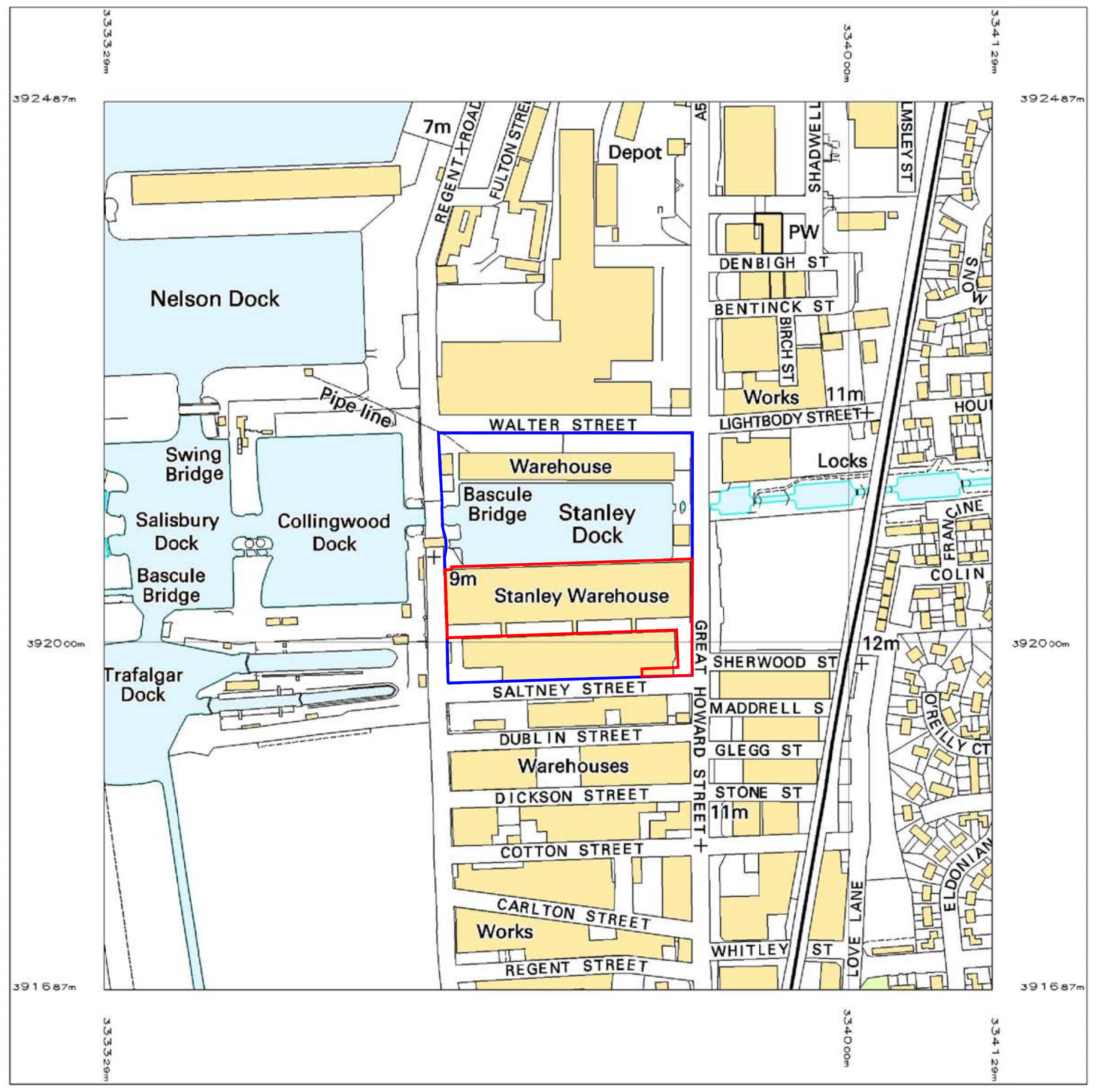


Figure 8: 1991 Site Plan

Figure 9: Geological Drift Map

Figure 10: Key to Geological Drift Map

OS Landplan®



Plotted 14 Jul 2011 from Ordnance Survey digitally derived data.

Produced using significant survey information from Ordnance Survey large scales digital data, and incorporated into OS Landplan May 2011.

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Administrative boundaries revised to May 2011.

Additional boundaries information:

Scale 1:5000

N

This OS Landplan plot is enlarged from derived mapping produced at 1:10000 scale

Heights are given in metres above Newlyn Datum. The representation of a road, track or path is no evidence of a right of way.

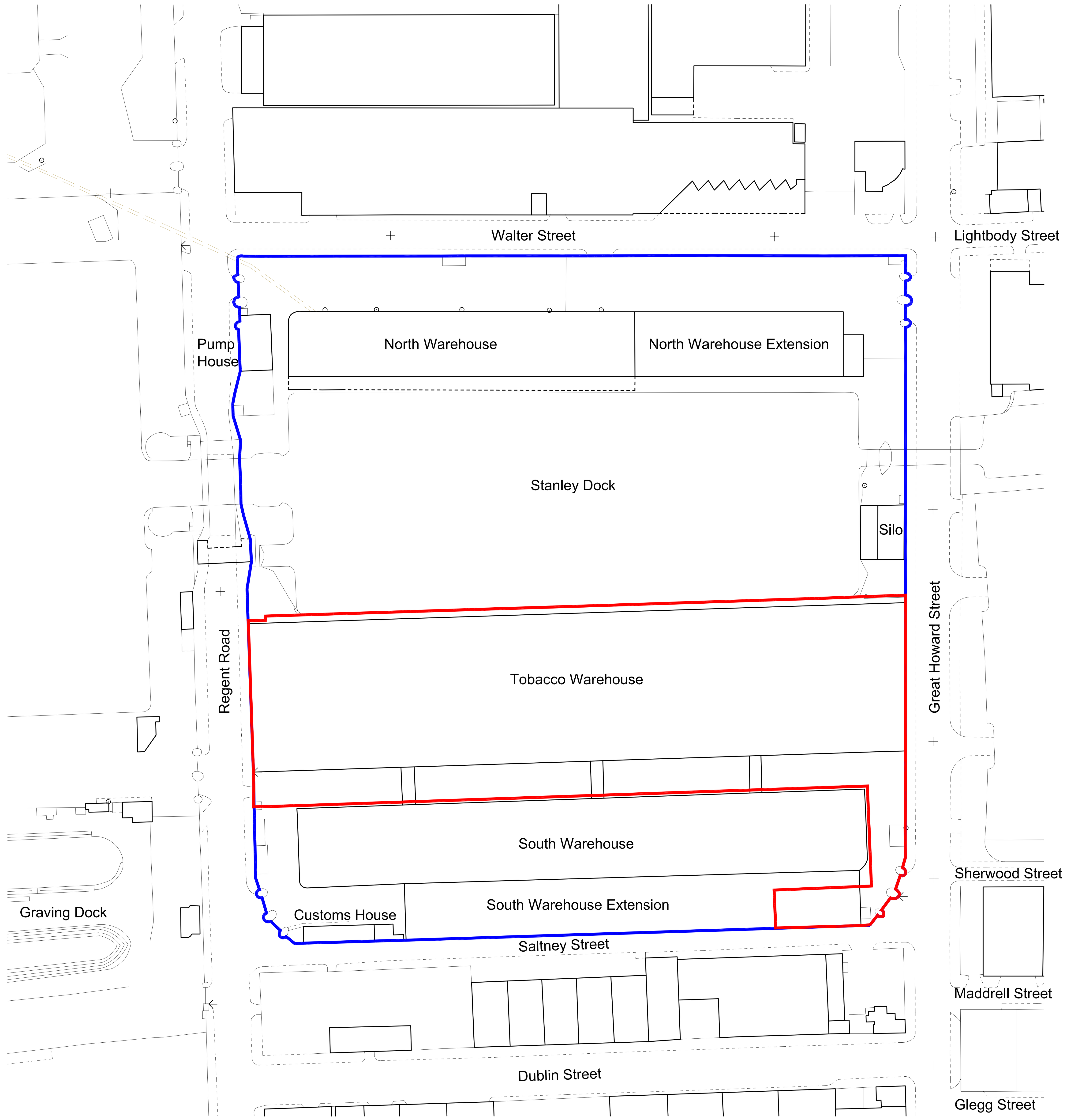
The alignment of tunnels is approximate.

An OS Landplan symbols leaflet is available on request from Ordnance Survey Mapping and Data Centres.

Ordnance Survey, the OS Symbol and OS Landplan are registered trade marks of Ordnance Survey, the national mapping agency of Great Britain.

Plot centre coordinates: 333729 392087
Supplied by: Stanfords
Plot serial number: 03431100

1 PA-000 Site Location 1:5000



2 PA-000 Site Plan - Existing 1:1250

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NOTES:

Do not scale from this drawing.

Any discrepancies found on site to be reported to Darmody Architects immediately.

Any discrepancies found on drawings to be reported to Darmody Architects immediately.

Refer to engineers drawings for structural details.

All dimensions sized to blockwork.

Rev.	Description.	Date.	Initials.

XREF'S
CAD REF.

DRAWING KEY

- SITE BOUNDARY (red)
- ADJACENT LAND WITHIN CLIENT'S OWNERSHIP (blue)

DRAWING KEY

NORTH POINT

N W E S

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Rev. No.	Scale	Date	Drn. By	Chkd. By	Issue
	1:5000 @ A1	11/06/2015	J Lynch	Tim Darmody	PLANNING

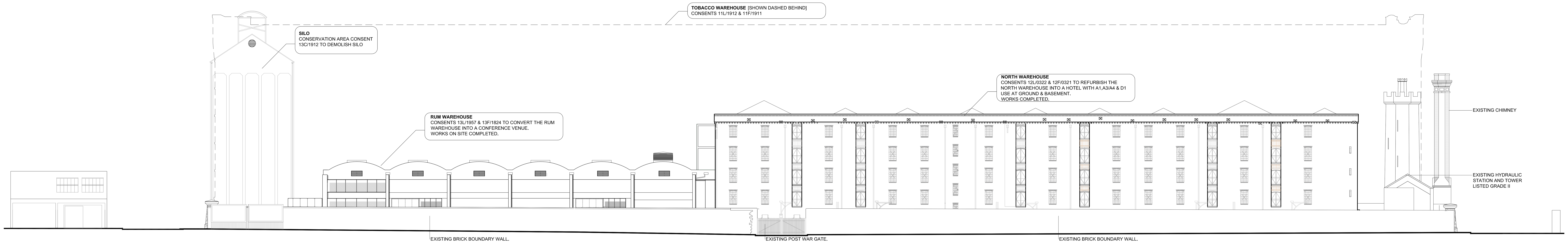
Project. Tobacco Warehouse at Stanley dock
Stanley Dock, Liverpool

Title. SITE LOCATION & SITE PLAN

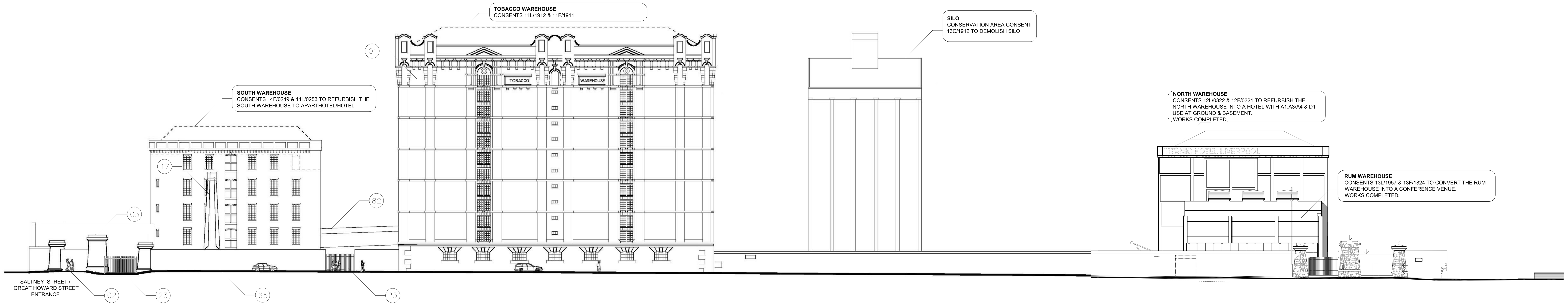
Client. Stanley Dock Properties Ltd.

Dwg. No.	Job No.
PA-000	1523

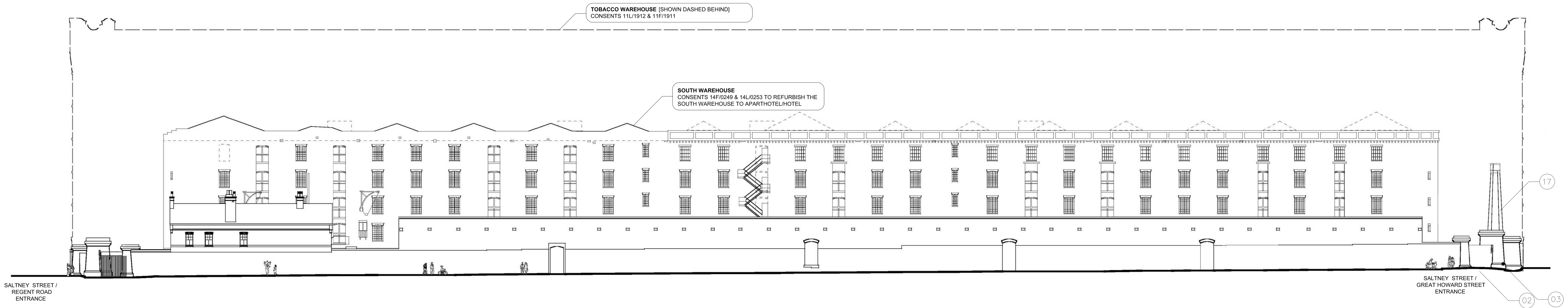
Appendix B – Existing Structure



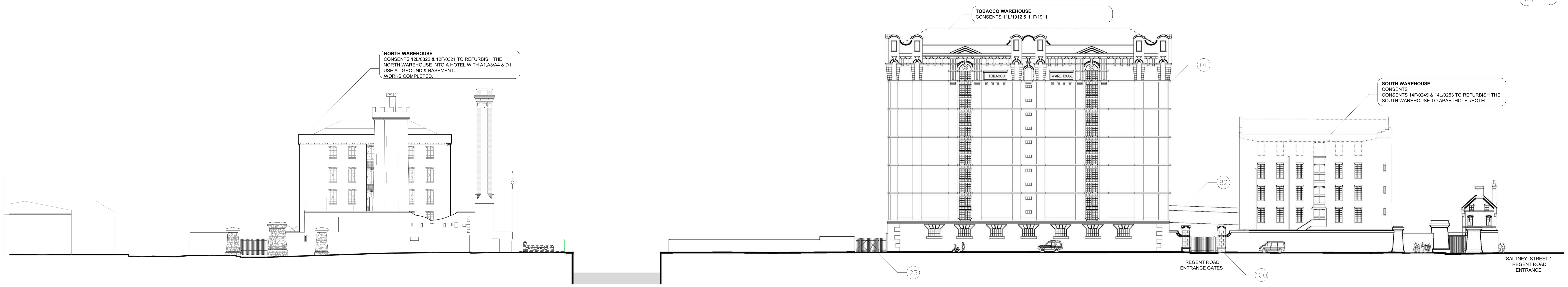
1 PA-003 External Wall - North Facade
1:400



2 PA-003 External Wall - East Facade
1:400



3 PA-003 External Wall - South Facade
1:400



4 PA-003 External Wall - West Facade
1:400

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Refer to engineers drawings for structural details.

All dimensions sized to blockwork.

Rev.	Description.	Date.	Initials.

XREF'S
CAD REF.

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Rev. No.	Scale	Date	Drn. By	Chkd. By	Issue
	1:400 @ A1	24/06/15	A Brzostek	Tim Darmody	PLANNING

Project. Tobacco Warehouse at Stanley dock
Stanley Dock, Liverpool

Title. EXISTING SITE ELEVATIONS

Client. Stanley Dock Properties Ltd.

Dwg. No.	Job No.
PA-003	1523