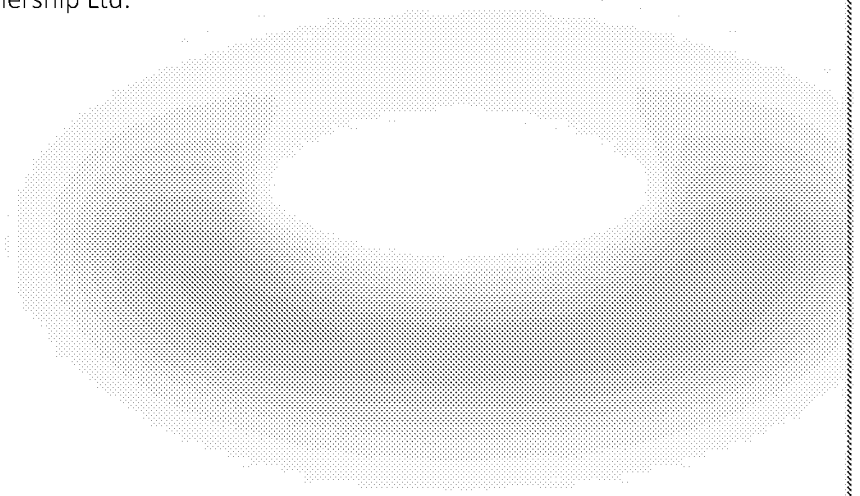




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Project: 46A to 47 Pier Road, Surface Water Drainage Strategy (SWDS)
Prepared for: Dowsett Mayhew Planning Partnership Ltd.
Reference: SWDS 3153
Date: August, 2017
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Project: Surface Water Drainage Strategy (SWDS)

Prepared for: Dowsett Mayhew Planning Partnership Ltd.

Reference: SWDS 3153

Site Location: 46A to 47, Pier Road, Littlehampton, West Sussex, BN17 5LW.

Proposed Development: It is understood that the development is for the demolition of the existing structure on site and construction of a new structure to provide commercial on the ground floor and 8 residential units above.

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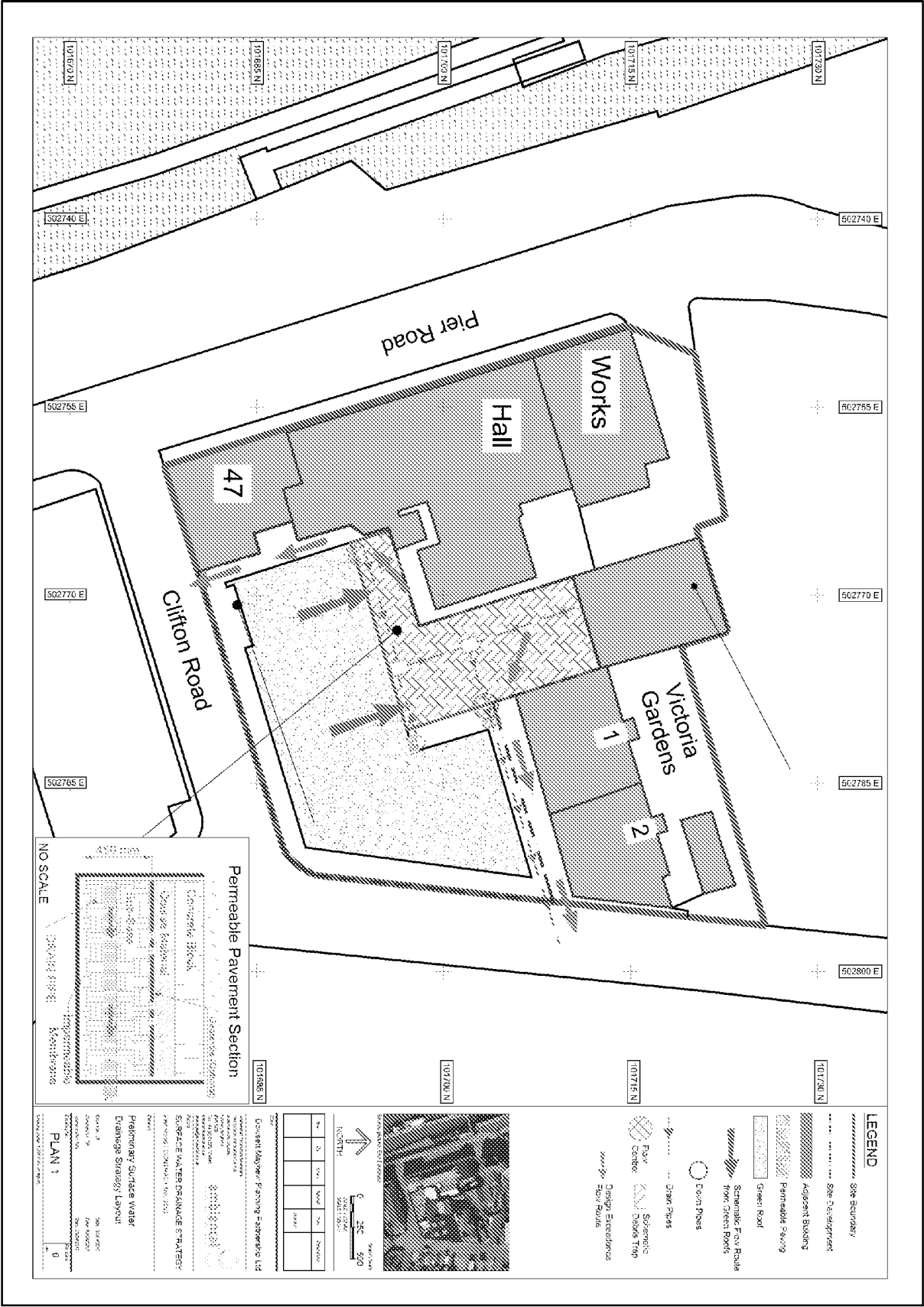
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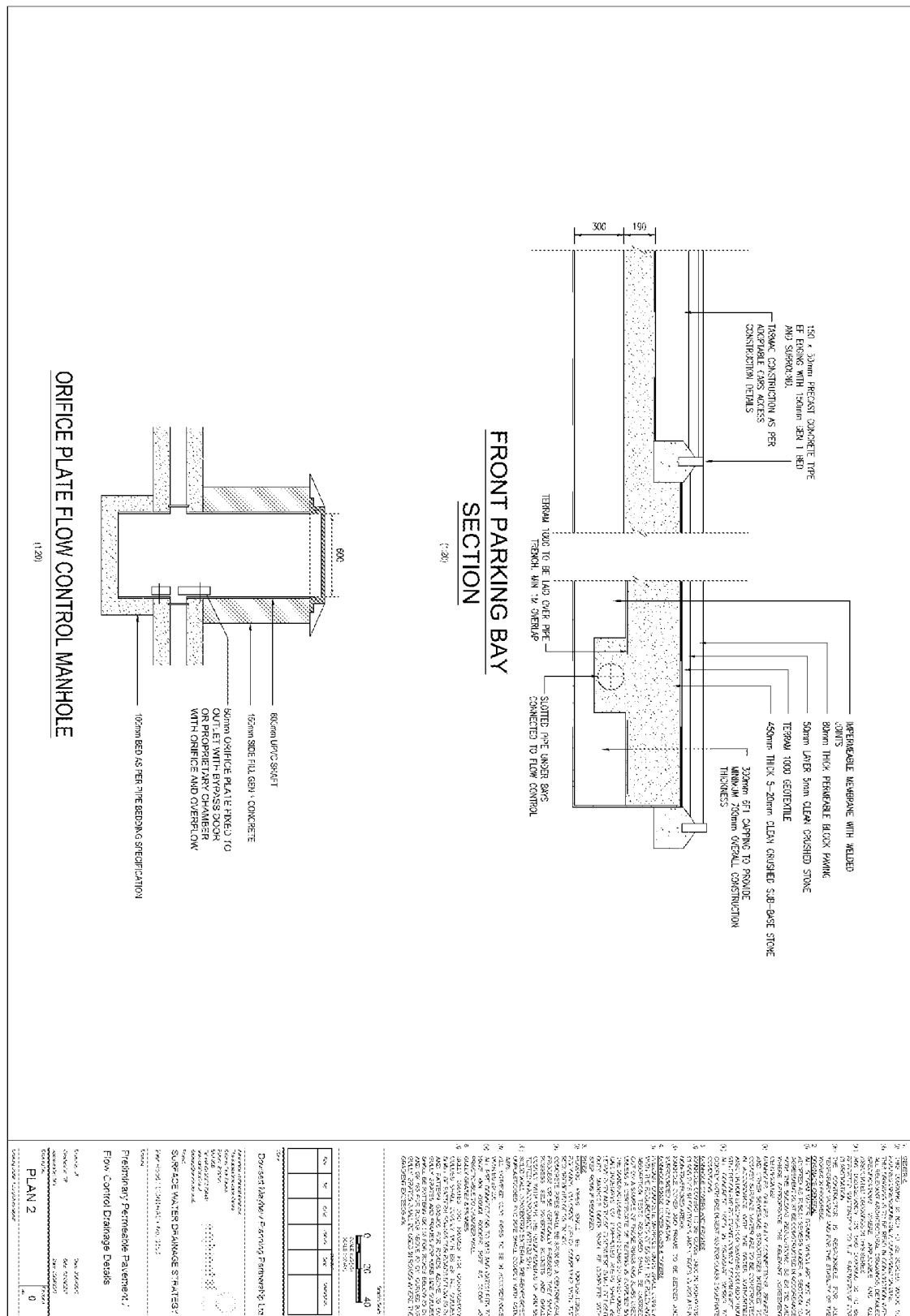
1. Summary

SITE DETAILS			
Site Name	46 to 47 Pier Road, Littlehampton, West Sussex, BN17 5LU		
Total Site Area	0.06 ha		
Site Area which is positively drained	0.06 ha		
Open Space	0.00 ha		
Predevelopment Use	Site already developed for residential purposes.		
Site Constraints	- Residential Site		
	- Groundwater Source Protection Zone:	N/A	
	- Groundwater Vulnerability Zone:	Major Aquifer High	
	- Good Infiltration Soils		
	- Unknown Groundwater Table		
IMPERMEABLE AREA			
	EXISTING	PROPOSED	DIFFERENCE (Proposed - Existing)
Impermeable Area (Ha)	0.06 ha	0.06 ha	0.000 ha
Drainage Method (Infiltration/Sewer/Watercourse)	Sewer	Sewer	N/A
PROPOSED TO DISCHARGE SURFACE WATER VIA			
	YES	NO	EVIDENCE
Infiltration		X	Potentially high groundwater and insufficient space for infiltration
To Watercourse		X	There is not a watercourse close enough to the site.
To Surface water sewer	X		
Combination of above		X	
PEAK DISCHARGE RATES			
	Greenfield Rates (l/s)	Proposed Pre-development Discharge Rates (l/s)	Proposed Discharge Rates (l/s)
Greenfield Q _{BAR}	0.18 l/s	N/A	N/A
1 in 1	0.15 l/s	8.3 l/s	2.2 l/s
1 in 20	-	18.6 l/s	-
1 in 30	0.45 l/s	20.3 l/s	5.00 l/s
1 in 100	0.58 l/s	26.2 l/s	5.00 l/s
1 in 100 plus climate change	N/A	N/A	5.00 l/s

SITE STORAGE VOLUME			
Source Control Provided	Yes		
Interception Volume (Capture and retention on site of the first 5 litres of the majority of all rainfall events)	2.44 m³		
Attenuation Volume (Storage - 1 in 100 year + CC) Volume to control discharge rate	11.90 m³	0.07 m³/m²	
Long Term Storage (1 in 100 years, 6 hours event) Difference in runoff volume between the development state and the equivalent greenfield (or predevelopment state)	0.00 m³	Not taken into account.	
Approach used for Long Term storage (Either Use Long Term Storage or Discharge at very low rate)	Either: • Approach A: Use Long Term Storage • Approach B: All runoff above 1 in 1 year return period discharged to max of 2 l/s/ha or QBAR	Discharge all runoff above 1 in 1 year return period using a Flow Control at Q _{BAR} rate.	
Total site Storage	14.34 m³		
INFILTRATION FEASIBILITY ANALYSIS			
Site's Geology	Quaternary Marine/Estuarine Sand Sand to Sandy Loam		
Infiltration Rates	3x10 ⁻⁵ m/s	This value must be confirmed through trial pit infiltration tests on site prior to the final detailed drainage design stage being carried out.	
Infiltration Rates Suitability	Suitable		
Ground Water Level	Unknown	It is highly recommended that a groundwater level check be undertaken at the later detailed design stage in order to accurately identify the depth of the water table at the site.	
Is the site within a known Source Protection Zones (SPZ)? Yes/No?	NO		
Is Infiltration feasible?	Infiltration is feasible as long as there is 1 metre of distance between the bottom of the proposed Infiltration Device and the Groundwater Table		
Site's Contamination	Site already developed, thus there would be a potential contamination due to petrochemical pollutants of the cars.		
Infiltration Feasibility	NO	Infiltration would NOT be feasible due to the proposed development layout and site constraints. Any infiltration device should not be built within 5m of a building or road or in areas of unstable land according to the Approved Document H of the Building Regulations.	
If Infiltration is not feasible, how is the Storage Requirements Approach?	Simple Approach. Discharge Long Term Storage and Attenuation Volume at Q _{BAR} rate.		

PROPOSED DRAINAGE COMPONENTS		
Permeable Pavement	Pervious surfaces provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into underlying layers.	
Green Roofs	Green Roofs are areas of living vegetation, installed on the top of buildings, providing visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff.	
Rills/Channels	Canals and rills are open surface water channels with hard edges. They are simply channels that water flows along whereby they can have a variety of cross sections to suit the urban landscape, including the use of planting to provide both enhanced visual appeal and water treatment.	
Flow Control (Hydrobrakes)	A self-activating device that provides improved hydraulic performance over conventional flow controls such as orifice plates and throttle pipes and reduced maintenance requirements.	
DESIGN CHECKS		
Drainage Systems Measures	Permeable Pavement, Green Roofs, Rills/Channels and Hydrobrake.	
How are rates being restricted	Hydrobrake	
Key Drainage component	Permeable Pavement	
Drainage Systems Maintenance	Supplier must provide appropriate guidance for maintenance	
All SuDS storage located outside Q100 floodplain	No	
Provision for blockage / Design Exceedance	Yes	Exceedance routes are provided
Time taken for 50% of storage to drain down	0.38 hours	





2. Introduction

- 2.1 This Surface Water Drainage Strategy has been prepared by Ambiental Technical Solutions, in respect of a planning application for the development at 46A to 47, Pier Road, Littlehampton, West Sussex, BN17 5LW (X =502780; Y = 101699). Refer to Appendix 1, Plan 1 – Site Location, Plan 2 – Block & Site Location Plan and an extract of the Plan 1 on Figure 1 below.

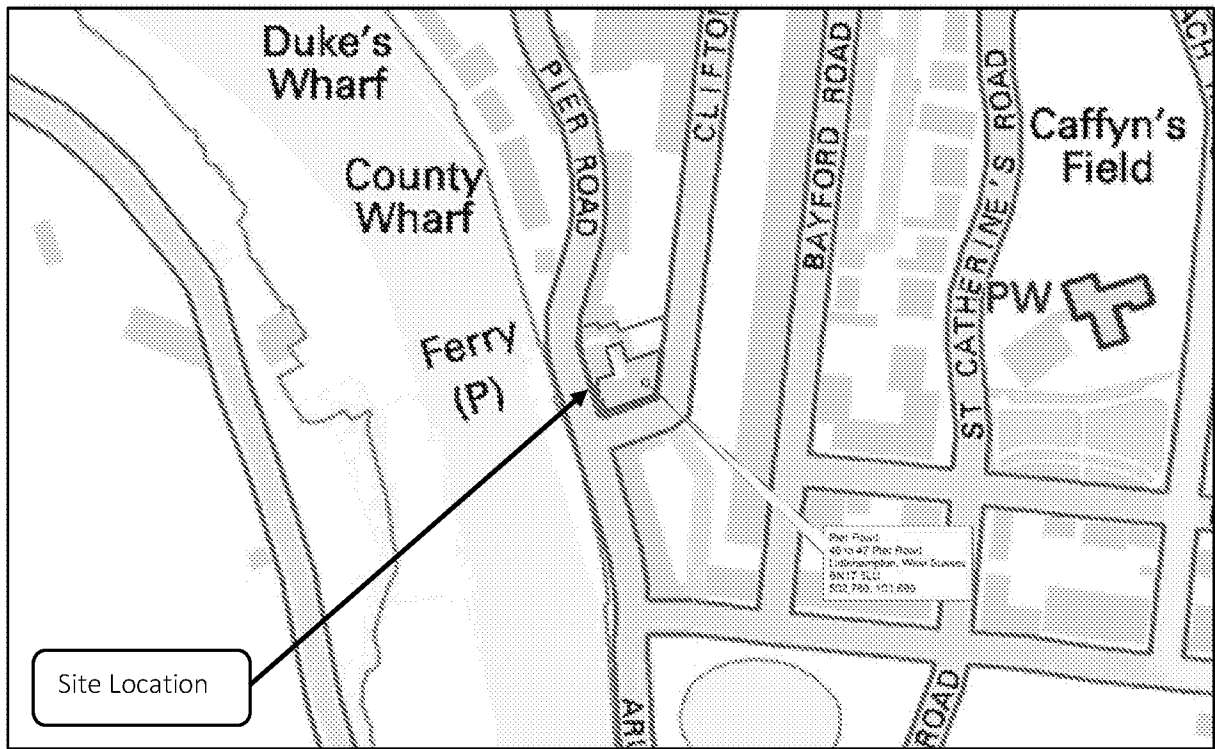


Figure 1 – Extract of Appendix 1, Plan 1 - Site Location (Source: OS-Street View). Site boundary shown in red.

Development Proposal

- 2.2 It is understood that the development is for the demolition of the existing structure on site and construction of a new structure to provide a commercial unit on the ground floor and 8 residential units above.
- 2.3 This study is based on the plans in Appendix 1 (refer to Plans 1 to 20. Plan 1 was made in-house, the plans 1 to 19 were provided by Turner Associates – Architects & Planning Consultants, while the Plan 20 was provided by Southern Water Ltd).

Need for Study

- 2.4 The purpose of this assessment is to demonstrate that the development proposal outlined above can be satisfactorily accommodated without worsening flood risk for the area and without placing the development itself at risk of flooding, as per National guidance provided within the National Planning Policy Framework (NPPF) and following the Supplementary Requirements for Surface Water Drainage Proposals of the Arun District Council.

3. Development Description and Site Area

- 3.1 The site is located at the town of Littlehampton in the Arun District of West Sussex. Specifically, the existing site is to the east of the town's harbour, being bounded by Clifton Road to the east and south, while the Pier Road is to the west. Residential buildings are to the north. Although the boundary of the existing site comprises several types of buildings, only the depot will be redeveloped. Refer to Appendix 1, Plan 1 – Site Location, Plan 2 – Block & Site Location Plan as well as the Figures 1 (above) and 2 (below).

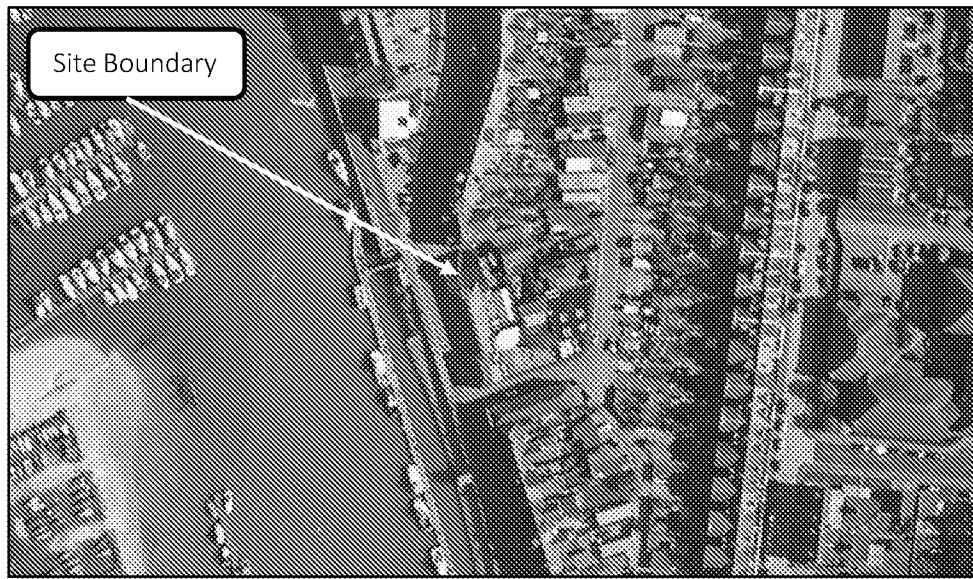


Figure 2 – Aerial View of Development Site (Source: ESRI).

- 3.2 It is understood that the development is for the demolition of the existing structure on site (refer to Appendix 1 – Plans 2, 3, 4 & 5) and construction of a new structure to provide a commercial unit on the ground floor and 8 residential units above as well as car and pedestrian facilities (refer to Appendix 1 - Plans 6 to 19 as well as the Figure 3 overleaf).
- 3.3 As the existing site is already developed, it is considered **brownfield**.
- 3.4 The total area of the site is approximately 609m² (0.06 Ha) based on plans the provided by the client. The whole existing site is considered impervious as all of it is already developed and there is no pervious zones (such as green areas or gardens). Following development, the impervious areas will not be reduced.
- 3.5 The topography of the site ranges from 2.64mAOD¹ to 1.96mAOD. Hence it can be considered that the site slightly slope to the north-east (Clifton Road) with no likelihood of rapid runoff within the property development boundary (Source: LiDAR, 2m resolution).

¹ mAOD: meters Above Ordnance Datum.

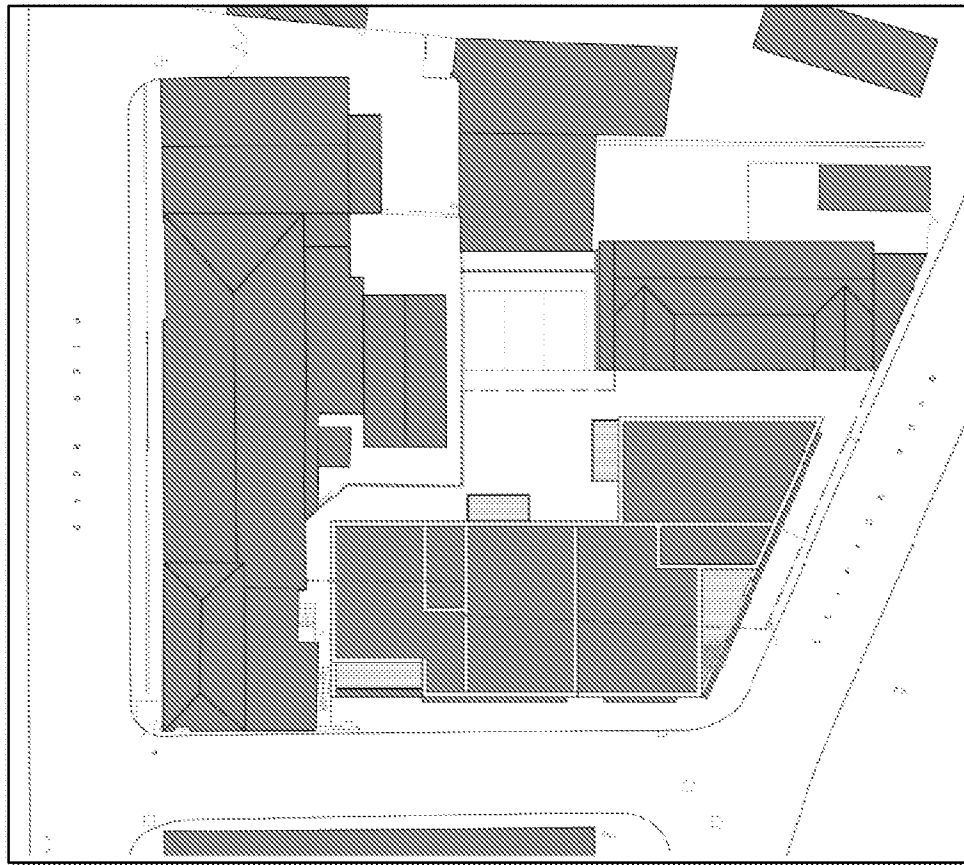


Figure 3 – Extract of the Appendix 1, Plan 6 – Proposed Site Plan

Existing Drainage Infrastructure

- 3.6 No site-based private drainage infrastructure data were provided by the client. A sewer network map of the site was requested (Southern Water). Please see Appendix 1, Plan 20A – Southern Waters Sewer Records Plan and the data tables on the Appendix 1 – Figure 20B – Southern Waters Sewer Records Data Table as well as the Figure 4, overleaf.
- 3.7 Based on the sewer network map of Southern Water, the location of the public surface water drainage infrastructure to the east and to the south of the site is confirmed. Likewise, there is foul water sewer drainage infrastructure located to the east of the site and within it.
- 3.8 Additionally, this map shows that the surface water sewer nodes 7650, 7651 and 7652 as well as the combined sewer node 7601 are near to the site to the south, while the foul water sewer node 771D is within the site.
- 3.9 **Hence, due to the proposed layout of the site it is proposed to discharge, by gravity, foul drainage to the public sewer network. The node 7601 could be utilised as discharge of the foul water. There is a potential utilisation of the public sewer drainage infrastructure to discharge the surface water runoff - Specifically to the node 4651.** See Appendix 1, Plan 20A and the data tables on the Appendix 1 – Figure 20B as well as the Figure 4, overleaf.
- 3.10 **It should be noted the drain from node 771D, if it serves the Victoria Gardens or other 3rd party property, may need to be diverted to facilitate the development.**

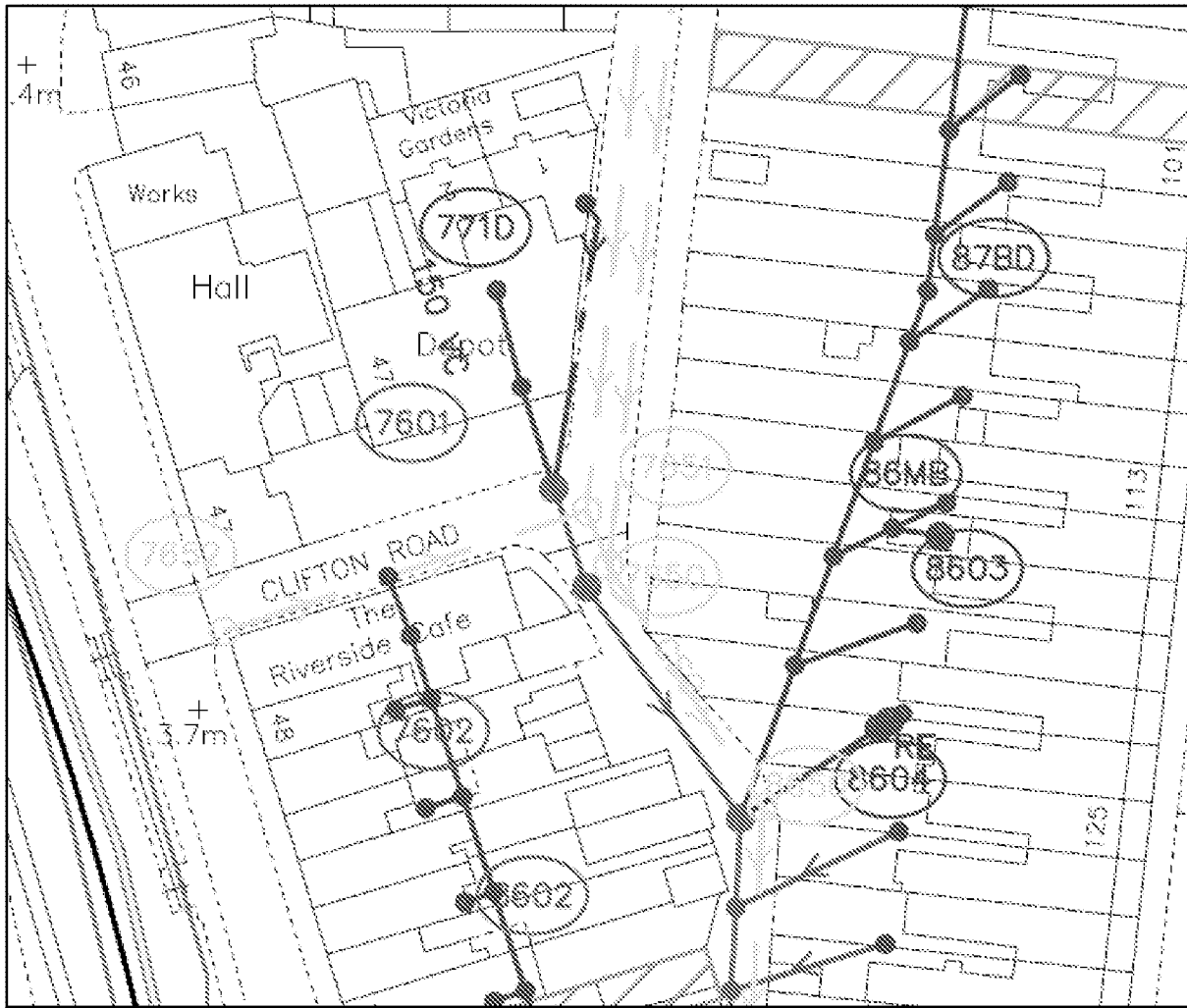


Figure 4 -- Extract of the Appendix 1, Plan 20A -- Southern Waters Sewer Records Plan

Existing Ground Conditions

- 3.11 The British Geological Survey (BGS) Online Map indicates that the bedrock underlying the site is the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation, formed approximately 71 to 94 million years ago in the Cretaceous Period. It was formed in warm chalk seas with little sediment input from land. See an extract from BGS Geology map in Appendix 2, Figure 1 – Bedrock Geology.
- 3.12 The superficial deposits are Raised Beach Deposits, 1 formed by Sand and Gravel up to 3 million years ago in the Quaternary Period. The local environment was previously dominated by shorelines with sediments deposited in beaches and barrier islands. See an extract from BGS Geology map in Appendix 2, Figure 2 – Superficial Deposits.
- 3.13 The Soil Parental Material in the area taken from the UK Soil Observatory (UKSO) website is classified as ‘Quaternary Marine/Estuarine Sand’ while the Soil Texture is Sand to Sandy Loam. See Appendix 2, Figure 3 – Soil Parental Material as well as the Appendix 2, Figure 4 – Soil Texture.

- 3.14 Standard values from the CIRIA 753 'The SUDS Manual' suggest the infiltration coefficient for Sand soils is between 0.036m/h (1×10^{-5} m/s) and 0.18m/h (5×10^{-5} m/s), while the Sandy Loam soils are ranged between 0.00036m/h (1×10^{-7} m/s) and 0.036m/h (1×10^{-5} m/s). Refer to Table 1 – Typical Infiltration Coefficients based on Soil Texture below. It is recommended that these values are checked through trial pit infiltration tests on site prior to the final detailed drainage design being carried out.

SOIL TYPE	Typical Infiltration Coefficients (m/h)		
Good Infiltration media			
Sand	0.036	-	0.18
Sandy Loam	0.00036	-	0.036

Table 1 – Typical Infiltration Coefficients based on Soil Texture

- 3.15 Borehole records were not provided and as such the BGS boreholes data has been taken to be accurate for this site due to the fact that there is a borehole (BGS Reference: TQ00SW269) very close to the site. Refer to Appendix 2, Figure 5.1 – BGS Boreholes Map and borehole data from the Figures 5.2 to 5.9 as well as an extract of this map on the Figure 5 below. According to the data provided by this borehole, the underlying soils are predominantly formed by gravel and sands.

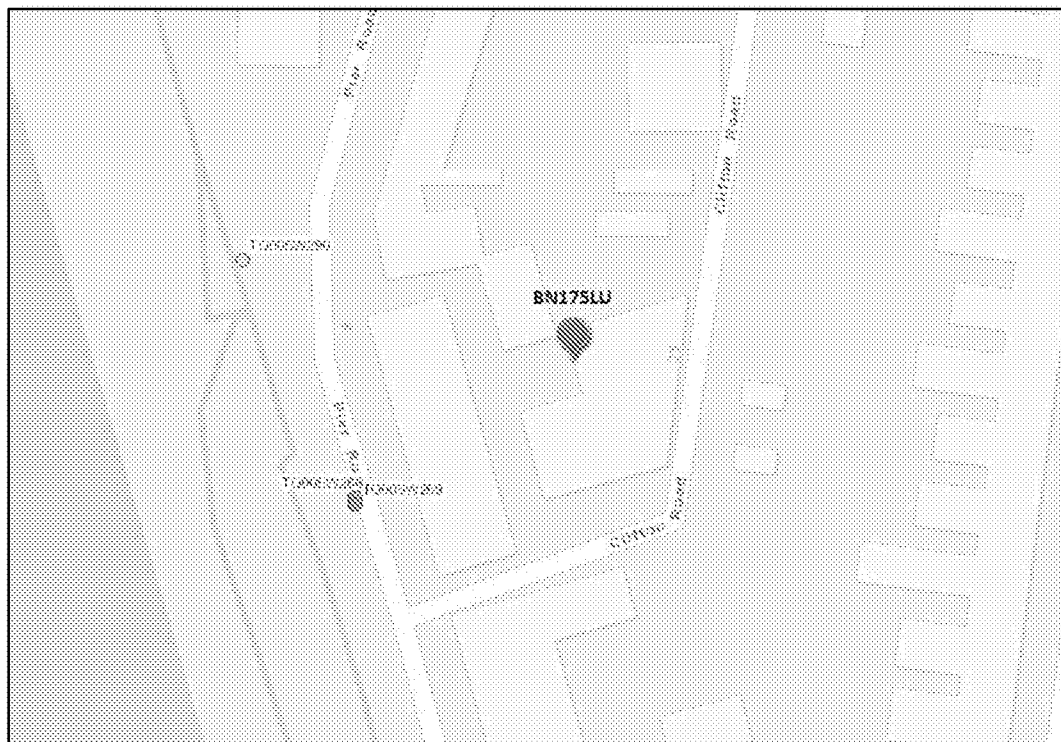


Figure 5 – Extract of Appendix 2, Figure 5.1 BGS Boreholes Map (Source: BGS).

- 3.16 It is recommended that a groundwater level check be undertaken at the later detailed design stage in order to accurately identify the depth of the water table at the site. It is assumed groundwater is likely to be high based on the gravel nature of the sub soil and proximity of the river.

- 3.17 Additionally, it is important to note that the infiltration devices should follow the guidance of the specialized literature, the *CIRIA 753 – ‘The SuDS Manual’*, section 25.2.2:

“Groundwater levels should be investigated to ensure that the base of a proposed infiltration component is at least 1 m above the maximum anticipated groundwater level (taking account of seasonal variations in levels and any underlying trends)”.

- 3.18 Thus, in compliance with the *CIRIA 753 – ‘The SuDS Manual’*, if an infiltration device was proposed, the groundwater table must always be at least 1 m below of the bottom of the device. This measure could be flexible - to fix the bottom of the device just above the groundwater table, under the consent of the corresponding environmental regulator or drainage approval body.
- 3.19 The site lies in within aquifers with significant intergranular flow and considered as a *Highly Productive Aquifer* according to the BGS hydrogeological database (refer to Appendix 2, Figure 6 – Hydrogeology).
- 3.20 The EA’s² Groundwater Source Protection Zone Map confirms that the site does not lie within a Source Protection Zone, and that it does lie within a Groundwater Vulnerability Zone classified as *Major Aquifer High*. See Appendix 2, Figure 7 - Groundwater Source Protection Zones and Figure 8 – Groundwater Vulnerability Zones.

Nearby Watercourses and Drainage

- 3.21 The River Arun, considered as a main river by the EA is located approximately 25m to the west of the red line application boundary. See Figure 6 below.
- 3.22 **Although in close proximity to the River Arun it is not possible to directly discharge to the river. The existing drainage infrastructure can be utilised to provide surface water drainage.**

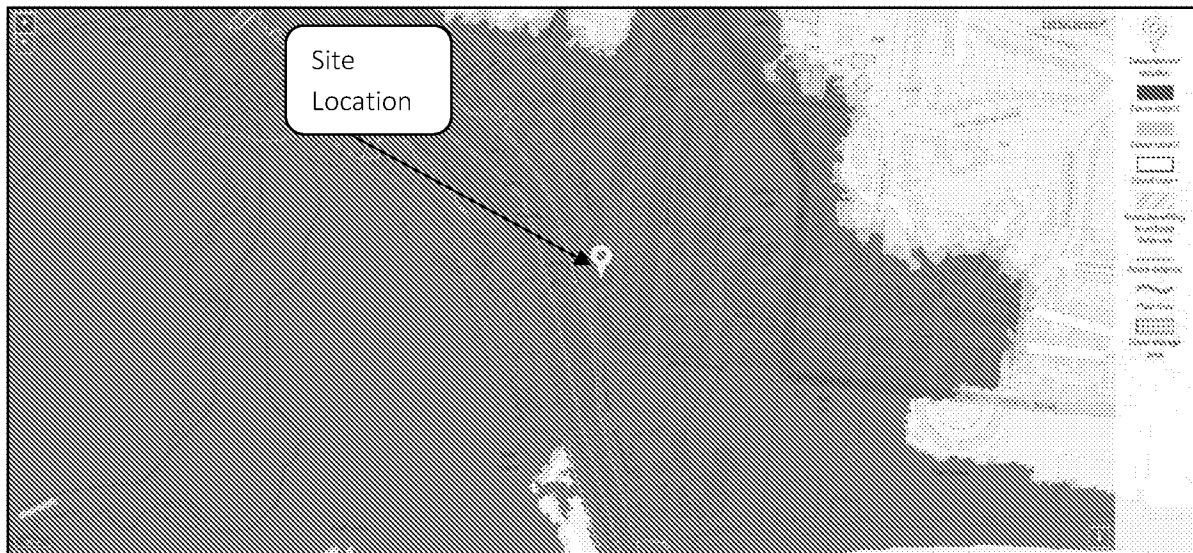


Figure 6 – Extract of EA Flood Map for Planning (Source: EA).

² EA: Environmental Agency

4. Surface Water Drainage

- 4.1 In order to mitigate flood risk posed by the proposed development adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.
- 4.2 The existing site is already developed, being considered brownfield, and it is comprised of impervious surfaces areas; hence it is assumed there should be an existing surface water drainage infrastructure within the site.
- 4.3 In accordance with the proposed development plans, the proposed development will not increase the impermeable surface cover to the site. As such, there will not be an increase of runoff arising from the proposed development.
- 4.4 Nevertheless, the runoff arising from the development will need to be managed according to the National Planning Policy Framework (NPPF) policy which requires SuDS³ to be considered where appropriate for major developments. The inclusion of climate change should be considered for all new development which may result in an increase in runoff over existing.
- 4.5 Additionally, the Supplementary Requirements for Surface Water Drainage Proposals by the Arun District Council (<http://www.arun.gov.uk/surfacewater>) states that any proposed surface water scheme must consider sustainable drainage principles.

Infiltration Potential

- 4.6 British geological survey records indicate the site is predominantly underlain by sand/gravel soils which are may be to be suitable for infiltration drainage.
- 4.7 Notwithstanding the potential suitability of the site soils for infiltration techniques, there are other facts to deal with to consider infiltration devices as appropriate for this site. If any infiltration technique was proposed, it should be in compliance with the *Approved Document H of the Building Regulations, section 3.25* which specifies that infiltration devices should not be built within 5 metres of a building or a road:

“(…)

3.25 Infiltration drainage is not always possible. Infiltration devices should not be built:

- a. within 5m of a building or road or in areas of unstable land (see Planning Policy Guidance Note 14 Annex 1);*
- b. in ground where the water table reaches the bottom of the device at any time of the year;*
- c. sufficiently far from any drainage fields, drainage mounds or other soakaways so that the overall soakage capacity of the ground is not exceeded and the effectiveness of any drainage field ins not impaired (see Approved Document H2);*
- d. where the presence of any contamination in the runoff could result in pollution of a groundwater source or resource.*

(…)”.

³ SuDS: Sustainable Drainage Systems. SuDS mimic natural drainage processes through a series of features that collect and convey water at or near the surface.

- 4.8 Therefore, due to the constraints of the site and the proposed layout development, **it is considered that infiltration devices to manage surface water runoff within the site are not feasible and it is proposed that runoff would be discharged post development via attenuation SuDS.**

Runoff rates

- 4.9 The specialised literature CIRIA 753 'The SUDS Manual' provides two approaches guidance for the rates of discharge in relation to the Long-Term Storage:

➤ Approach A

"Where there is extra volume generated by the development that has to be discharged (because there are no opportunities for it to be infiltrated and/or used on site), this volume should be released at a very low rate (eg < 2 l/s/ha or as agreed with the local drainage approving body and/or environmental regulator) and the 1:100 year greenfield allowable runoff rate reduced to take account of this extra discharge." (Kellagher, 2002).

➤ Approach B

*"An alternative approach to managing the extra runoff volumes from extreme events separately from the main drainage system is to release **all runoff (above the 1 year event)** from the site at a maximum rate of 2 l/s/ha or Q_{BAR} , whichever is the higher value (or as agreed with the drainage approving body and/or environmental regulator). This avoids the need to undertake more detailed calculations and modelling."*

- 4.10 As Infiltration techniques are not viable, it is proposed to discharge all runoff due to any storm events above than 1 in 1 year event at a low rate such as Q_{BAR} or as agreed with the drainage approving body in compliance with the **Approach B** above.
- 4.11 Greenfield runoff rates have been calculated using the *Institute of Hydrology Report 124* (Marshall and Bayliss, 1994), as recommended in the CIRIA 753 'The SUDS Manual' (See calculations in Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary).
- 4.12 The Greenfield runoff rates for the several storm duration for various return periods have been calculated based on the following equation:

$$Q_{BAR_{rural}} = 0.00108 * AREA^{0.89} * SAAR^{1.179} * SOIL^{2.17}$$

Where,

$Q_{BAR_{rural}}$: Mean Annual Flood (m^3/s).

AREA: Catchment Area (km^2).

SAAR: Standard Average Annual Rainfall for the 1941 to 1970 (mm).

SOIL: Soil Index of the catchment from Wallingford Procedure Volume 3.

Equation 1 -- IH 124 Mean Annual flood flow Rate Equation.

- 4.13 Preliminary calculations based on Equation 1 show that the *Greenfield Runoff Rate* ($Q_{BAR,rural}$) from 50Ha is 148.5l/s. According to the size area positively drained (0.06ha), **the Greenfield Runoff Rate from the area of the site is 0.18l/s**. Other results properly factored for each return period and area of the site are shown in Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary.
- 4.14 The Supplementary Requirements for Surface Water Drainage Proposals states in relation to how the discharge to a watercourse or a surface water sewer that:

“Restricted Discharge

Discharge to a watercourse or surface water sewer must be restricted to the estimated mean greenfield runoff rate (Q_{bar}) by means of a controlled outflow (or restricted to existing runoff rates for brownfield sites). This can be derived from IH124 or a similar approved method. Any storage design must be submitted with groundwater monitoring data where applicable to ensure there will be no detrimental effect on the structure or storage. Storage areas are preferred to be in an ‘open’ form such as ponds, rather than underground tanks.”

- 4.15 Therefore, in order to look into the existing runoff rates of the existing site, a storm sewer design simulation has been carried out using the industry standard software, Microdrainage v2017.1. The results for a variety of rainfall events are shown on the Appendix 3 – Calculations, Existing Runoff Rates Simulation and a summary of them on the Table 2 overleaf.
- 4.16 Additionally, it is important to take into consideration the recommendations given by the DEFRA Report ‘*Rainfall runoff management for Developments*’. In accordance to them, the design principle is to limit the runoff for events of similar frequency of occurrence to the same peak rate of run as that which takes place from greenfield sites. However, there are two situations where the greenfield flow rate is not actually applied to define the limiting discharge rates (based on this literature as well):
- a) The limit of discharges based on Q_{BAR} that are less than 1 l/s/ha for permeable sites as this is seen as being an unreasonable requirement (producing very large storage volumes). Q_{BAR} is then set to 1 l/s/ha;
 - b) Small sites would require impractically small controls to achieve the required flow rates where these are calculated to be less than 5 l/s and therefore in this case a minimum flow of 5 l/s is used.
- 4.17 As such, and in order to comply with Approach B outlined in paragraph 4.9 above, a limiting discharge of 5l/s, typically considered as minimum discharge flow rate by the industry standards to avoid blockages, will be taken into account to release all runoff above 1 in 1 year storm event as infiltration devices are dismissed.

- 4.18 Hence, a limiting discharge of 5l/s is proposed as the design runoff rate. See Table 2 – Surface Water Discharge Rates Summary below:

SURFACE WATER DISCHARGE RATES SUMMARY						
	Approximate Impermeable Area (m ²)	Discharge Rates (l/s)				
		Q _{BAR}	1 year	20 years	30 years	100 years
Greenfield Site	0	0.18	0.15	-	0.45	0.58
Existing Site (Using Microdrainage)	609	-	8.3	18.6	20.3	26.2
Reduction to 25% for the Existing Site	609	-	2.1	4.65	5.1	6.55
Limiting Discharge for Proposed Site	609	-	5.0	-	5.0	5.0 < 6.55
Designed Discharge for Proposed Site (from calculations in Appendix D3)	609	-	2.2	-	5.0	5.0

Table 2 – Surface Water Discharge Rates Summary

- 4.19 It can be seen from the Table 2 that the proposed limiting discharge rates are lower than the 25% of the existing runoff rates for the 1 in 100 years rainfall events, improving the existing discharge conditions.

Interception Storage

- 4.20 Preliminary calculations have been carried out for a typical rainfall depth of 5 mm/m² to store the volume owing to these very frequent storms.
- 4.21 Urban Creep Factor (UCF) is defined as any increase in the impervious area that is drained to an existing drainage system without planning permission being required, such as the construction of patios, conservatories, small extensions, etc. An increase in paved surface area of 10% is suggested by the CIRIA 753 'The SUDS Manual', nevertheless is not taken into account as the whole existing and proposed site surface is impervious. A typical *Runoff Percentage* of 80% have been considered.
- 4.22 Based on the size of the whole area of the site, the UCF and the Runoff Percentage, the Interception Storage is 2.44 m³.

Long Term Storage

- 4.23 Long-Term Storage is not taken into account as defined by *Approach B* in Paragraph 4.9.

Attenuation Storage

- 4.24 Attenuation storage is needed to temporarily store water during periods when the runoff rates from the development site exceed the allowable discharge rates from the site.
- 4.25 Rainfall depths for the 1 in 100 years Return Period plus 40% of climate change were produced using the *Microdrainage* software in order to estimate the largest volume, *critical storm*, for typical storm durations up to and including 48 hours for the proposed site limiting the discharge rate up to a rate of 5l/s if necessary. The Urban Creep Factor, 10%, it is not considered in the Site as all of it is impervious. See summary calculations in Appendix 3, Calculations, and Summary of Results.
- 4.26 Thus, it meets with the minimum standards required by the DEFRA - Non-statutory technical standards for sustainable drainage systems (March 2015) to avoid the flood risk within the development in a 1 in 100 year rainfall event.
- 4.27 In terms of storage, for a 100 years storm event with an allowance for climate change, the **largest volume per square metre is 0.0195 m³/m² for the Site. Therefore the Attenuation Storage Volume required is 11.9 m³.** See Appendix 3, Calculations, Summary of Results.

Storage Volumes

- 4.28 Preliminary calculations indicate that approximately 11.9m³ of storage will be required to attenuate all runoff above the 1:1 year storm events. 2.4m³ of storage are required for the day-to-day rainfall as Interception Volume. Long-Term Storage Volume (6 hours, 100 year Return Period event) is not taken into account.
- 4.29 **Thus a Total Storage of 14.3m³ is required to be managed through SuDS techniques.**

5. SuDS Assessment

- 5.1 In accordance with a SuDS management train approach, the use of various SuDS measures to reduce and control surface water flows have been considered in details for the development. Based on the hierarchy line of discharge provided by the specialized literature *CIRIA 753 'The SUDS Manual'*, Section 3.2.3 and the Supplementary Requirements for Surface Water Drainage Proposals of the Arun District Council:

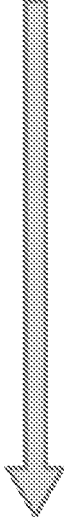
SuDS Drainage Hierarchy			
		Suitability	Comment
	1. Infiltration (discharge into the ground)	✗	Due to the geology at the site, infiltration is suitable for infiltration however it is not viable due to the layout constraints of the Site.
	2. Controlled discharge to a surface water body	✗	Complex drainage infrastructure for this purpose.
	3. Controlled discharge to surface water sewer, Highway Drain or another Drainage System	✓	Discharge would be to the existing public sewer.
	4. Discharge to Combined Sewer	-	
	5. Discharge to a foul sewer (should not be considered as a possible option)	-	

Table 3 – SuDS Drainage Hierarchy

5.2 At this stage the practicality and viability of certain SuDS options have been ruled out on the basis of ground conditions and constraints presented by the site layout:

Suitability of SuDS Components		
SuDS Component	Description	Suitability
Infiltrating SuDS	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The suitability and infiltration rate depends on the permeability of the surrounding soils	×
Permeable Pavement	Pervious surfaces can be used in combination with aggregate sub-base and/or geocellular/modular storage to attenuate and/or infiltrate runoff from surrounding surfaces and roofs. Liners can be used where ground conditions are not suitable for infiltration	✓
Green Roofs	Green Roofs provide areas of visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. They are generally more costly to install and maintain than conventional roofs but can provide many long-term benefits and reduce the on-site storage volumes	✓
Rainwater Harvesting	Rainwater Harvesting is the collection of rainwater runoff for use. It can be collected from roofs or other impermeable area, stored, treated (where required) and then used as a supply of water for domestic, commercial and industrial properties. Not appropriate for the proposed development.	×
Swales	Swales are designed to convey, treat and attenuate surface water runoff and provide aesthetic and biodiversity benefits. They can replace conventional pipework as a means of conveying runoff, however space constraints of some sites can make it difficult incorporating them into the design	×
Rills and Channels	Rills and Channels keep runoff on the surface and convey runoff along the surface to downstream SuDS components. They can be incorporated into the design to provide a visually appealing method of conveyance, but they are dismissed due to the constraints of the proposed layout.	✓
Bioretention Systems	Bioretention systems can reduce runoff rates and volumes and treat pollution through the use of engineer soils and vegetation. They are particularly effective in delivering interception, but can also be an attractive landscape feature whilst providing habitat and biodiversity. However, they are dismissed due to the proposed layout constraints.	×
Retention Ponds and Wetlands	Ponds and Wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water runoff. They enhance treatment processes and have great amenity and biodiversity benefits. Often a flow control system at the outfall controls the rates of discharge for a range of water levels during storm events. Nevertheless, they are dismissed as they are recommended to manage high volumes runoff due to large developments such as a neighbourhood.	×
Detention Basins	Detention Basins are landscaped depressions that are usually dry except during and immediately following storm events, and can be used as a recreational or other amenity facility. They generally appropriate to manage high volumes of surface water from larger sites such as a neighbourhood.	×
Geocellular Systems	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. The inherent flexibility in size and shape means they can be tailored to suit the specific characteristics and requirements of any site	×
Proprietary Treatment Systems	Proprietary treatment systems are manufactured products that remove specific pollutants from surface water runoff. They are especially useful where site constraints preclude the use of other methods and can be useful in reducing the maintenance requirements of downstream SuDS	×
Filter Drains and Filter Strips	Filter drains are shallow trenches filled with stone, gravel that create temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. Filter strips are uniformly graded and gently sloping strips of grass or dense vegetation, designed to treat runoff from adjacent impermeable areas by promoting sedimentation, filtration and infiltration	×

Table 4 – Suitability of SuDS Components

- 5.3 Consequently, given the nature of the proposed development, including the provision of hardstanding areas to be used as car park and access areas and the proposed development layout with roof top patios, a SuDS train management using infiltration devices composed by **Green Roofs**, **Permeable Paving** (without infiltration, Type C) and **Rills/Channels** is deemed appropriate. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.
- 5.4 The combined action of the Permeable Pavement and the Green Roof will be able to manage the Interception Volume as well as the surface water runoff due to a 1 in 100 years storm event with a 40% climate change allowance.
- 5.5 Green Roofs are divided into two categories:
- Extensive, with low substrate depth, simple planting and low maintenance requirement, are normally set up at non-accessible roofs.

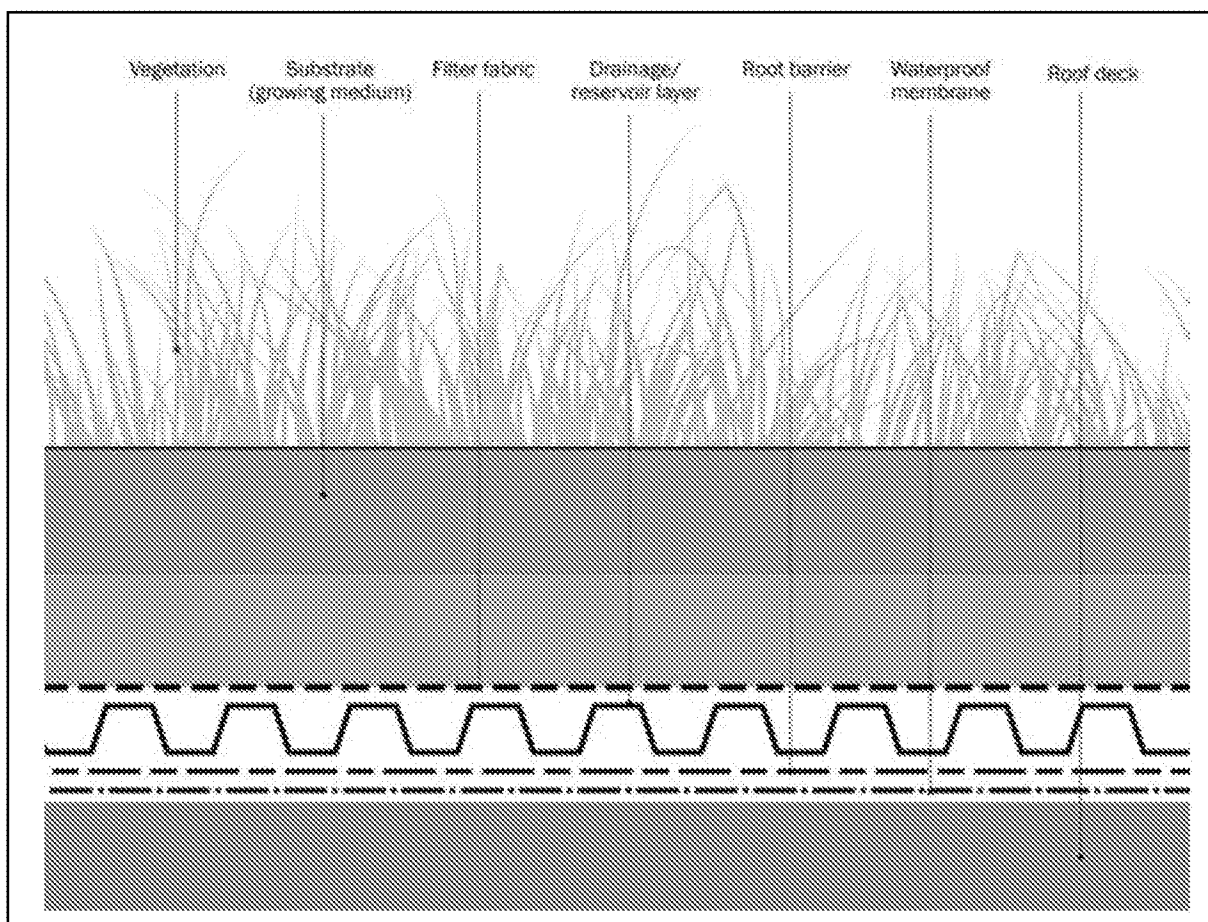


Figure 7 – Section showing typical extensive green roof components (Source: CIRIA 753 'The SuDS Manual').

- Intensive, also named as 'Roof Gardens', have higher substrate depth, being higher the loading on the structure building. They are usually set up on accessible roofs as the maintenance is higher.
- 5.6 Design and best choice for the proposed development should be stated in a later detailed design by a specialist consultant on this matter and provide guidance about proper use and maintenance.

5.7 The Permeable Paving will be Type C (No infiltration), with Geotextile to retain pollutants. It would be formed by 3 layers:

- Permeable Concrete blocks at the top;
- Laying Course Material;
- Sub-Base: Clean Stone (Depth = 450mm. A typical porosity of 0.3 has been taken into account);
- Filter and separation membrane.

Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout and Plan 2 – Preliminary Permeable Pavement / Flow Control Drainage Details.

5.8 Sediment Traps should be installed on the storm drainage pipework at incoming connections to SuDS features to reduce the incidence of blockage. It is proposed to be laid external hard landscaping such that the arising runoff from hardstanding areas can be collected and managed by the proposed SuDS train. Other options such as Rills/Channels is deemed appropriate as well for this purpose.

5.9 Guidance about proper use, installation and maintenance of any proprietary system must be provided by the supplier and incorporated into the site proposals at the later detailed design stage.

6. Drainage Strategy

6.1 Following the hierarchy line provided by the *CIRIA 753 'The SUDS Manual'* and the Supplementary Requirements for Surface Water Drainage Proposals, it is proposed to discharge the post-development surface water runoff to the existing public sewer network.

6.2 A Surface Water Capacity check has been carried by the local water company, Southern Water (see Appendix 5 – Information, Southern Water Ltd Information). A review confirmed that there is adequate capacity to discharge to the manhole reference TA020107651 (**node 7651**), as suggested at the paragraph 3.9, **as long as** the discharge is reduced and limited to 5 l/s, as proposed in the paragraph 4.18. See emailing contact to Southern Water on Appendix 5 – information, Southern Water Ltd Information.

6.3 The proposed storm water management regime for the site is to store runoff in Permeable Paving located on the car/pedestrian accesses/facilities. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout and Plan 2 – Preliminary Permeable Pavement / Flow Control Drainage Details.

Interception Volume

- 6.4 It is proposed to contain rainwater from the roofs due to the day-to-day storms (Interception Volume) through the proposed Green Roofs and Permeable Pavement. See a conceptual design of an extensive green roof on the Figure 7.
- 6.5 This daily runoff arising would be infiltrated to the drainage/reservoir layer of the Green Roof to be gradually discharged through down pipes to the sub-base of the Permeable Pavement located on the car park area. It is important to note that Debris/Sediment Traps must be installed at the outfalls pipes from the Green Roofs to the down pipes in order to avoid any blockage. While the runoff from the Permeable Pavement of the pedestrian/car facilities would be infiltrated through the block paving to the sub-base. Likewise, SuDS such as Rills/Channel could collect runoff from the ground floor hardstanding surfaces where Permeable Pavement cannot be installed to convey it to the sub-base of the Permeable Pavement.
- 6.6 This daily water runoff would be stored at the drainage/reservoir layer of the Green Roof to be evapotranspired, while if there was any day-to-day water runoff exceedance, it would be conveyed to the sub-base of the Permeable Pavement. Runoff infiltrated and stored in the sub-base of the Permeable Pavement would be gradually discharged to the public sewer network being throttled up to 5l/s by flow controls such as Hydrobrakes. See scheme on Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout and Plan 2 – Preliminary Permeable Pavement / Flow Control Drainage Details.

Attenuation Volume

- 6.7 In relation to the arising runoff due to a 1 in 100 years + climate change storm event (Attenuation Volume), the Permeable Pavement would be able to manage the surface water from the roofs and the car/pedestrian accesses/facilities.
- 6.8 Volume of water runoff that exceeds the capacity of storage of the Green Roof would be discharged to the sub-base of the Permeable Pavement where it would be properly managed.
- 6.9 The total Attenuation Volume would be properly stored in the sub-base of the Permeable Pavement to be discharged to the local public sewer network, being throttled by flow controls such as Hydrobrakes up to a limiting discharge rate of 5l/s. Refer to Appendix 4 – Plans 1 & 2.
- 6.10 The plan area of the proposed Permeable Pavement for this option is approximately 150m². Preliminary calculations show that the storage capacity of a typical Permeable Pavement (depth=0.45m; Porosity=0.3) is approximately 20.25m³ which is higher than the total required volume, 14.3m³. See Appendix 3, Calculations, Summary of Results.
- 6.11 In the case of a rainfall event that exceeds the storage capacity of these SuDS techniques, overland conveyance routes should be established that direct water away from property to landscaped areas or off site. Design of external ground levels will need to be undertaken at detailed design stage to finalise these routes but some indicative flow paths have been indicated on the outline strategy drawings. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

- 6.12 It may be necessary to update or alter the drainage strategy at detailed design stage following confirmation of site constraints or alterations to the overall layout. Calculations for, and the design of the SuDS devices, should be reviewed at detailed design stage to ensure a robust drainage strategy is maintained.

Design Exceedance

- 6.13 In the event of drainage system failure under extreme rainfall events or blockage, flooding may occur within the site. In the event of the development's drainage system failure, the runoff flow will be dictated by topography on site. This will not impact on the site or nearby dwellings.
- 6.14 It is advised that the finished floor level of the proposed building should be 300mm above surrounding finished ground levels to mitigate against any potential surface water flows. Refer to plans on Appendix 4, Plan 1 - Preliminary Surface Water Drainage Strategy Layout.
- 6.15 External ground levels should be designed to convey water away from thresholds and property where feasible to be directed down the site access.

Water Quality

- 6.16 Adequate treatment must be delivered to the water runoff to remove pollutants through SuDS devices which are able to provide pollution mitigation. Pollution Hazards and the SuDS Mitigation have been indexed in the specialized literature *CIRIA 753 'The SuDS Manual'*. This is determined by the following restriction:

$$\text{Total SuDS Mitigation Index} \geq \text{Pollution Hazard Index}$$

- 6.17 The Pollution Hazard Indices are summarized in Table 5 – Summary of Pollution Hazard Indices for different Land Use below:

POLLUTION HAZARD INDICES FOR DIFFERENT LAND USE CLASSIFICATIONS				
LAND USE	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

Table 5 – Summary of Pollution Hazard Indices for different Land Use.

- 6.18 Runoff from roof areas is considered to be uncontaminated, being treated by Sediments Traps and through the proposed Permeable Pavement. While any potential pollutant due to the vehicles would be mitigated by the proposed Permeable Pavement.

6.19 The Mitigation Indices of the proposed SuDS techniques are summarized in the Table 6 – Indicative SuDS Mitigation Indices below:

INDICATIVE SuDS MITIGATION INDICES FOR DISCHARGES TO SURFACE WATER			
SuDS Component	Total suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7

Table 6 – Indicative SuDS Mitigation Indices

6.20 Table 7 – Pollution Treatment below, summarizes the water treatment:

POLLUTION HAZARD TREATMENT					
LAND USE	Treatment	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Roofs	Permeable Pavement	Very Low	0.7 > 0.2	0.6 > 0.2	0.7 > 0.05
Car Facilities / Accesses	Permeable Pavement	Low	0.7 > 0.5	0.6 > 0.4	0.7 > 0.4

Table 7 – Pollution Treatment

6.21 Thus, the water treatment provided by any of these SuDS trains would be enough to remove the pollutants.

Adoption and Maintenance

All onsite SuDS and drainage systems will be privately maintained. A long term maintenance regime should be agreed with the site owners before adoption. In addition to a long term maintenance regime it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction.

Proposed Schedule of Maintenance for Below Ground Drainage				
Item	Visual Inspection	Cleanse / De-sludge	CCTV Survey	Comments
Surface Water Drainage System (pipework, chambers etc.)	5 years	10 years	10 years	Cleansing to be carried as necessary
Gullies/Channels	1 year	1 year	N/A	Cleansing to be carried as necessary
Permeable Block Paving	1 year	'Swept' clean of debris every 2 years.	N/A	Lift blocks and remove sand bedding and replace and re-bed paving – refer to individual manufacturers recommendations.

Table 8 – Proposed Schedule of Maintenance for Below Ground Drainage

7. Foul Water Drainage Strategy

- 7.1 Public sewer records obtained from Southern Water Services Ltd. indicate foul water sewers are present in the immediate vicinity of the site. The nearest public foul water sewers are indicated to be within the site. Refer to Appendix 1 – Plan 4A and Figure 4B.
- 7.2 Foul water from the proposed development will be discharged to the existing public foul water sewerage system. The point of connection to the existing sewerage system has not yet been determined. However, given the adequate location of the Node 771D, this would be the best point of connection. Preliminary calculations show that the discharge would be 0.127 l/s.
- 7.3 A pre-development capacity check has been submitted to Southern Water to identify whether capacity exists within the existing public sewer system to accommodate the additional flow generated by the development without compromising existing levels of service. Should Southern Water hydraulic sewer models identify capacity issues within the public sewer network, then Southern Water may require developer-funded offsite improvement works.
- 7.4 A Foul Water Capacity Check carried out by Southern Water confirmed that there is adequate capacity in the local sewerage network to accommodate a foul flow for the proposed development at the manhole reference TQ0201**7601 (Node 7601)**, to the south and very close of the proposed manhole on paragraph 7.2 (Node 771D). Refer to Appendix 1, Plan 20A and the data tables on the Appendix 1 – Figure 20B as well as the Appendix 5 – Information, Southern Water Ltd information.

8. Conclusions

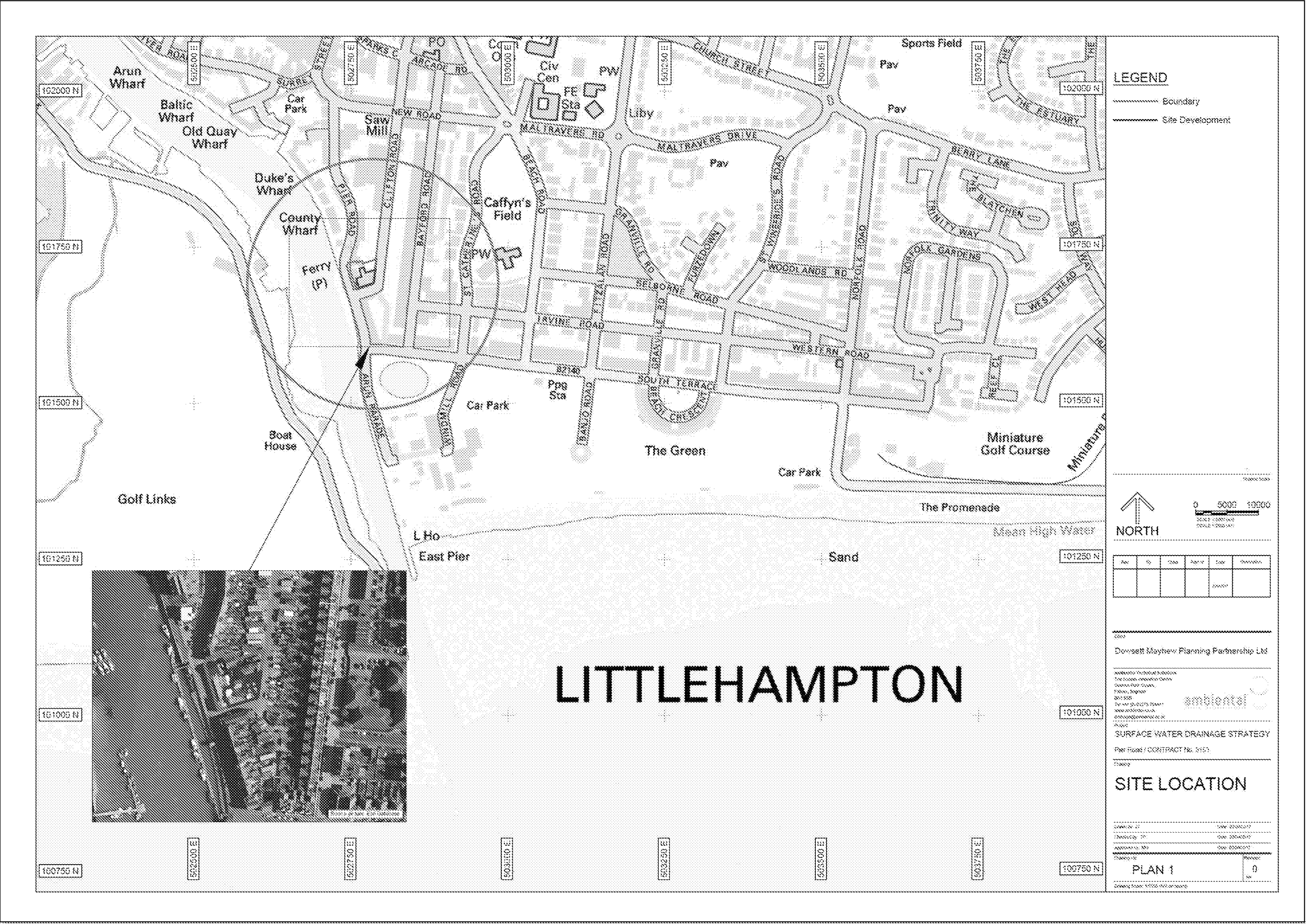
- 8.1 This study has been undertaken in accordance with the principles set out in NPPF. We can conclude that providing the development adheres to the conditions advised in the conclusions of this report, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set by Central Government, the EA and the Arun District Council.
- 8.2 The surface water drainage strategy for the proposed development is to discharge to the public sewer network with the use of SuDS devices such as **Green Roofs, Permeable Pavement** and **Rills/Channels** with managed offsite flows controlled by **hydrobrakes**, or similar flow control, as necessary, up to a **maximum rate given by 5l/s**.
- 8.3 The Treatment train provided by the combined action of Green Roofs, Permeable Pavement and Debris/Sediment Traps is suitable to offer acceptable contamination treatment to runoff prior to being discharged to the local public sewer network.
- 8.4 Foul runoff from the proposed development will be discharged to the existing public foul water sewerage system. A Foul Water Capacity Check carried out by Southern Water confirmed that there is adequate capacity in the local sewerage network to accommodate a foul flow for the proposed development at the manhole reference TQ0201**7601 (Node 7601)**. Preliminary calculations show that a foul runoff discharge of 0.127 l/s would be adequate.
- 8.5 The findings and recommendations of this report are for the use of the client who commissioned the assessment, and no responsibility or liability can be accepted for the use of the report or its findings by any other person or for any other purpose.

Dr. J. B. Butler
B.Sc., M.Phil., PhD.
Ambiental Technical Solutions Ltd.

August 2017

Appendix 1 – Plans

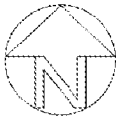
- ✧ *Plan 1 – Site Location*
- ✧ *Plan 2 – Block & Site Location Plan*
- ✧ *Plan 3 – Existing Survey*
- ✧ *Plan 4A – Existing Street Scenes*
- ✧ *Plan 4B – Existing Street Scenes*
- ✧ *Plan 4C – Existing Street Scenes*
- ✧ *Plan 5 – Existing Ground Floor / First Floor Plans*
- ✧ *Plan 6 – Proposed Site Plan*
- ✧ *Plan 7 – Proposed Ground Floor Plan*
- ✧ *Plan 8 – Proposed First Floor Plan*
- ✧ *Plan 9 – Proposed Second Floor Plan*
- ✧ *Plan 10 – Proposed Front / South Elevation*
- ✧ *Plan 11 – Proposed Side / East Elevation*
- ✧ *Plan 12 – Proposed Rear / North Elevation*
- ✧ *Plan 13 – Proposed Side / West Elevation*
- ✧ *Plan 14 – Proposed Side / West Elevation*
- ✧ *Plan 15 – Proposed Front / South Elevation*
- ✧ *Plan 16 – Proposed Side / East Elevation*
- ✧ *Plan 17 – Proposed Rear / North Elevation*
- ✧ *Plan 18 – Proposed Side / West Elevation*
- ✧ *Plan 19 – Proposed Side / West Elevation*
- ✧ *Plan 20A – Southern Waters Sewer Records Plan*
- ✧ *Figure 20B – Southern Waters Sewer Records Data Table*



Appendix 1, Plan 1 – Site Location



Existing site location plan
Scale 1:1250 @A3



Planning issue

B 170517 Minor amendment
A 280417 Boundary lines amended

rev.	date

These drawings should be approved by local authority.
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client Emsdale Residential Limited

project 46A - 47 Pier Road
Littlehampton, BN17 5LW

drawing Block & site location plans

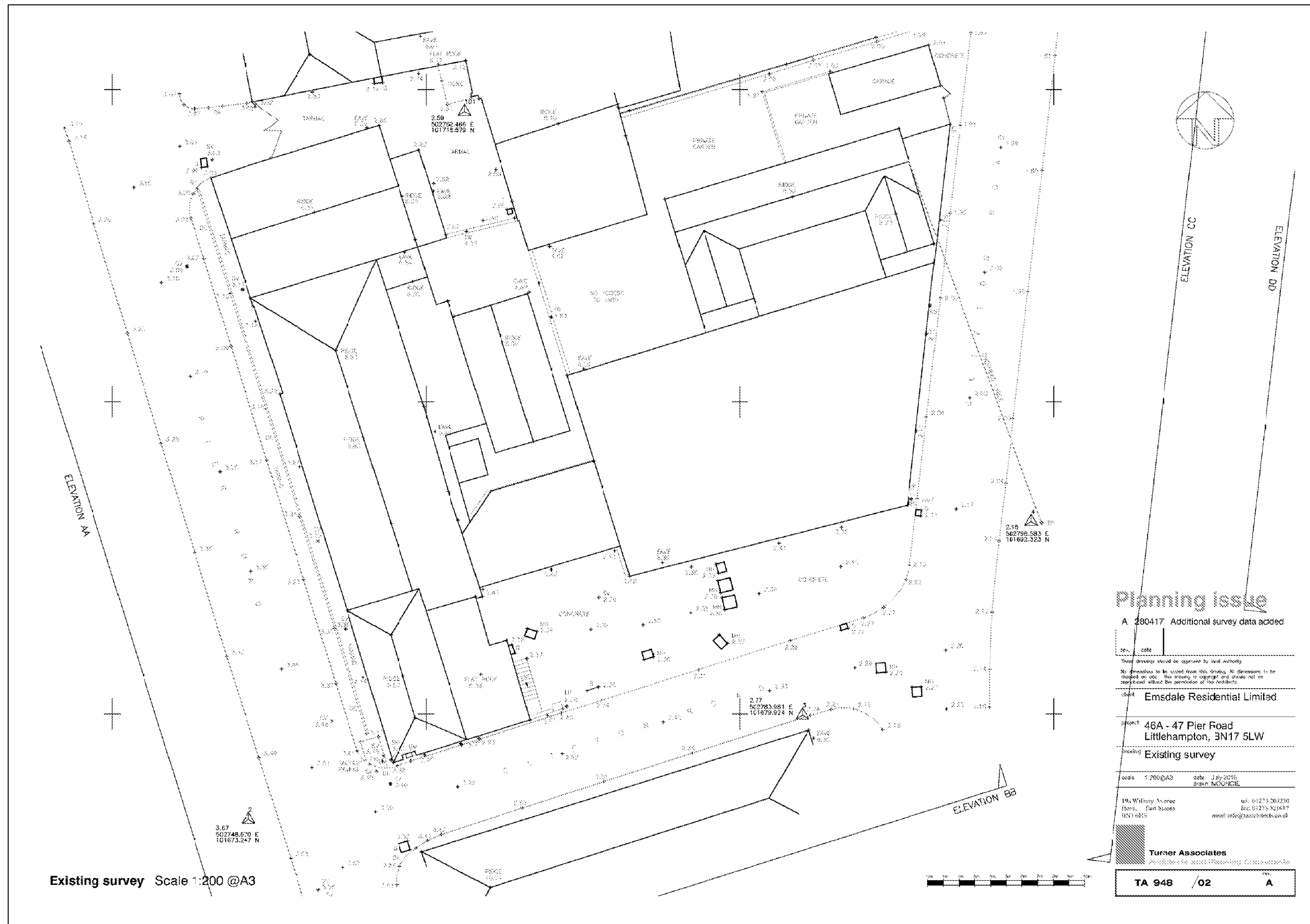
scale Shown @A3 date July 2016
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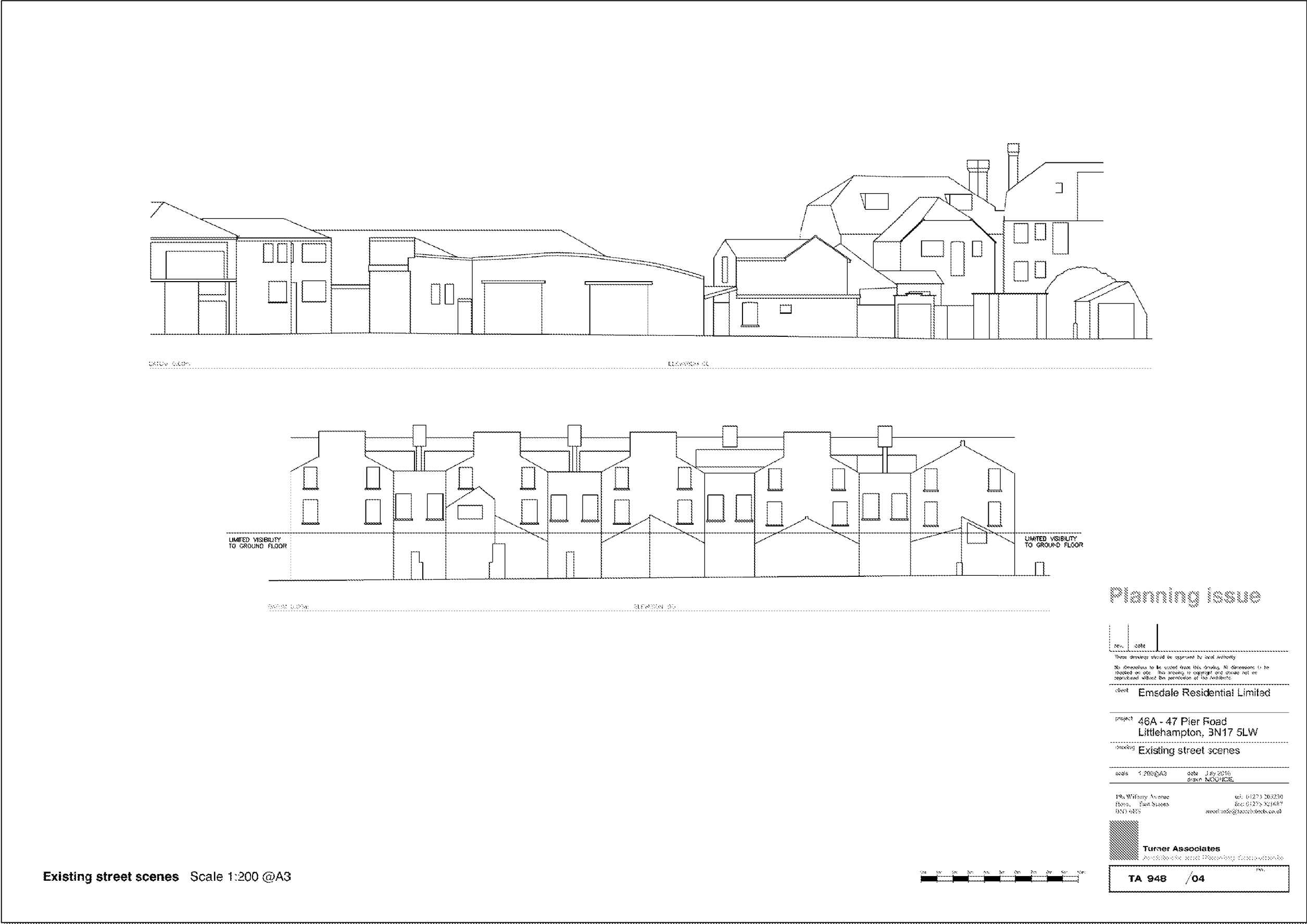
Appendix 1, Plan 2 – Block & Site Location Plan



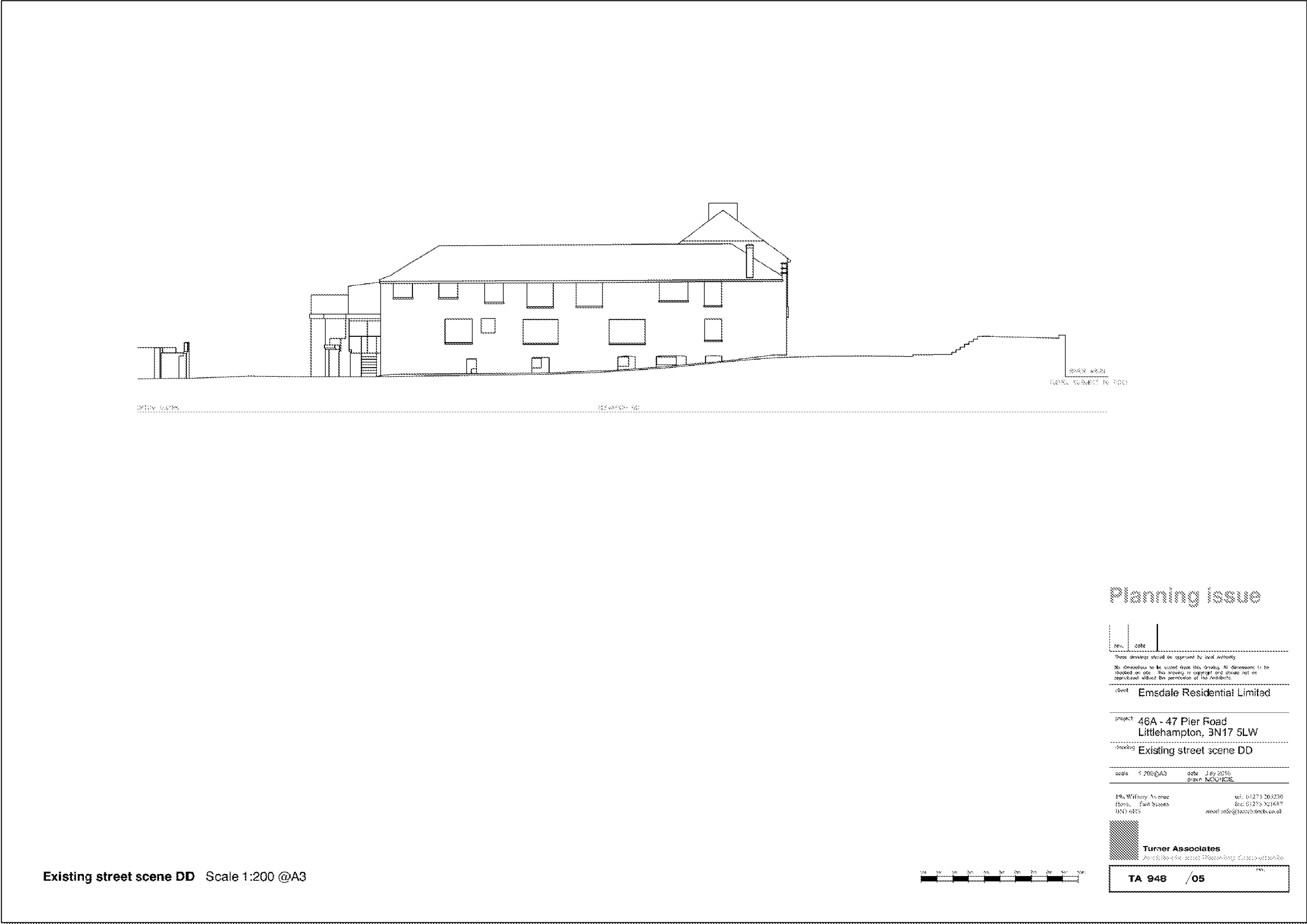
Appendix 1, Plan 3 – Existing Survey



Appendix 1, Plan 4A -- Existing Street Scenes



Appendix 1, Plan 4B -- Existing Street Scenes



Appendix 1, Plan 4C – Existing Street Scenes