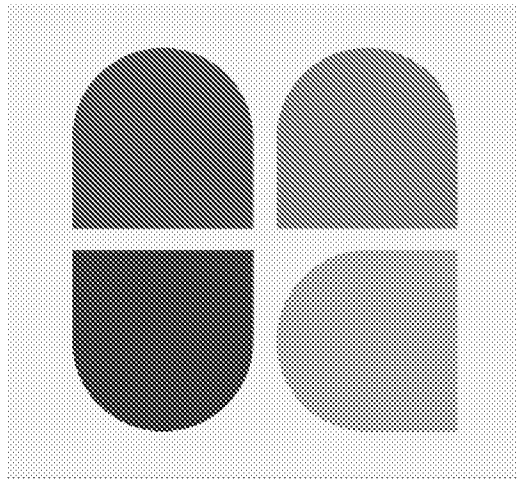




BRIGHT PLAN CIVILS

**WATERLOO SQUARE, BOGNOR REGIS
PO21 1SU**

**PROPOSED MIXED RESIDENTIAL
DEVELOPMENT**

Flood Risk Assessment & Conceptual
Drainage Strategy

Prepared on Behalf of

B5 Ltd

BROK/19/D1832/FRA1.0

13 December 2019

DOCUMENT CONTROL

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Proposed Mixed Residential Development

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1 INTRODUCTION

1.1 Background

- 1.1.1 RGP Design Ltd is instructed by B5 Ltd to prepare a Flood Risk Assessment & Conceptual Drainage Strategy to support a planning application for a Proposed Mixed Residential Development at Waterloo Square, Bognor Regis PO21 1SU.
- 1.1.2 This FRA has been undertaken in accordance with Planning Practice Guidance: Flood Risk and Coastal Change and National Planning Policy Framework Section 14.
- 1.1.3 The proposed development will involve the redevelopment of the former Beach Hotel, former Mud Club & 2-4 Waterloo Square properties into basement level parking, 2 No. commercial units (A3 Restaurant & Cafe) at ground floor level and 49 No. apartments at upper floors - as demonstrated within the preliminary site layout, contained within **Appendix A** of this report.
- 1.1.4 In preparing this report, RGP has referred to the following documents and information:
- Environment Agency Flood Maps for Planning
 - Long Term Flood Risk Information; Flood Risk Maps
 - Local Authorities Strategic Flood Risk Assessment
 - Southern Water and Local Authority Drainage Records
 - Site-specific Environmental Investigation Report
 - British Geological Survey & Records
- 1.1.5 This document has been prepared to assess if the proposed development is suitable for the site and confirms if mitigation is required to ensure that flood risk is not increased, and that the proposed development remains safe during its design life.
- 1.1.6 This report has been prepared for the benefit of the named Client only.

1.2 Site Location and Description

- 1.2.1 The property is in a suburban area of Bognor Regis, a seaside town in West Sussex.
- 1.2.2 The property is bounded by Waterloo Square and a park area to the west, The Esplanade and a shingle beach to the south, Norfolk Street and a number of shops and residential properties to the east and a number of dilapidated buildings to the north.
- 1.2.3 A topographical survey of the site has been undertaken and provided by the client. It is included in **Appendix B** of this report.
- 1.2.4 The topographical survey shows that the site is typically at 5.7m to 6.0m AOD, and consists of buildings and remnants of demolished buildings. The land around the site falls towards the carriageway to the west, south and east with levels at typically 5.5m to 5.7m AOD. Along The Esplanade to the south, the land falls southerly towards the beach, with a low point of approximately 5.3m AOD. There is however a slight rise opposite the carriageway although the height of defence from the sea is not confirmed by the topographic survey – as detailed in Drawing **PL100**.

- 1.2.5 The site is presumed to utilise existing connections to the public foul and surface water sewers running adjacent to the site. The carriageways around the site appear to drain largely by surface runoff to the highway gullies, however connection route is not confirmed by the public sewer records.
- 1.2.6 The nearest watercourse is the Aldingbourne Rife, which is a main river approximately 1.3km northeast of the site, where it discharges into the sea.
- 1.2.7 The site is also approximately 55 metres north of the mean high water line for the sea along the shingle frontage to the English Channel of Bognor Regis.
- 1.2.8 The site has a total area of approximately 1,097m² (0.110 Ha), with the entire existing site being impermeable as it is occupied either by existing building or former building foundations – as seen in Drawing **PL200**.

1.3 Ground Conditions

- 1.3.1 In the absence of a site-specific geotechnical investigation, reference has been made to the British Geological Survey (BGS) website.
- 1.3.2 The BGS geology viewer states that the bedrock geology is likely to consist of 'London Clay Formation – Clay, Silt and Sand', as seen in **Figure 1**.

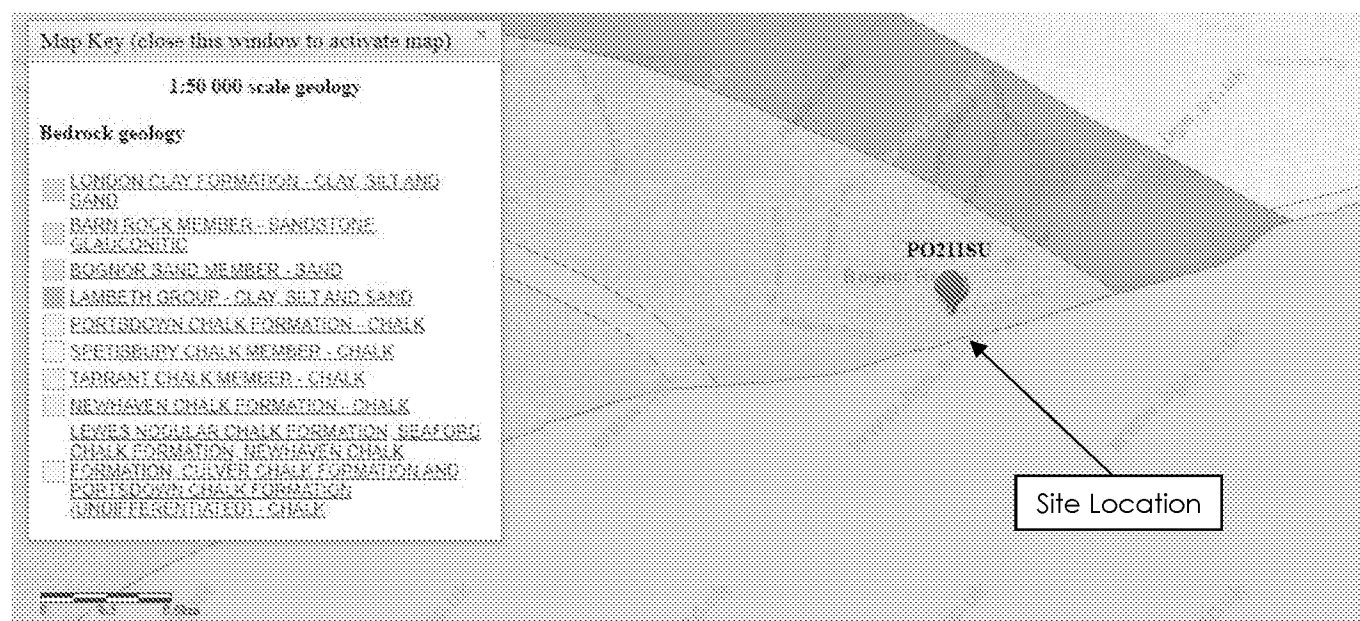


Figure 1. BGS website Bedrock geology

- 1.3.3 Superficial Deposits recorded at the site consist of 'River Terrace Deposits (undifferentiated) - Sand, Silt and Clay', as seen in **Figure 2**.

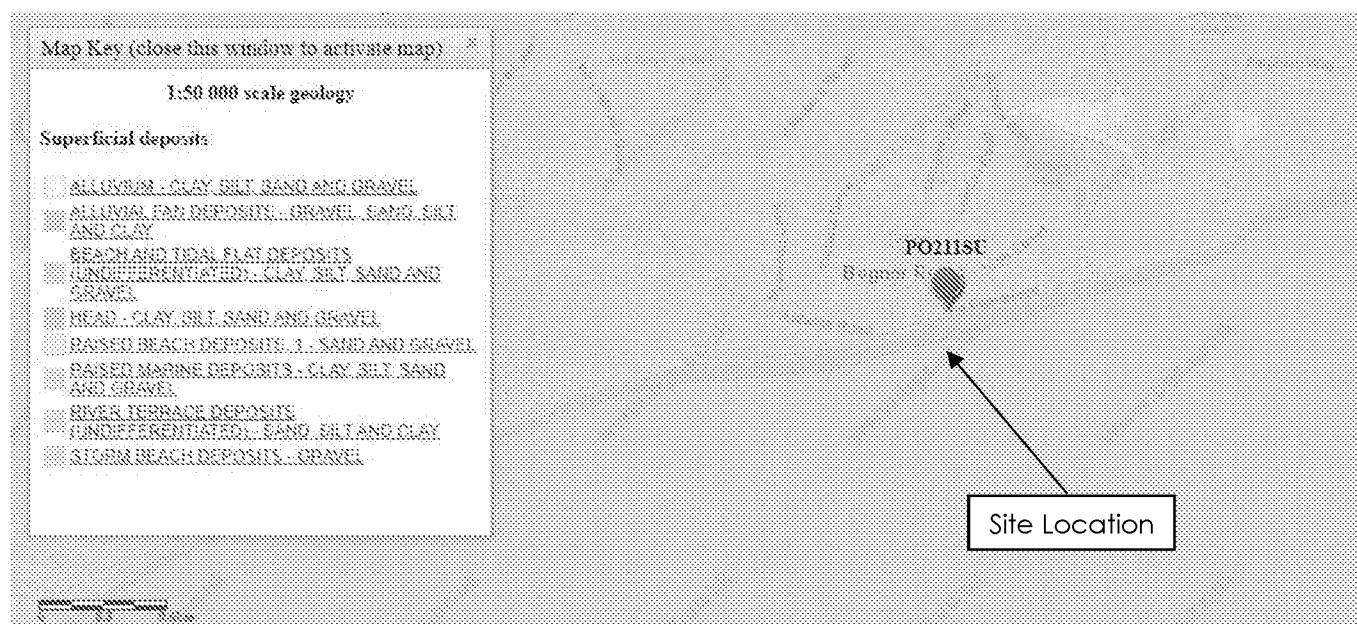


Figure 2. BGS website superficial deposits

- 1.3.4 Historic borehole records from the Single Onshore Boreholes Index (SOBI) on the BGS website have also been reviewed in the absence of a site-specific geotechnical investigation, as depicted in **Figure 3**.

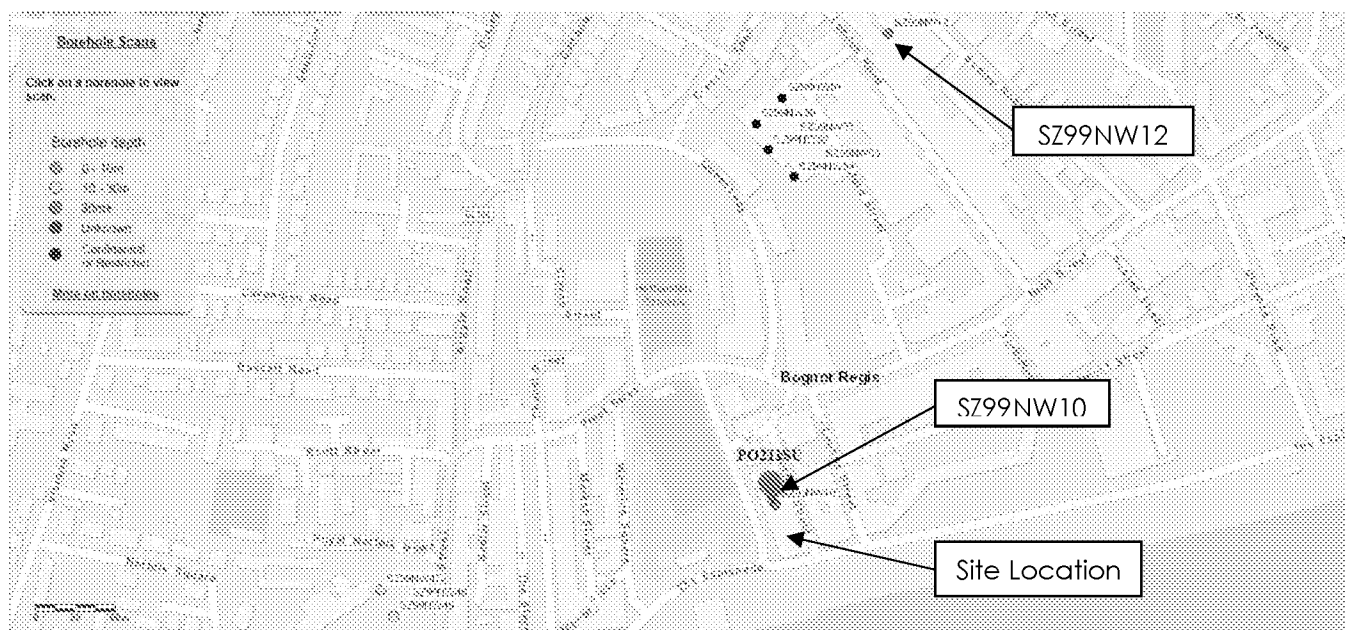


Figure 3. BGS website borehole locations

- 1.3.5 The borehole at Waterloo Square, just north of the site, is recorded as dug well to a depth of 5.2 metres below ground level (mbgl), before London Clay (blue clay) to a depth of 14.6mbgl was assessed in comparison to the site, as seen in **Figure 3**.
- 1.3.6 One borehole 300m northeast of the site (The Old Waterworks off London Road) was also assessed. This borehole has similar geotechnical strata according to the BGS online mapping, and was found to have Drift deposits consisting of 'Brickearth' to a depth of 2.7mbgl, underlain by 'Sand, saturated with water' to a depth of 7.3mbgl, followed by 'red and blue clay' to a depth of 17.7mbgl.
- 1.3.7 A copy of the BGS records reviewed can be found within **Appendix C** of this report.

1.4 Groundwater

- 1.4.1 The recorded borehole SZ99NW10 – Waterloo Square is located adjacent to the north of the site. Rest groundwater is noted at 3.8mbgl, and noted as having a supply yield before being sealed.
- 1.4.2 The recorded borehole SZ99NW12 – Spa Hill Allotments is located approximately 300m northeast of the site and is believed to have been a former water supply manhole. It is noted that water was struck at the base of the brickearth at 2.7mbgl.
- 1.4.3 The Arun District Council SFRA indicates the site as within the 25-50th percentile for susceptibility to groundwater flooding below ground level or at the surface, however the area just to the north of the site is within the 75-100th percentile which may further explain the shallow groundwater and high yields found in the boreholes to the north of the site. Unfortunately data was not available for the boreholes to the southwest of the site. Extracts from the SFRA can be found within **Appendix D**.
- 1.4.4 Mapping managed by MAGIC (magic.defra.gov.uk) provides geographic information concerning the natural environment from across government. This mapping tool has been referred to in order to confirm whether the site is located within either any groundwater source protection zones or groundwater vulnerability zones. The site is situated within a 'Unproductive' Aquifer, as seen in **Figure 4**.
- 1.4.5 This refers to bedrock geology that does not exhibit permeability or provide groundwater storage or supply.

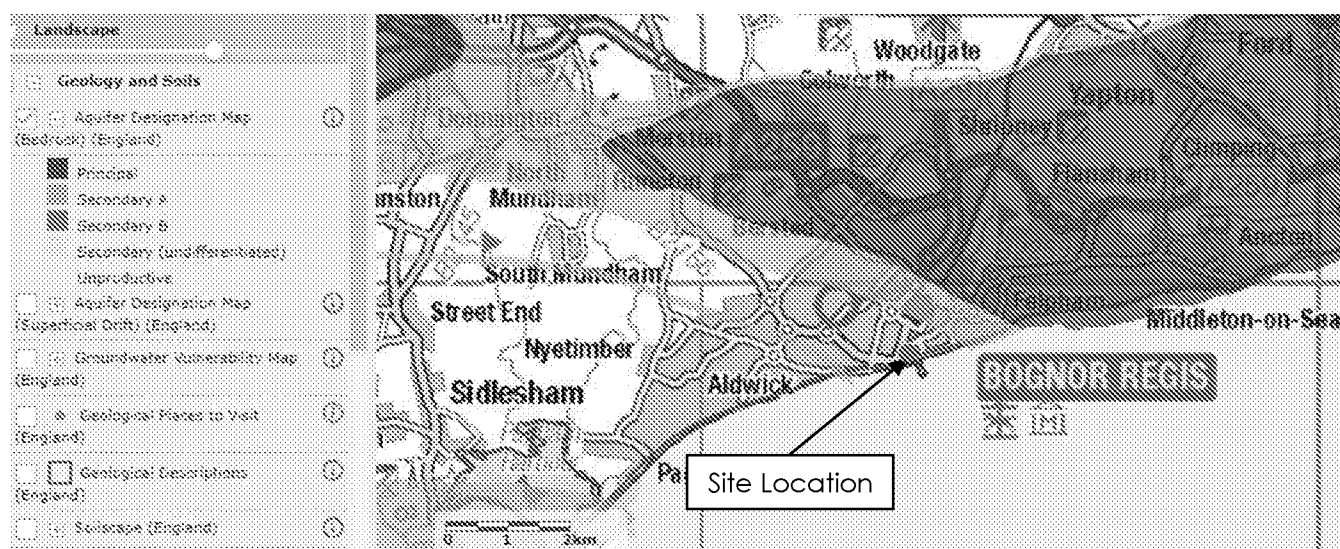


Figure 4. DEFRA Aquifer Designation Map

- 1.4.6 The site is however situated above a Secondary A Superficial Deposits Aquifer, which refers to deposits that will likely exhibit moderate permeability for shallow groundwater storage, as seen in **Figure 5**.
- 1.4.7 Given the proximity to the sea and the low elevation of the site area, it is likely that groundwater levels are tidally influenced.

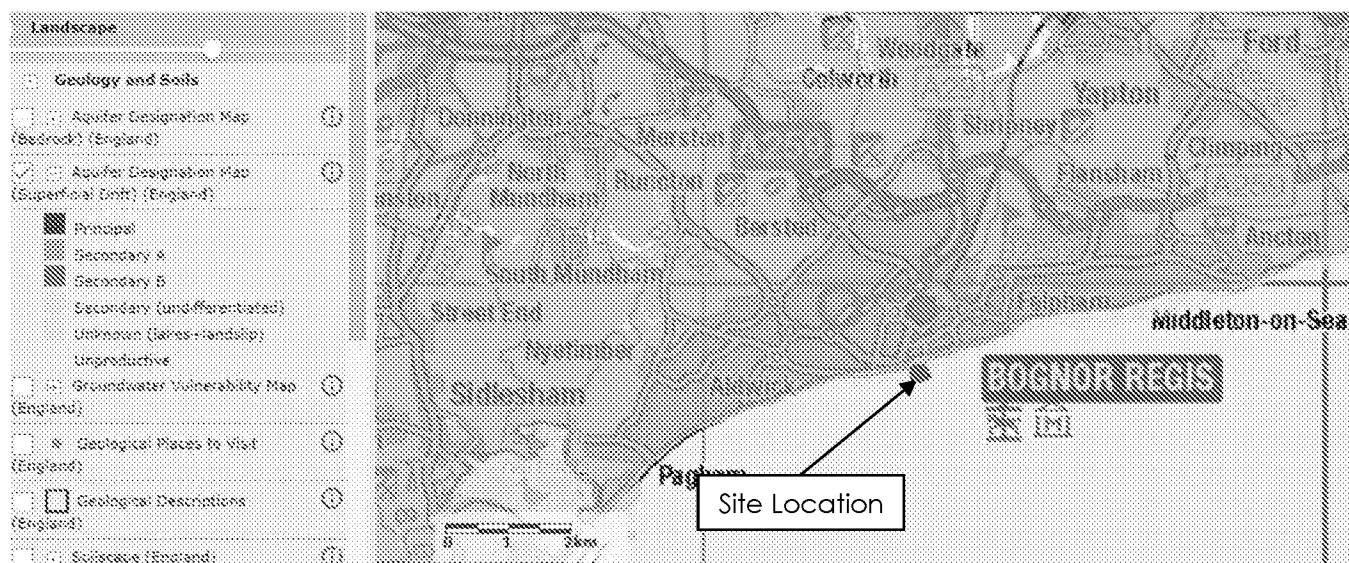


Figure 5. DEFRA Aquifer Designation Map

- 1.4.8 The Groundwater Vulnerability Map (**Figure 6**) confirms that the site also falls within the 'Minor Aquifer High' groundwater vulnerability zone, which refers to high leaching potential due to the permeable superficial deposits and shallow groundwater.

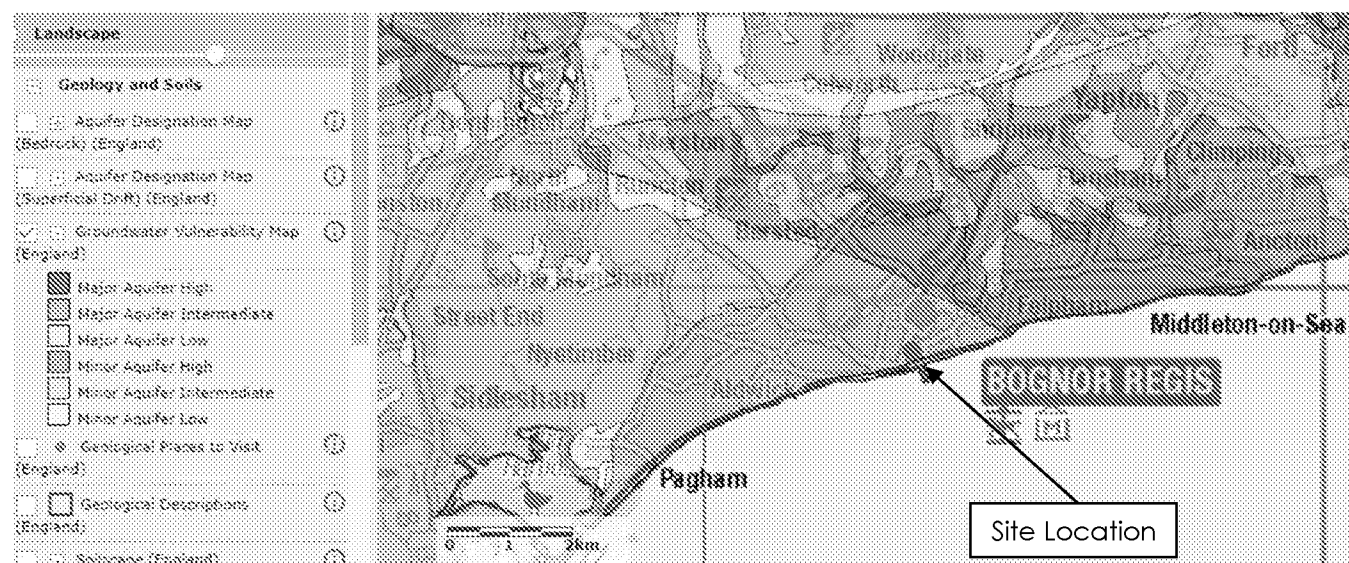


Figure 6. DEFRA Groundwater Vulnerability Map

- 1.4.9 The site is not indicated as within a Drinking Water Safeguard Zone or a Source Protection Zone.
- 1.4.10 The points above would indicate that there is potential for infiltration in the shallow deposits, however there is also a risk of high groundwater, emergence and leaching which would need to be considered.

1.5 Existing Drainage

- 1.5.1 The local Water Authority is Southern Water, who provide sewerage services within the area. Public sewer records have been obtained from Southern Water, as contained within this report in **Appendix E**.

- 1.5.2 Surface Water:

- The Southern Water public sewer records (**Appendix E**) show a public 225mm surface water sewer and a 600mm surface water sewer running south along Waterloo Road and then west along The Esplanade, which both then feed into an outfall into the sea south of the site.
- Both surface water sewers have a manhole adjacent to the site where Waterloo Square meets The Esplanade. The manhole of the 225mm sewer (closest to the site) demonstrates cover level as 5.68mAOD and pipe invert level as 3.66mAOD, whilst the manhole of the 600mm sewer demonstrates cover level as 5.74mAOD and pipe invert level as 3.15mAOD
- The existing building and previous buildings are assumed to have been drained by rainwater pipes. The connection route of this drainage is not currently confirmed; however some existing manholes within the site were identified on the topographic survey.
- The nearest surface water feature is the sea, with the mean high water line approximately 55 metres south of the site, with the surface water outfall approximately 60m metres south of the site.
- The nearest watercourse is the Aldingbourne Rife, which is a main river approximately 1.3km northeast of the site, where it discharges into the sea.
- Greenfield runoff rate (Q_{bar}) has been calculated to be 0.32l/s. However, as the entirety of the existing site is hardstanding and there does not appear to have been any previous attenuation features it is therefore expected that existing average peak annual runoff would be approximately 15.2l/s ($1097m^2 \times 50mm/hr / 3600s$).

1.5.3 Foul Water:

- The Southern Water public sewer records (**Appendix E**) show a public 225mm foul water sewer running south adjacent to the site along Norfolk Street (east boundary), which feeds into a 450mm foul sewer on The Esplanade and subsequently continues eastwards. The nearest manhole on Norfolk Street demonstrates cover level as 5.49mAOD and pipe invert level as 4.14mAOD.
- In addition, there is a foul sewer along Waterloo Square that also feeds into the 450mm sewer on The Esplanade, however levels and diameter of this route are unconfirmed.
- In addition, there appears to be a foul overflow to the surface water outfall to the sea on The Esplanade, where the trunk sewer runs eastwards from the site.
- The location of the foul water connection from the site has not been confirmed, however it is assumed that the previous properties would have had a connection to the existing foul sewer either on Norfolk Street, The Esplanade and/or Waterloo Square which could be utilized.

1.5.4 Highway Drainage:

- Waterloo Square, The Esplanade and Norfolk Street all appear to be drained by highway gullies. The final outfall location of the gullies has not been confirmed.

2 PROBABILITY

2.1 Sources of Information

2.1.1 The NPPF requires that all sources of flooding are considered being Tidal, Fluvial, Pluvial, Groundwater, Sewers and Man-made reservoirs/canals.

2.1.2 The likelihood of the site flooding has been established by reviewing the following information:

- Environment Agency Flood Maps for Planning
- Long Term Flood Risk Assessment Surface Water Flood Risk Maps
- Long Term Flood Risk Assessment Reservoir Flood Risk Maps
- Local Authorities Strategic Flood Risk Assessment
- Consultation with Local Authority/Lead Local Flood Authority

2.2 Flood Maps and Modelling

2.2.1 The Environment Agency's on-line Flood Maps for Planning (rivers and sea) show that the site is located within Flood Zones 1, 2 and 3. The flood zones are consistent within other flood risk mapping reviewed.

2.2.2 The Environment Agency's Product 4 Response provided flood maps for rivers, sea and surface water as seen in **Appendix F**. Flood levels and modelled flood outlines are also provided.

2.2.3 The Product 4 shows the site location within Flood Zones 1, 2 and 3 from the surrounding road areas, with the centre of the site within Flood Zone 1. The exact boundaries of the Flood Zones in the vicinity to the site are unclear due to the course nature of the Flood Map for Planning.

2.2.4 The modelled food outlines show the site protected in a 0.5% AEP defended tidal scenario, however the majority of the site flooded in 0.1% AEP and 0.5% AEP climate change scenarios. The site is stated to be partially protected from tidal flooding by flood defences in the form of groynes and a raised shingle beach, meaning that the site could be considered to be within Flood Zone 3 (Defended) and only at residual risk of tidal flooding.

2.2.5 Flood levels for 2 No. nodes have been taken from the River Arun to East Head Coastal Modelling, completed by JBA Consulting in 2016. Node 1 is located in the north of the site, and Node 2 is located in the south of the site.

2.2.6 When the modelled flood levels are considered in comparison with the topographic survey, there is potential for flooding of up to 200mm at the site, and of approximately 300mm at potential access points along Waterloo Square, The Esplanade and Norfolk Street. The levels confirmed below correspond with the plan contained within the appendices of this report;

Node Ref	Modelled Flood Levels (m AOD)							
	Undefended Annual Exceedance Probability				Defended Annual Exceedance Probability			
	0.5%	0.5% (2070)	0.5% (2115)	0.1%	0.5%	0.5% (2070)	0.5% (2115)	0.1%

1	-	5.82	5.90	5.82	-	5.80	5.87	5.87
2	5.67	5.69	5.77	5.68	-	5.62	5.68	-

- 2.2.7 The results demonstrate that the site is expected to be protected in an existing 0.5% AEP flood event, however increases as a result of climate change mean flood levels for a 0.5% AEP flood event would increase up to 5.87mAOD by year 2115, potentially causing widespread flooding to the public highways surrounding the site (as seen in the modelled flood outlines in **Appendix F**).
- 2.2.8 The Environment Agency's on-line Flood Maps for Planning (rivers and sea) show that the site is partially located within Flood Zone 3a. The flood zones are also confirmed by information and mapping obtained from The Environment Agency following consultation, which is consistent within other flood risk mapping reviewed.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

- 2.2.9 The Environment Agency's long term flood risk assessment takes into account flood defences and other aspects unlike the Flood Map for Planning. In addition to showing the site and surrounding highways at very low risk of flooding from rivers or sea, the maps demonstrate flood risk from surface water and reservoirs.
- 2.2.10 **Figure 7** shows that the site at very low risk of surface water flooding. There are some areas at low risk of surface water flooding along the surrounding highways, however depths are limited to below 300mm.
- 2.2.11 **Figure 8** shows that the site is not at risk of flooding from reservoirs.

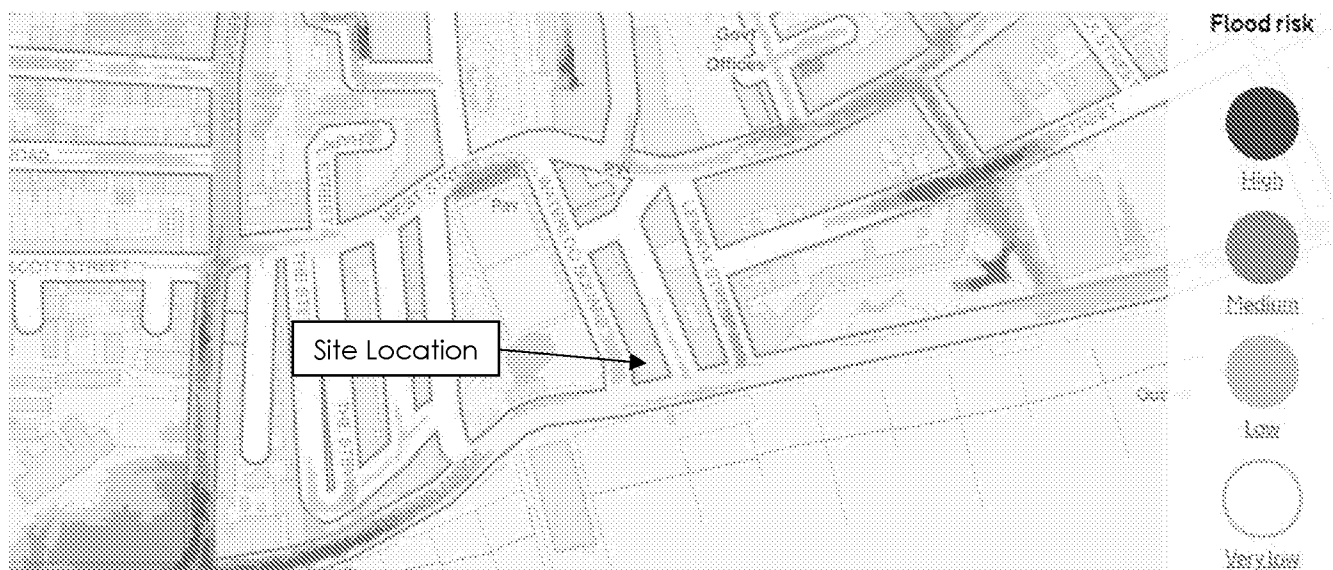


Figure 7. Long Term Flood Risk Map; Flood risk from surface water

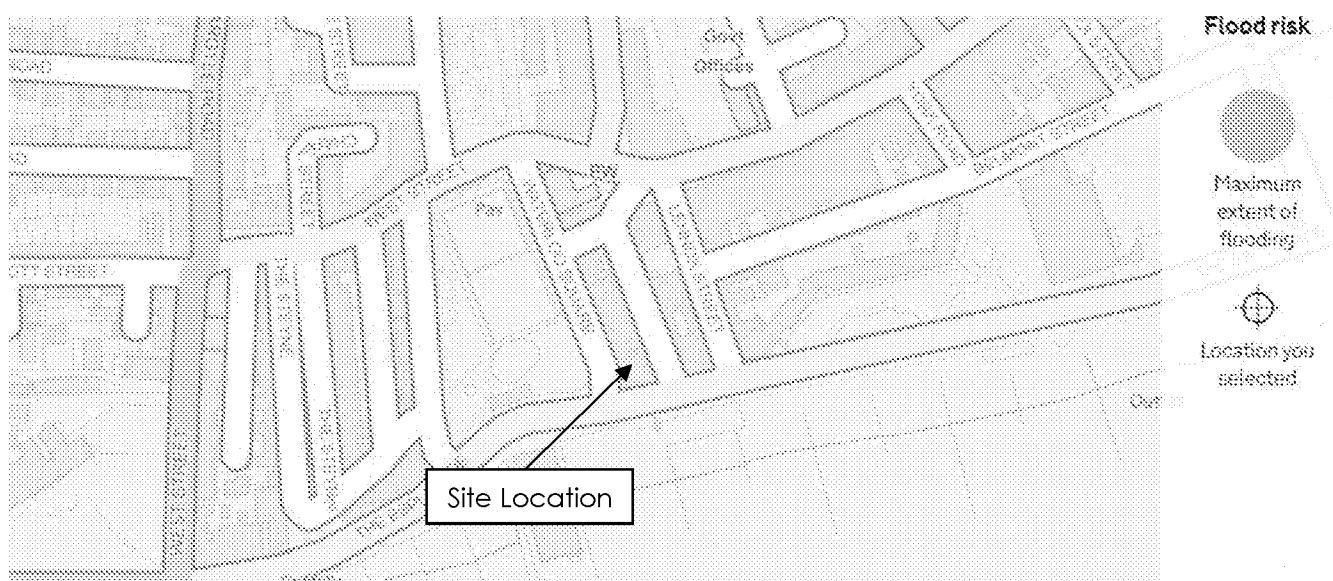


Figure 8. Long Term Flood Risk Map; Flood risk from reservoirs

2.3 Strategic Flood Risk Assessment

- 2.3.1 The Arun District SFRA demonstrates that the site is not within a flood warning area, within any historic flood outlines, or within any groundwater or surface water nitrate vulnerable zones.

2.4 Historic Flooding

- 2.4.1 The Environment Agency responded that they did not hold any record of historic flood incidents within the vicinity of the site.
- 2.4.2 The SFRA did not indicate any historic flood records or incidents within vicinity of the site.

2.5 Summary of Flood Risk

2.5.1 The potential sources of flooding are:

Source of Flooding	Level of Risk
Rivers and Coastal	Medium (Residual Risk: High) The site is within Flood Zones 1,2 and 3. However, the site is not at risk of fluvial flooding and is shown to be currently protected up to a 0.5% AEP event. This level of risk is forecast to rise with climate change with up to 300mm of flood potential to the site and access points from the public highway. There are no records of historic flooding at the site.
Surface Water	Low The long-term flood risk for surface water is classified as 'Very Low' across the site location. Surface water flood risk is 'low' within parts of the surrounding public highway; however depths are indicated to be a maximum of 300mm.
Groundwater	Medium BGS records found the site to be situated above Secondary Aquifer deposits, and nearby borehole logs found shallow groundwater with high yields. The groundwater vulnerability is classified as higher to the north of the site where the boreholes are located than at the site itself, however there may still be a risk of shallow groundwater and emergence at the site itself.
Sewers	Low The SFRA indicated that the site is not within an area with record of sewer flooding. In view of this information the risk of flooding from this source is deemed to be 'Low'.
Artificial Sources	None The site is not shown to be at risk of flooding due to artificial sources.

2.5.2 The primary sources of flood risk to the site are tidal and groundwater flooding. With climate change there is a risk of up to 300mm tidal flooding to the site and access routes. There is also the risk of shallow groundwater causing ingress to the basement or emergence as a result of the proposed basement construction. Mitigation measures to mitigate against flooding to the basement level will be required, as well as flood proofing measures for the ground floor level.

3 PROPOSED DEVELOPMENT

3.1 Description of Development

- 3.1.1 The proposed development will involve the redevelopment of the former Beach Hotel, former Mud Club & 2-4 Waterloo Square properties into basement level parking, 2 No. commercial units (A3 Restaurant & Cafe) at ground floor level and 49 No. apartments at upper floors - as demonstrated within **Appendix A**.
- 3.1.2 The ground floor development falls within the 'Less Vulnerable' classification (Flood Risk and Coastal Change Table 2) and is appropriate in Flood Zone 3 (Flood Risk and Coastal Change Table 3).
- 3.1.3 The upper floor residential development falls within the 'More Vulnerable' classification. More Vulnerable developments require an Exception Test for Flood Zone 3, and therefore this report will consider the implications of this despite residential units being raised above potential flood levels.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	Exception Test Required	✓	✓	✓
Flood Zone 3a†	Exception Test Required †	✗	Exception Test Required	✓	✓
Flood Zone 3b*	Exceptions Test Required *	✗	✗	✗	✗

✓ = Development is appropriate
 ✗ = Development should not be permitted

- 3.1.4 The proposed development will not increase the hardstanding area of the site. The post-development impermeable/hardstanding area has been determined to be 1,097m² (0.110Ha).
- 3.1.5 The use of Sustainable Drainage System (SuDS) methods and techniques (where site conditions and constraints allow) within the bounds of the site (whilst adhering to the SuDS hierarchy as stated within Building Regulations (Part H) and The CIRIA SuDS Manual C753) will be used to provide a betterment of surface water run-off compared to the existing site.
- 3.1.6 The specific Surface Water and Foul Water drainage proposals are detailed in **Section 4** of this report.

4 PROPOSED DRAINAGE STRATEGY

4.1 Surface Water

4.1.1 The SUDS manual and Building Regulations set out a hierarchy of drainage methods to ensure that developments maximise the use of sustainable drainage techniques. The hierarchy favours infiltration methods of disposal over other methods such as watercourse and sewers, as detailed below;

- i. Utilise infiltration techniques
- ii. Attenuate rainwater in ponds or open water features for gradual release
- iii. Attenuate rainwater by storing in tanks or sealed water features for gradual release
- iv. Discharge rainwater direct to a watercourse
- v. Discharge rainwater to a surface water sewer/drain
- vi. Discharge rainwater to a combined sewer

SUDS Technique	Suitable	Comments
Living Roof	Yes	No initial constraints, flat roof proposed, would reduce runoff and provide a betterment.
Basins and Ponds (such as Wetlands, Ponds, Detention Basins)	No	No space available within the site boundary.
Filter strips and swales	No	No space available within the site boundary.
Infiltration Devices - Soakaways - Infiltration trenches and basins	No	High groundwater levels present. Basement structure proposed, and lack of necessary clearance available within the site boundary.
Permeable surfaces and filter drains - Gravelled areas - Porous block paving	Yes	No initial constraints, deposits may infiltrate however there could be high groundwater levels. Tanked permeable paving would capture and slow runoff.
Tanked systems - Oversized pipes - Cellular tanks	No	No space available within the site boundary.

- 4.1.2 It is proposed that a green roof is to be used on the roof areas where possible. This will capture rainfall onto the site and provide attenuation for surface water, in order that it can be discharged at a reduced controlled rate, providing a betterment to the predevelopment situation.
- 4.1.3 SuDS techniques that rely on infiltration are not viable, because the necessary clearance from structures would not be possible. In addition, groundwater is likely to be shallow and tidally influenced, and the underlying bedrock is impermeable clay. Permeable paving within the layby area could be installed to capture and slow runoff, providing attenuation of surface water, in order that it can be discharged from the site at a reduced rate, providing a betterment.
- 4.1.4 It is recommended that the existing drainage on and in the vicinity of the site is investigated. It may be possible to reuse the existing surface water drainage infrastructure that served the former Beach Hotel, former Mud Club & 2-4 Waterloo Square properties, avoiding the need to make a new connection into the public surface water system directly.
- 4.1.5 The proposed drainage system will include 497m² of green roof and 82m² of tanked permeable paving, with a resultant reduced discharge to the public surface water sewer system, as detailed in Drawing **PL300**. Confirmation of existing drainage infrastructure is required to confirm a connection point for the proposed drainage system.
- 4.1.6 The strategy above will ensure that there a decrease in the rate of run-off leaving the site, therefore reducing the risk of flooding from this source. Discharge would be reduced by approximately 73%, for a 1 year storm, 59% for a 30 year storm, and 55% for a 100 year (plus 40% climate change) storm, as can be seen in the MicroDrainage calculations in **Appendix G**.
- 4.1.7 It is proposed that the building ground floor level is set at 5.75mAOD, raising it above the surrounding ground level to provide some mitigation against flood risk whilst ensuring that the required access provisions can be met.
- 4.1.8 In addition, a sump should be provided in the basement to assist with the removal of flood water in the unlikely event that it enters the basement. Further detail of measures to protect the basement from flooding are detailed in **Section 5.2**.

4.2 Treatment

- 4.2.1 The use of permeable paving and green roof will ensure that run-off from the site receives a level of treatment required by the SuDS manual, with hydrocarbons being filtered by the aggregate and geotextile layers.
- 4.2.2 In accordance with the CIRIA SuDS Manual C753 regarding methods for managing pollution risks, the risk posed by surface water runoff to the receiving environment depends on the pollution hazard at the site (the source), SuDS treatment techniques (the pathway), and the sensitivity of the environment (the receptor).
- 4.2.3 The simple index approach considers whether SuDS techniques are appropriate for the site. The states that for SuDS components to deliver adequate treatment, the total pollution mitigation index for each contaminant type should equal or exceed the pollution hazard index.
- 4.2.4 The SuDS Manual outlines three categories of pollution hazard identification, which vary depending on proposed land use, which are as follows:

- Total Suspended Solids (TSS).

- Metals (M).
- Hydrocarbons (H).

4.2.5 In accordance with C753 Table 26.2, the proposed land uses at the site are categorised as follows:

- Residential Roofs – very low/TSS=0.2/M=0.2/H=0.05
- Residential Car Parking – low/TSS=0.5/ M=0.4/H=0.4

4.2.6 In accordance with C753 Table 26.3, the values of SuDS Mitigation indices are provided for permeable paving:

- Permeable Pavement – TSS=0.7/M=0.6/H=0.7

4.2.7 As the pollution hazard index does not exceed any pollution mitigation index for any contaminant type, the proposed SuDS methods will provide sufficient treatment for the proposed development.

4.2.8 The majority of the roofing area will also be captured by green roofing, which will provide significant treatment to flows captured before being discharged to the surface water drainage system.

4.3 Foul Water Drainage

4.3.1 An existing foul water sewer runs adjacent the site along Norfolk Street. In addition, foul sewers are indicated along The Esplanade and Waterloo Square. Investigation is required into the existing site connection in order to ascertain the proposed connection arrangement for the proposed development.

4.3.2 Post development, there will be an estimated increase in peak foul water flows to 1.85 l/s (based on Sewers for Adoption). The estimated peak foul flows for the existing site is 1.0l/s, based on an estimated residential occupancy and capacity of the drinking establishment and hotel.

4.3.3 Recent changes to infrastructure and connection charges (OFWAT Charging Rules) place the onus on the sewerage undertaker to reinforce their network should there no longer be sufficient capacity to serve the new development. Funding for this is provided by revised charging arrangements for infrastructure and connection charges for each dwelling constructed comprising a Network Reinforcement Charge and Site-Specific Charges. The revised charging arrangement (funded by the developer) covers alterations to the Existing Sewer Network and the sewerage undertaker remains responsible for the cost of reinforcing their Strategic Assets. The developer is responsible for connecting the development to the public sewer network.

4.3.4 Additionally, it is considered that the significant decrease in surface water runoff will more than offset the minor increase in foul discharge, and the previous use of the site would have also generated similar peak foul discharge prior to disuse and demolition.

4.4 Climate Change

4.4.1 In February 2017 the Environment Agency updates the latest climate change allowances (available online at <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>), which supports the NPPF in making an allowance for climate change within flood risk assessment. The

allowances provide predictions of anticipated change for peak river flow by river basin district and peak rainfall intensity.

- 4.4.2 The table below shows the anticipated changes in extreme rainfall intensity. For flood risk assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

- 4.4.3 Based on the latest allowances, an increase of 20% should be applied to peak rainfall to this development, with a review undertaken to determine the impact of a 40% increase.

- 4.4.4 The drainage strategy calculations have considered a design storm event of 100 year inclusive of 40% climate change to reflect the possible 40% increase in rainfall intensity.

5 RESIDUAL RISK AND MITIGATION

5.1 Residual Risk

5.1.1 The following residual risks have been identified in relation to the proposed development:

- i. Extreme rainfall events that exceed the design criteria used for the drainage system causing surface water flooding.
- ii. Blockage/failure of the proposed drainage system causing flooding to the site.
- iii. Groundwater flooding to the site caused by groundwater levels exceeding the ground surface level.
- iv. Surface water flooding of proposed buildings from the area/flow path of identified risk.
- v. Extreme tidal flood levels causing flooding to the ground floor level, and inundation of the basement level. Modelled defended tidal flood levels are 5.87mAOD during a 0.5% AEP event in 2115 (as a result of climate change) or during a 0.1% AEP event.

5.2 Mitigation

5.2.1 Consideration has been taken to the residual risks stated in Section 5.1, and the following mitigation measures are proposed:

- The drainage strategy has been designed to capture and slow the surface water runoff that leaves the site, providing a betterment compared to the predevelopment situation. No formal flow controls are proposed as the SuDS methods proposed will natural attenuate the flow with runoff being discharged into the sea via the short run of public surface water sewer.
- During an exceedance event, run off would flow away from the proposed building, in the same way as the predevelopment situation, and the proposed elevation would prevent flows from reaching the internal ground floor. It is proposed that the finished floor level is raised above the external levels to mitigate against the risk of internal flooding.
- The proposed drainage system will capture and slow runoff. Blockage of drainage system components has the potential to cause flooding on the site. Surcharged flows will likely travel overland to the highway drainage, however maintenance measures proposed in Chapter 8 will mitigate the risk of the system becoming blocked.
- An assessment of nearby borehole records and the groundwater susceptibility map, which indicate that there is a risk of groundwater exceeding the surface level and emerging on the site. It is recommended that the basement is constructed with flood resilient basement methods to mitigate against possible high groundwater levels.

- There are some areas of public highway surrounding the site at low risk of surface water flooding. The raised elevation of the ground floor level to 5.75mAOD and the design of the site levels to convey overland flow away from buildings will help to prevent surface water flooding. Additionally, flood resilient construction to the ground floor would ensure that damage to the proposed building is minimised in the event of flooding.
- Although the proposed site is protected from a 1 in 200 year tidal flood event during an existing scenario, the building is at residual risk of tidal flooding as a result of climate change or an extreme tidal flood event (1 in 1000 year). Modelled flood levels show a maximum flood level of 5.87mAOD. This would cause flooding to the ground floor (set at 5.75mAOD) to flood by up to 120mm, and for potential inundation of the basement level. The following measures are proposed to mitigate against tidal flood risk.
 - Flood resilient construction of the ground floor level and flood proofing of the commercial units and plant area to mitigate against the potential damage of tidal flooding in an extreme event. The building could be allowed to flood at ground floor level in an extreme event, however flood proofing could be provided to at least 150mm above the finished floor level, above the predicted flood levels.
 - Raised entrance lip to the basement level of at least 5.87mAOD, to ensure that the basement was protected against tidal flooding. In addition, a sump would be included at basement level for emergency pumping down of basement in the unlikely occurrence of exceedance. The lip could be provided at above the extreme tidal flood level whilst still providing a compliant entrance slope of 1:20. This lip would also reduce any risk of a surface water flow path to the basement level.
 - Inclusion of a flood warning and alert system, and a flood evacuation plan for both residents, employees and commercial visitors to ensure safe access, egress and evacuation in the event of an extreme tidal flood event.
- In addition, a sump for emergency pumping down of basement in the event of flooding will be required.

6 SEQUENTIAL AND EXCEPTION TESTS

6.1 Sequential Test

- 6.1.1 The area of proposed development is in Flood Zones 1 to 3 and is at risk of flooding. In view of this, the application of the sequential test is required.
- 6.1.2 The site is shown to be above the tidal flood level for a 1 in 200 year flood event when flood defences are taken into consideration however, and is therefore within Flood Zone 3 (Defended).
- 6.1.3 The site lies within a central town location and is therefore considered a highly sustainable location for residential and commercial development. The site consists of a previous hotel, residential units and commercial premises requiring significant development for mixed residential and commercial regeneration.
- 6.1.4 In addition, the site arrangement has been set out sequentially so that residential buildings (more vulnerable use) are set only above the ground floor level, above the existing and future flood levels in order to minimise the risk of potential flooding from the sources detailed within **Section 2.5 - Summary of Flood Risk**.

6.2 Exception Test

- 6.2.1 The development is appropriate for Flood Zones 1 and 2 and does not require an Exception Test.
- 6.2.2 The site is currently assessed to be Flood Zone 3 (Defended), with the site above modelled flood levels for a 1 in 200 year tidal defended scenario. The proposed site is however predicted to be within Flood Zone 3 during the lifetime of the development at ground floor level, as a result of climate change. The proposed ground floor use of commercial units are classified as 'Less Vulnerable' and are appropriate for Flood Zone 3, without the need for an Exception Test.
- 6.2.3 Appropriate drainage measures have been proposed to ensure flood risk is not increased elsewhere. In addition, appropriate flood risk mitigation measures have been proposed to prevent inundation or flood damage from an extreme or climate change induced storm event.

7 FLOOD RISK MANAGEMENT

7.1 Safe Access and Egress

- 7.1.1 Tidal flooding during an extreme event could affect access and egress to the site, with flood levels of up to 300mm along the access and egress points of the site. Levels of under 300mm would not significantly inhibit pedestrian access or egress.
- 7.1.2 In addition, appropriate flood mitigation measures are proposed to prevent inundation of the basement level by tidal flooding.
- 7.1.3 Access to higher ground via Norfolk Street and Waterloo Square are easily accessible from all points of the building for pedestrian access and egress. Residential units are all situated on higher floor levels and as such inhabitants would be safe within their properties until tidal flood levels had receded, with immediate access or egress is not a safety requirement.

7.2 Flood Warning

- 7.2.1 The site is at risk of tidal flooding therefore there is a need for a Flood Evacuation Plan (FEP). This should consider the provision of a Flood Warning System.

8 MAINTENANCE

8.1 Proposed Maintenance Regime

8.1.1 Maintenance is required to ensure the long-term operational performance of the proposed surface water drainage system.

8.1.2 The drainage system has been designed to minimise maintenance requirements; however a number of key tasks will need to be undertaken so that the system remains in optimal condition. These operations are summarised in the table below, along with the required frequency of works.

Drainage System feature	Proposed maintenance / remedial works	Required frequency of works
Permeable Paving	Surface sweeping to reduce silt and debris accumulation.	Every 8 to 12 weeks
	Removal / management of weed growth	At least once a year
	Silt removal from permeable surfaces, possibly involving raking out of joints, redressing, removal and remedial works.	As required / to be specified by manufacturer
Green Roof	Inspection	Twice annually
	Removal of unwanted items	As required
	Clearing of roof outlets and removal of encroaching vegetation	As required
Diffuser units & catch pits, gully sumps and drains	Inspection and additional cleansing as required.	Annual
	Desilting	Year 1, Year 3, then every 5 years
Pipework	Jetting to clear blockages	As required

8.1.3 The responsibility of maintenance regime will be determined by the Developer, by agreed appointment.

Green Roof

8.1.4 The areas of green roof are designed to capture rainfall and allow infiltration through the soil at an attenuated rate. The water is then collected and discharged into the positive drainage system.

8.1.5 In order for a green roof to continue to deliver environmental, aesthetic and flood risk benefits maintenance will be required on a regular basis. Two inspections a year should ensure that outlets are maintained, and that unwanted species do not become established. Failure in carrying out this maintenance, could increase the risk of flooding. The additional measures are as follows:

- Roof evaluation to determine what remedial works are required, if any. Typically twice a year
- Removal of leaves, debris and other unwanted vegetation to prevent green roof from becoming congested. As required following inspection
- Clearance of roof outlets and removal of encroaching vegetation to enable water to flow freely through rainwater pipes. As required following inspection
- Application of fertiliser to help restore green roof. As required following inspection

Permeable Paving / Diffuser Units

- 8.1.6 The areas of permeable paving are designed to allow infiltration of surface water run-off through the joints in the block paving surface course and into the subbase below. The water is then collected and discharged into the positive drainage system.
- 8.1.7 As part of the permeable paving system, diffuser units are used to discharge surface water run-off from roof areas into the sub-base, as well as forming links between areas of permeable paving. These diffuser units are small heavy-duty cellular units which allow more efficient discharge of surface water into the sub-base base of the permeable paved areas.
- 8.1.8 The areas of permeable paving will require additional maintenance measures to ensure they operate as designed. Failure in carrying out this maintenance, could increase the risk of flooding. The additional measures are as follow:
- Periodic surface sweeping to reduce silt and debris accumulation. The permeable surfaces should be swept at least every 8 to 12 weeks with additional sweeps in the autumn to clear fallen leaves
 - Removal / management of weed growth, as required. Typically, once or twice a year for regularly used areas
 - Periodic silt removal from permeable surfaces as described by the manufacturer. If any areas are showing signs of ponding, they shall be dealt with by raking out the joints and redressing. The entire surface shall be monitored and when there are signs of excessive siltation resulting in poor drainage over the whole area, the blocks shall be taken up and a replacement of bedding layer and geotextile shall be undertaken
 - Redressing of joints on the block paving as required
 - Catchpits upstream of diffuser units, should be emptied and inspected on the same regime as all catchpits specified previously set out in this document

Remedial/Repair Actions

- 8.1.9 Significant storm events may cause considerable damage to SuDS and their associated components. As such, it may be necessary to inspect and carry out essential recovery works to return the feature to full working order.
- 8.1.10 Resetting of uneven blocks by lifting block area, removing bedding material and relaying to match original design are all actions which may need to be undertaken.

Accidental Spillages

- 8.1.11 It is not envisaged that any materials are to be stored onsite once the development has been completed, which could cause major spills and potential pollution issues within the drainage system. If this situation alters in the future consultation with a specialist will be required in order to confirm if any upgrades to the existing system are necessary.
- 8.1.12 Minor spillages of fuels and oils will be dealt with by the permeable paving and deep trapped gullies,

by bio-degrading and collecting the hydrocarbons respectively.

Future Alterations to the Development

- 8.1.13 Any future alterations to the permeable paving should be confirmed by a specialist. Where possible any future services are to avoid being located through areas of permeable paving. If new services are required to run through areas of permeable paving, services should be installed below the depth of permeable paving with the permeable system reinstalled above.

9 OFFSITE IMPACTS

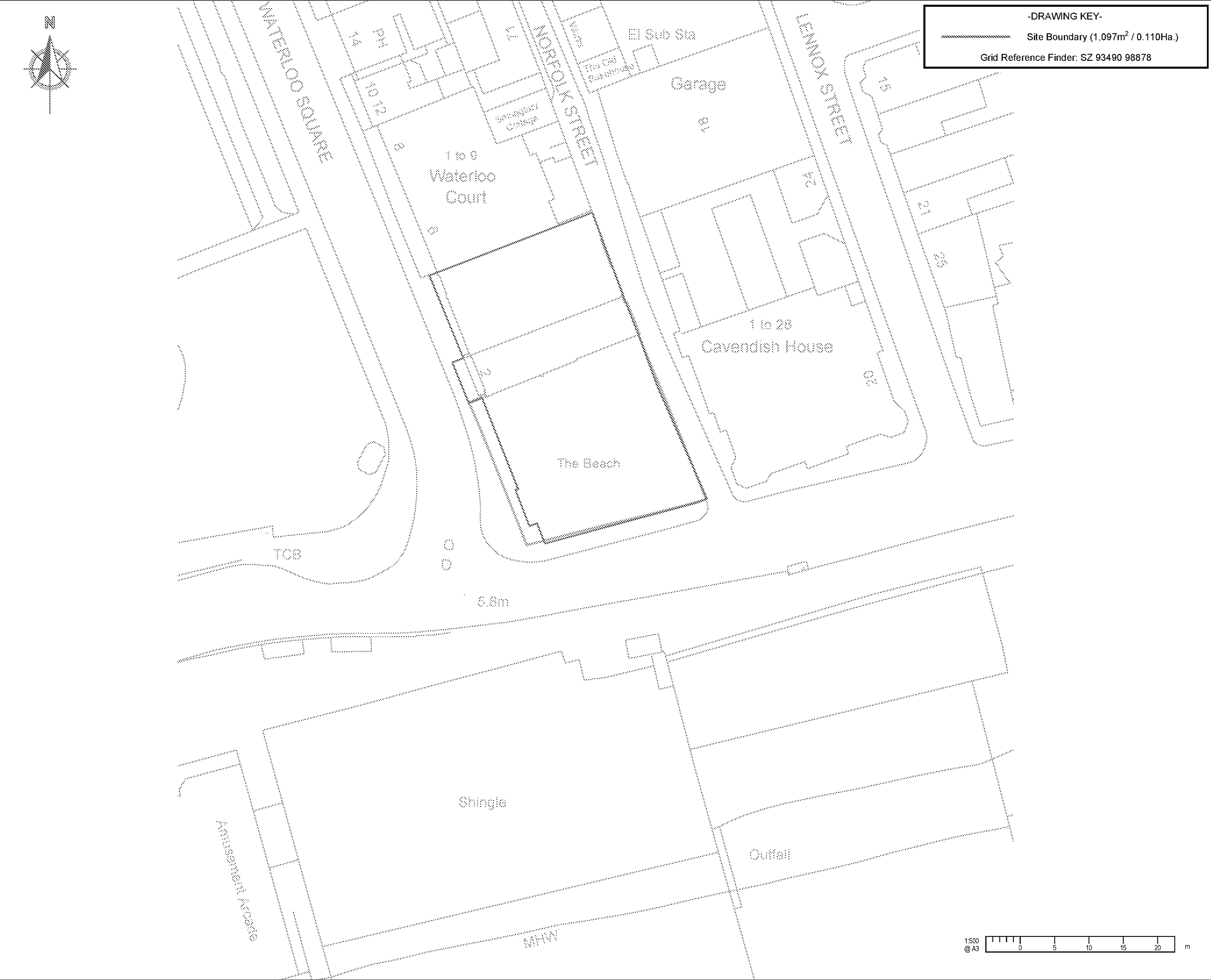
- 9.1.1 The proposed development will reduce the rate of runoff from the site, and therefore will not cause an increase in flood risk offsite.
- 9.1.2 Post development foul water flows will contribute an increase to the sewer network compared to the previous use – it is expected that the foul sewer flow will be 1.85l/s, an increase of 0.85l/s.
- 9.1.3 The effects of climate change have been considered in the design of the proposed surface water drainage system, to ensure there is no off-site impact.

10 SUMMARY

- 10.1.1 This site-specific flood risk assessment is based on Flood Maps, the Local Authority's Strategic Flood Risk Assessment and Public Sewer Records.
- 10.1.2 The development comprises the demolition of the former Beach Hotel, former Mud Club & 2-4 Waterloo Square properties and the construction of 2 No. commercial units (A3 Restaurant & Cafe) at ground floor level and 49 No. apartments at upper floors and basement parking.
- 10.1.3 The site is typically elevated at 5.7m to 6.0m AOD, and consists of buildings and the remnants of demolished buildings. The land around the site falls towards the carriageway to the west, south and east with levels at typically 5.5m to 5.7m AOD. Along The Esplanade to the south, the land falls southerly towards the beach, with a low point of approximately 5.3m AOD. There is however a slight rise opposite the carriageway although the height of defence from the sea is not confirmed.
- 10.1.4 The site area is 0.011Ha and is entirely hardstanding, which will remain hardstanding as a result of the proposed development.
- 10.1.5 The site lies within Flood Zones 1, 2 and 3, however is protected from flooding up to the 1 in 200 year tidal storm event. Flood mitigation measures are proposed due to the residual risk of tidal flooding from a 1 in 1000 year event, or as a result of climate change. Tidal flood risk is only to the less vulnerable commercial use at ground floor and not to the residential units at higher floor levels.
- 10.1.6 The existing/previous run-off from the site is assumed to drain to the public surface water sewer system.
- 10.1.7 Post-development surface water run-off will be managed through sustainable drainage measures, with the installation of green roof and permeable paving with off-site discharge to the public sewer network significantly reduced, without causing surface water flooding on site.
- 10.1.8 The wastewater from the proposed development will discharge to the public foul sewer network, with connection arrangement to be confirmed subject to site investigation.
- 10.1.9 The completion of the development will not increase flood risk on or off the site.
- 10.1.10 In conclusion, this development is suitable with regards to flood risk and surface water drainage.

DRAWINGS

- 001** Site Location Plan
- 002** Existing Topography & Overland Flow Routes
- 003** Impermeable Areas Comparison
- 004** Conceptual Drainage Strategy



NOTES

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4. Any information given regarding existing underground services is given in good faith after consultation with the relevant authority, however accuracy is not certain.

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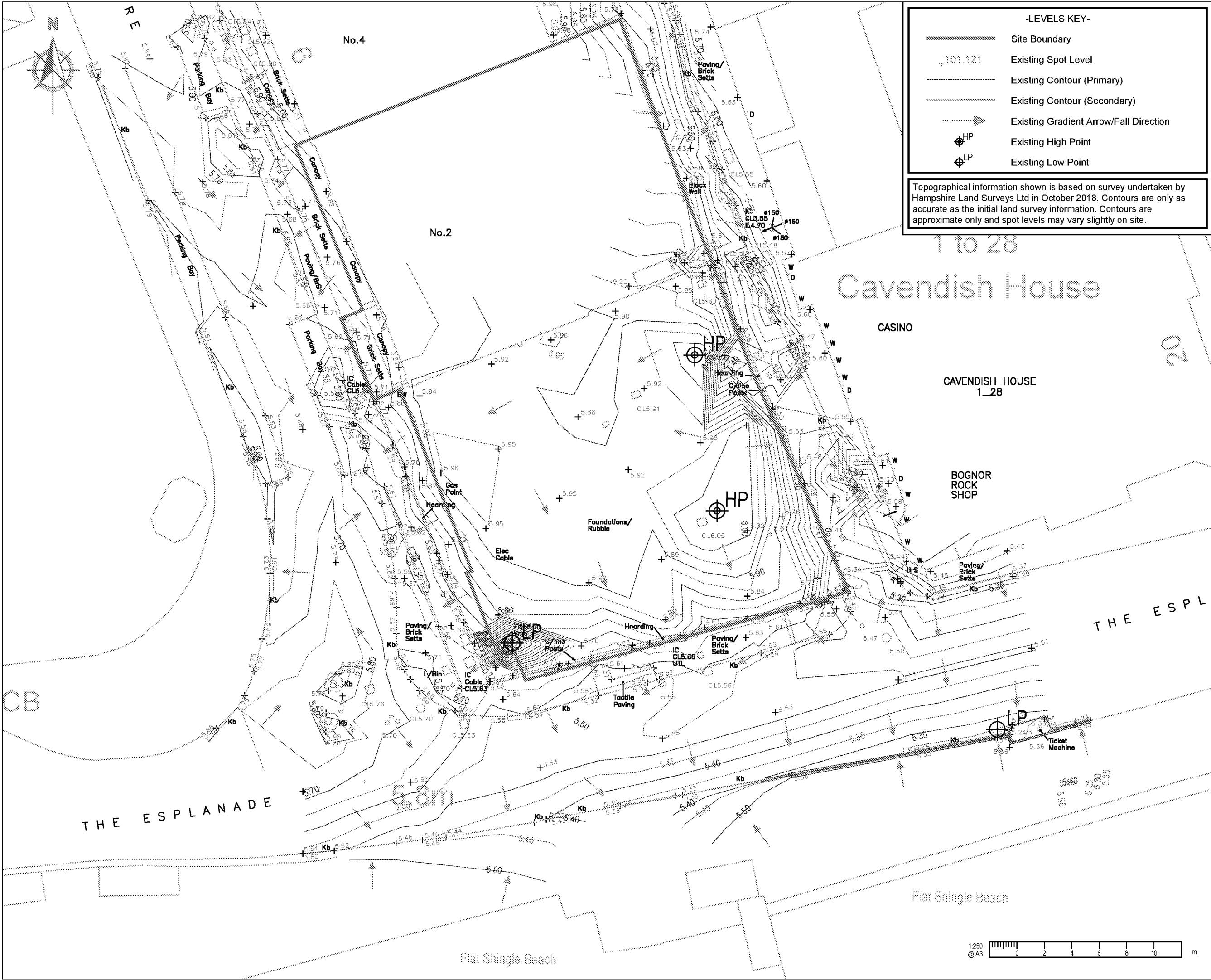
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Rev.	Amendments	Date

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Drawing Status			
PLANNING			
Client			
B5 Ltd			
Drawing Title			
Site Location Plan			
Project			
Waterloo Square Bognor Regis			
Scale	Date	Drawn By	Checked
1:500	Dec' 19	DJL	MJA
Drawing No.			Rev.
2019-D1832-PL001			-

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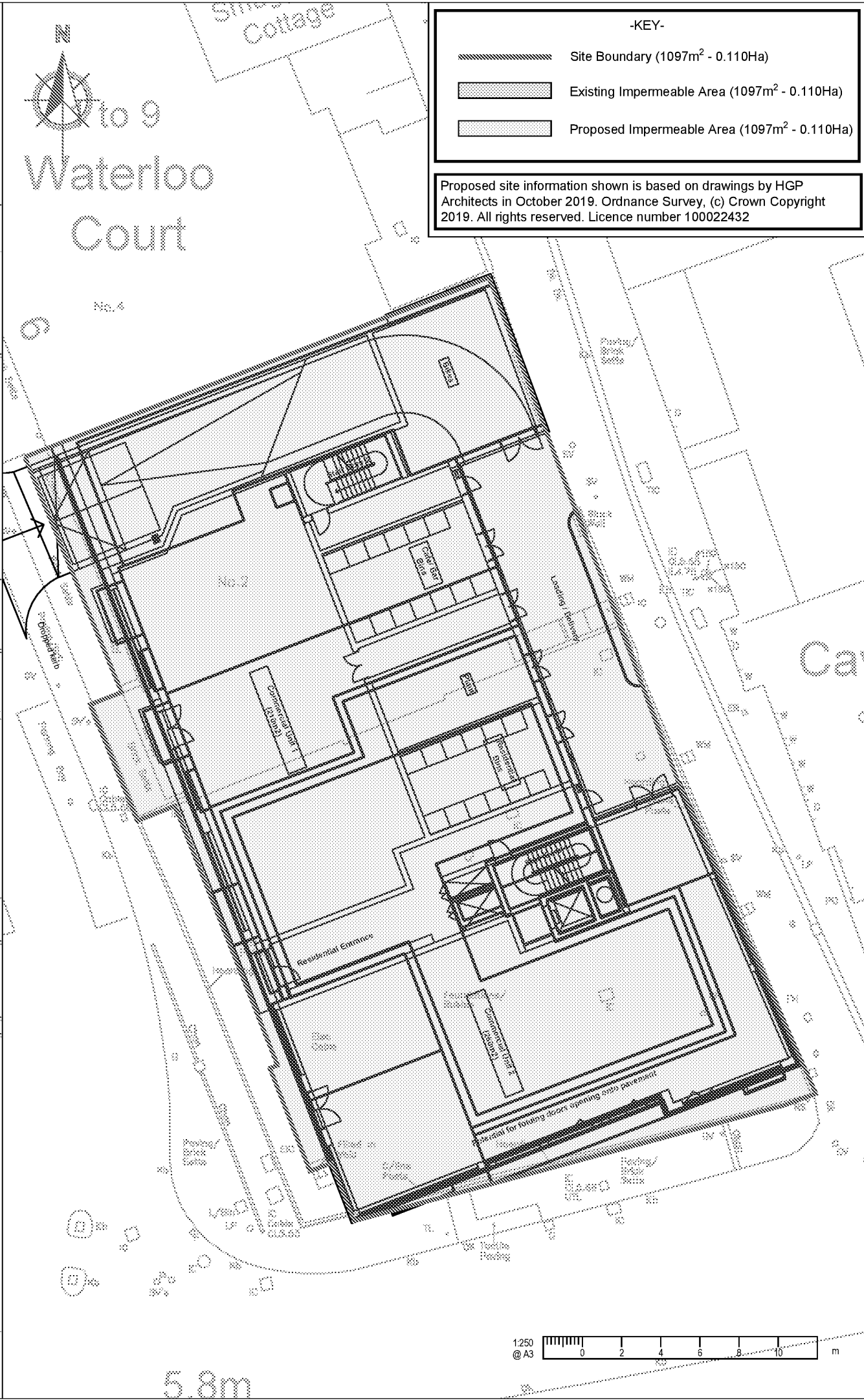
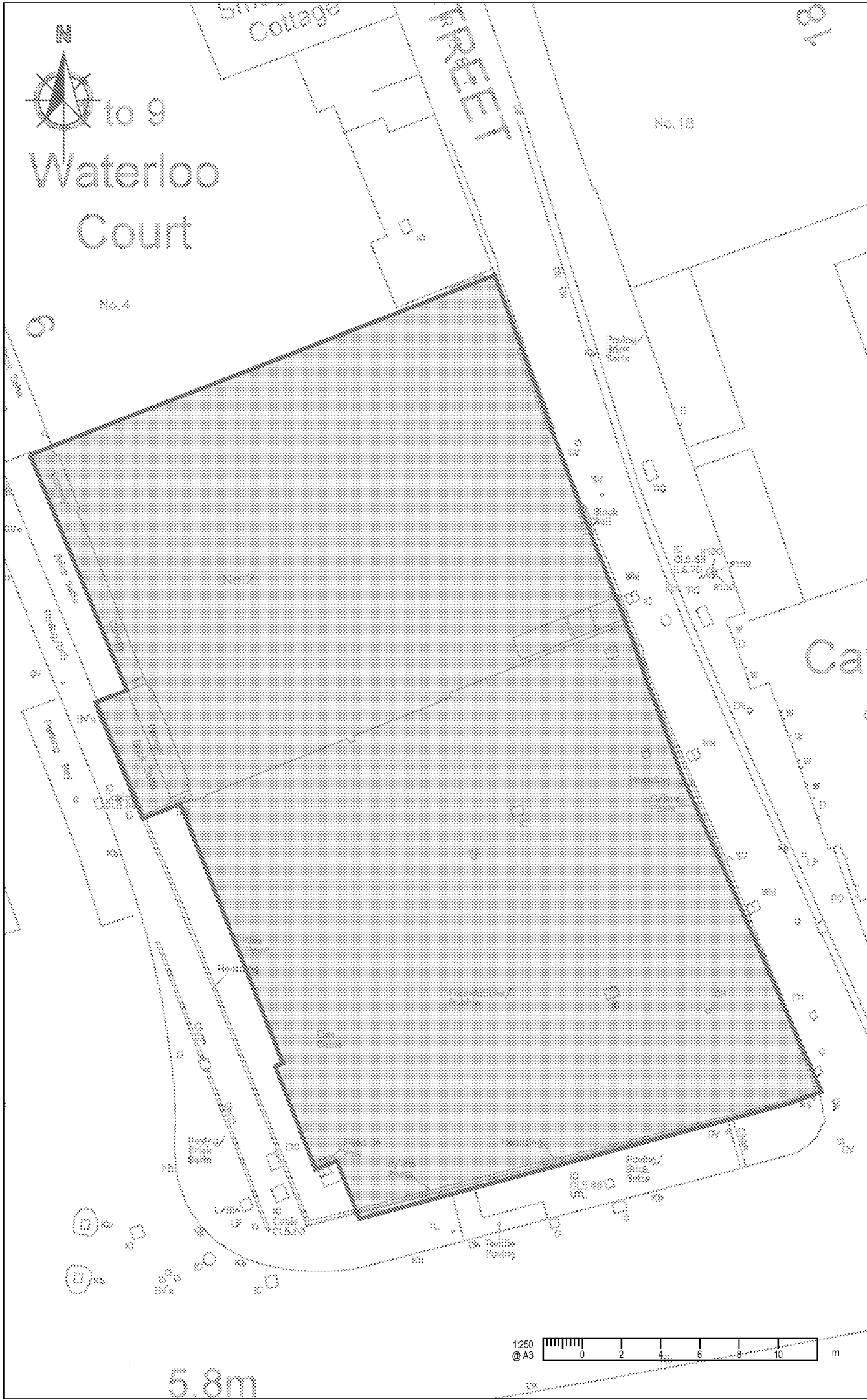
Existing Topography & Overland Flow Routes

Project

Waterloo Square Bognor Regis

Scale	Date	Drawn By	Checked
1:250	Dec '19	DJL	MJA

Drawing No.	Rev.
2019-D1832-PL100	-



-KEY-

- Site Boundary (1097m² - 0.110Ha)
- Existing Impermeable Area (1097m² - 0.110Ha)
- Proposed Impermeable Area (1097m² - 0.110Ha)

Proposed site information shown is based on drawings by HGP Architects in October 2019, Ordnance Survey, (c) Crown Copyright 2019. All rights reserved. Licence number 100022432

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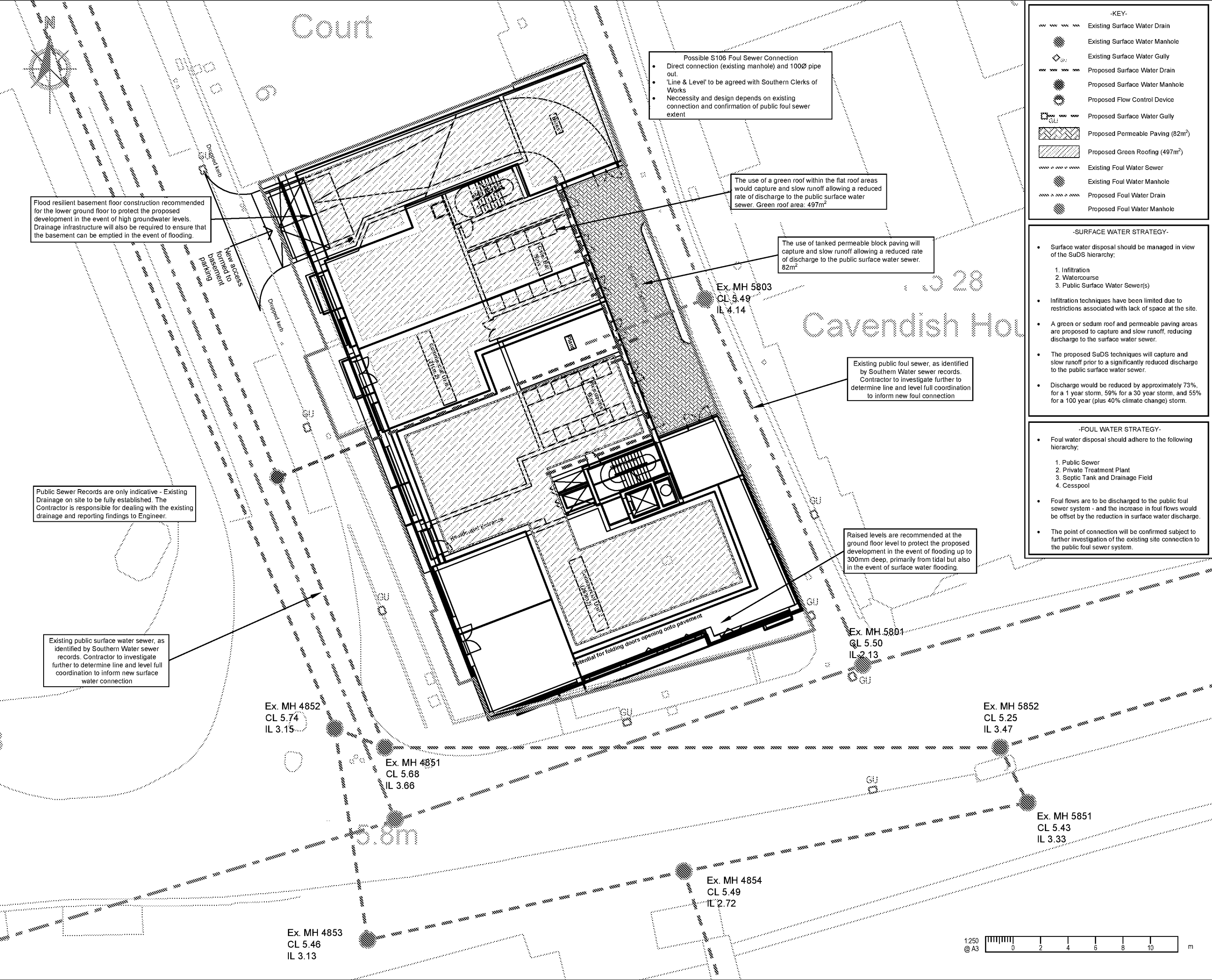
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Drawing Status		PLANNING	
Client		B5 Ltd	
Drawing Title		Impermeable Areas Comparison	
Project		Waterloo Square Bognor Regis	
Scale	Date	Drawn By	Checked
1:250	Dec '19	DJL	MJA
Drawing No.		Rev.	
2019-D1832-PL200		-	

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-KEY-

- Existing Surface Water Drain
- Existing Surface Water Manhole
- Existing Surface Water Gully
- Proposed Surface Water Drain
- Proposed Surface Water Manhole
- Proposed Flow Control Device
- Proposed Surface Water Gully
- Proposed Permeable Paving (82m²)
- Proposed Green Roofing (497m²)
- Existing Foul Water Sewer
- Existing Foul Water Manhole
- Proposed Foul Water Drain
- Proposed Foul Water Manhole

-SURFACE WATER STRATEGY-

- Surface water disposal should be managed in view of the SuDS hierarchy:
 - Infiltration
 - Watercourse
 - Public Surface Water Sewer(s)
- Infiltration techniques have been limited due to restrictions associated with lack of space at the site.
- A green or sedum roof and permeable paving areas are proposed to capture and slow runoff, reducing discharge to the surface water sewer.
- The proposed SuDS techniques will capture and slow runoff prior to a significantly reduced discharge to the public surface water sewer.
- Discharge would be reduced by approximately 73%, for a 1 year storm, 59% for a 30 year storm, and 55% for a 100 year (plus 40% climate change) storm.

-FOUL WATER STRATEGY-

- Foul water disposal should adhere to the following hierarchy:
 - Public Sewer
 - Private Treatment Plant
 - Septic Tank and Drainage Field
 - Cesspool
- Foul flows are to be discharged to the public foul sewer system - and the increase in foul flows would be offset by the reduction in surface water discharge.
- The point of connection will be confirmed subject to further investigation of the existing site connection to the public foul sewer system.

NOTES

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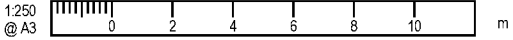
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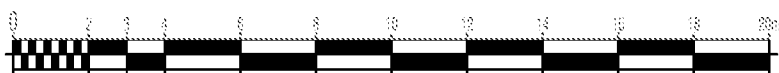
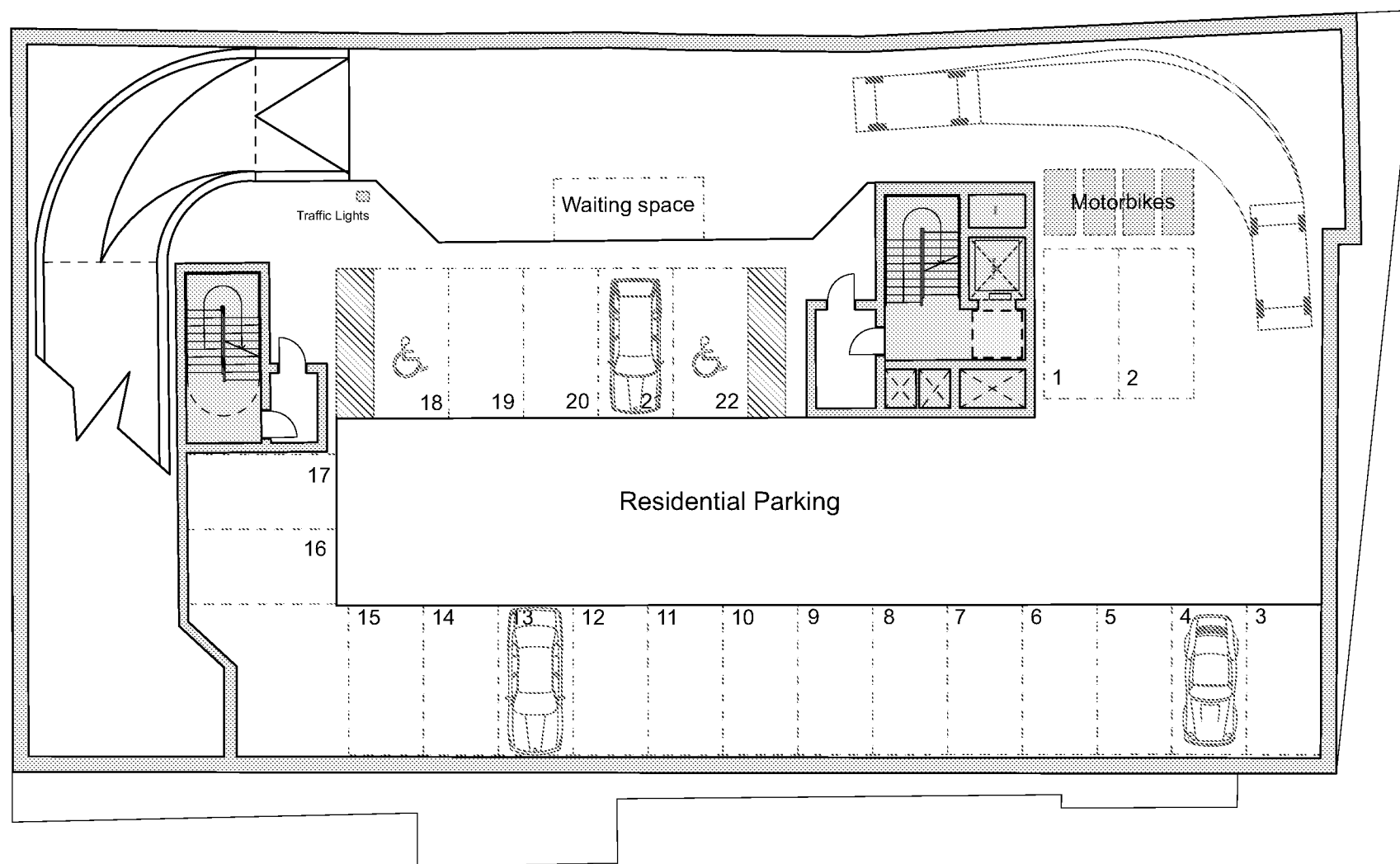
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Client B5 Ltd			
Drawing Title Conceptual Drainage Strategy			
Project Waterloo Square Bognor Regis PO21 1SU			
Scale 1:250	Date Dec '19	Drawn By DJL	Checked MJA
Drawing No. 2019-D1832-PL300			Rev. -



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APPENDICES

Appendix A Preliminary Site Layout



Revisions	Date (yyymmdd)	Description	Notes
			Layout subject to survey information and design development

Project Title:
Waterloo Square, Bognor Regis

Document Title:
Proposed Basement Level Floor Plan

Drawing Scale / Sheet Size:
1:200 @ A3

Drawing Status:
PLANNING

Date:
01.10.19

Drawn by / Checked by:
SR / GG

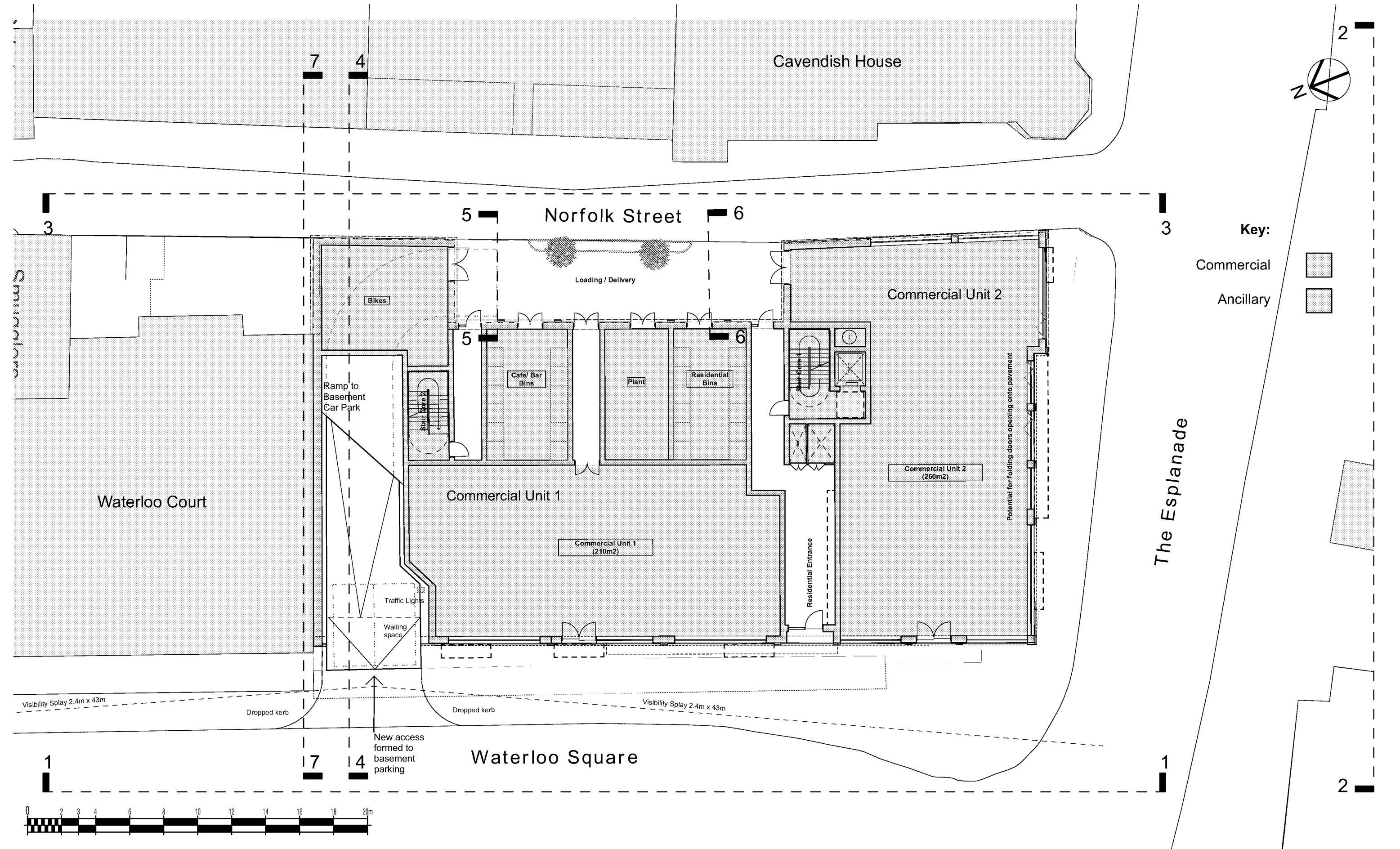
Client:
B5 ltd

Drawing Number / Revision:
18.103.201

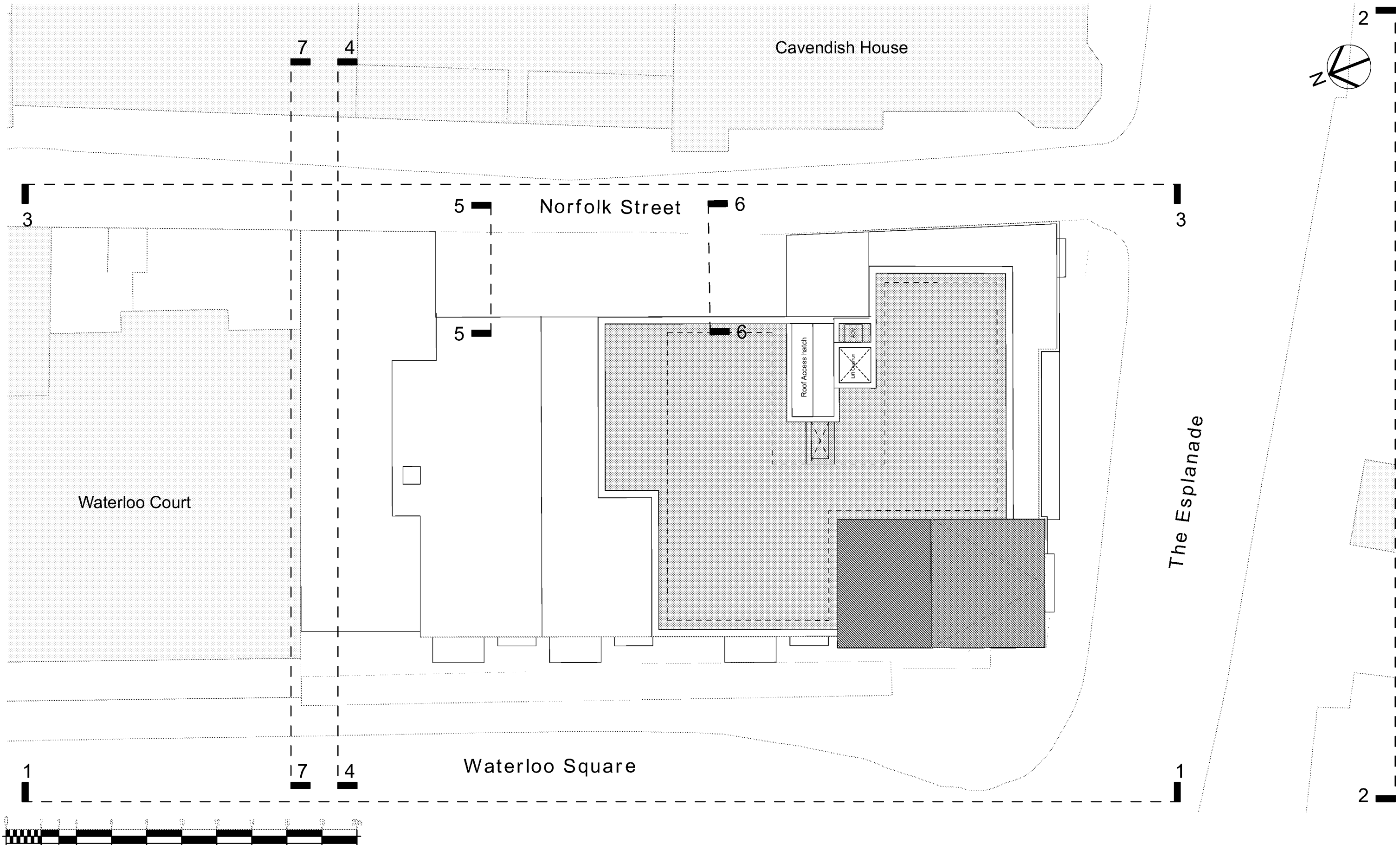
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Revisions	Date (yymmdd)	Description	Notes	Project Title:	Date:	HGP ARCHITECTS Furzehall Farm Wickham Road, Fareham Hampshire, PO16 7JH 01329 283225 email@hgp-architects.co.uk
			Layout subject to survey information and design development	Waterloo Square, Bognor Regis	01.10.19	
				Document Title:	Drawn by / Checked by:	
				Proposed Ground Floor plan	SR / GG	
				Drawing Scale / Sheet Size:	Client:	
				1:200 @ A3	B5 ltd	
				Drawing Status:	Drawing Number / Revision:	
				PLANNING	18.103.202	



Revisions	Date (yy/mm/dd)	Description	Notes	Project Title:	Date:	HGP ARCHITECTS Furzehall Farm Wickham Road, Fareham Hampshire, PO16 7JH 01329 283225 email@hgp-architects.co.uk
			Layout subject to survey information and design development	Waterloo Square, Bognor Regis	01.10.19	
				Document Title:	Drawn by / Checked by:	
				Proposed Roof Plan	SR / GG	
				Drawing Scale / Sheet Size:	Client:	
				1:200 @ A3	B5 ltd	
				Drawing Status:	Drawing Number / Revision:	
				PLANNING	18.103.209	

Appendix B Topographic Survey

Appendix C BGS Records

58. ANTARCTIC ICE CO. Waterloo Square, 100 yds. N. of Pier.
1923. Ht. above O.D. 20 ft. Map 74 N.W.

		Thickness	Depth
		Ft.	Ft.
London Clay	Dug well	17	17
	Blue clay	31	48
	Mottled clay	63	116
Reading Beds	Dark clay	29	139
	Red mottled clay	28	168
	Chalk	6	174
Upper Chalk	Chalk and flints	171	235
	Flints	4	239
	Chalk and flints	404	3784
	Flints	1	3774
	Chalk and flints	1374	515
277	Hard and soft chalk	5	520
	Hard chalk and flints	15	535

Water blankish. R.L.W. 12 1/2 ft. down. Yield 284 g. per hour. Lined 144 ft. of 5 in. tubes, 12 1/2 ft. below surface. Information from Messrs. C. Isler and Co. Ltd.

DATA Bank

Bognor—Map N.S.G. 332.

London Road, Bognor Regis.

55. Old Waterworks, 1 mile S.E. of railway station. Ill.
above O.D. 35 ft. Map 74 N.W.

SZ 9356 9926

		Thickness		Depth	
		ft.	Ft.	ft.	Ft.
Drift	Gravelly sand, saturated with water, which supplied the town	15	24		
	Red and blue clay	34	58		
	Underscribed bed	4	62		
	Red sand	3	65		
Reading Beds	Red and blue clay	47	114		
	Marl rock	4	118		
Upper Chalk	Chalk and flint	212	330		

R.L.W. was 20 ft. down, depressed to nearly 80 ft. pumping 180,000 g p. day. Shaft and cylinders 80 ft. the rest bored. From a lithographical section, communicated by Mr. J. W. Crover, C.E. (published as a woodcut in *The Builder*, 25th March, 1876). Well is now filled in (1925).

Analysis, see W.S.S. II. p. 216

See also W.S.S. I., p. 15. - account as above.

The site as given above indicates the position of the old Water Tower which was immediately to the N.W. of the Parish Church of St. John the Baptist. The tower is pulled down - the site built over. The well has been filled in (the waterworks was at Small Basset some 1200 yards N.W.E. of the Station). O.D. 15.

According to Waterworks Directory 1909, the works were established in 1870. The yearly supply is 60 million gallons. W.S.S. E. 159. Note site S.E. of Ring St. marked by C. Reid on fold slip L.XIV. NW/12. with - Blue & G. 5' (black sd. & 10' 8" Blue clay. 'waterworks' are marked by C. Reid at S. Basset. Situated on 1" sheet N.S. 332. (where waterworks also marked as Basset). 'Well, water works' marked at S. Basset on 1" sheet O.S. 9.

See note on ³³²/36 referring to high salt content at Bognor Old Waterworks nearby. This would appear to be incorrect - see letter from Bognor Regis W.D.C. 8-5-41. P.T.O.

Published in
'Wells & Springs
of Sussex.'
page 60

Appendix D Arun District Council SFRA Extracts



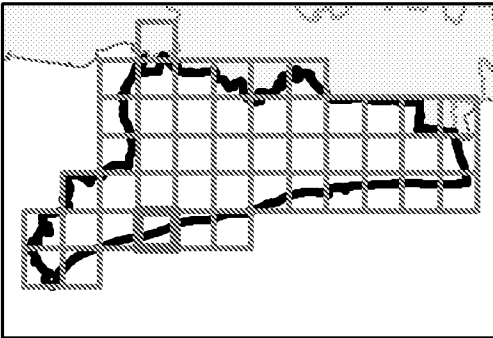
Notes

The Areas Susceptible to Groundwater Flooding (ASiGWF) is a strategic scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate Indicative Flood Risk Areas for Preliminary Flood Risk Assessment (PFRA) studies and allow the Lead Local Flood Authorities (LLFAs) to determine whether there may be a risk of flooding from groundwater.

This data shows the proportion of each 1km grid square where geological and hydrogeological condition show that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring. It does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The ASiGWF data should be used only in combination with other information, for example local data or historic data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

Key Plan



Legend

- Arun District SFRA boundary
- < 25%
- >= 25% <50%
- >= 50% <75%
- >= 75%



REF	Date	Comments
A	June 2016	-
B		
C		

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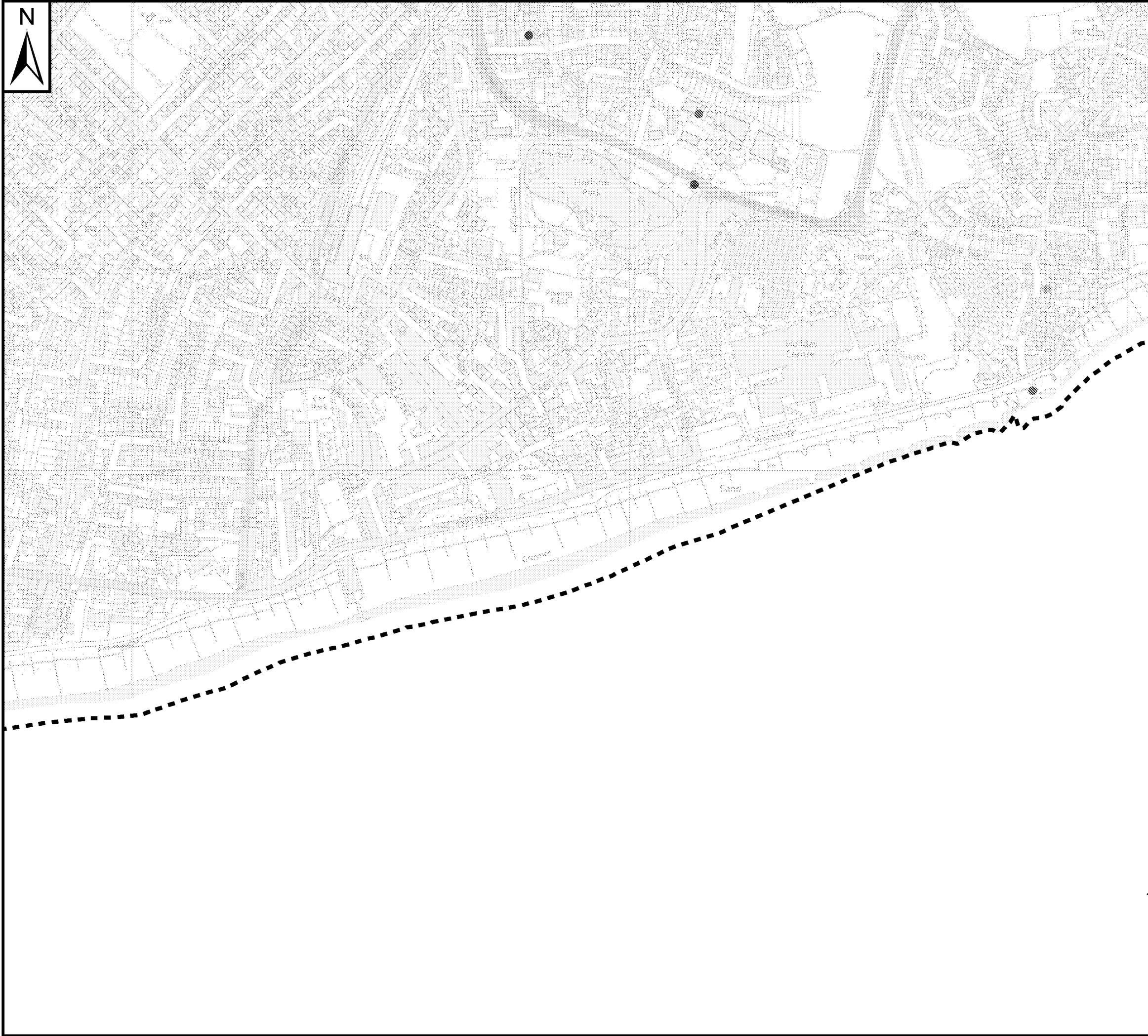
ARUN DISTRICT COUNCIL

LEVEL 1 SFRA: APPENDIX F
AREAS SUSCEPTIBLE TO GROUNDWATER

Sheet No. 6 of 46 Index Number: AGC_06

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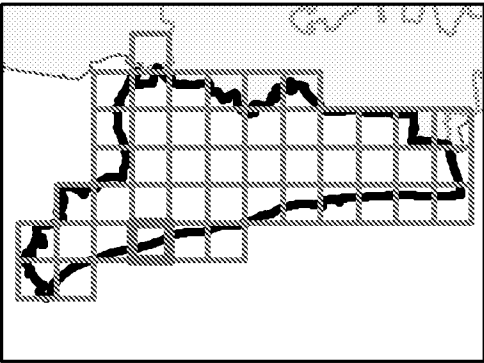
Notes

The Historic Flooding Map shows the recorded incidents and flood outlines provided by Arun District Council, West Sussex County Council, Southern Water and Environment Agency. Historical flood extent was obtained from the Environment Agency

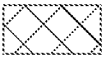
Flooding incidents provided have been categorised based upon the details provided in the records. Unknown flood points could not be determined from the information provided, and therefore could be from a number of sources.

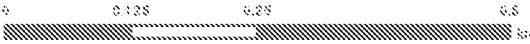
Please note that not all historical records may be shown on this map, and that it is therefore advised you contact Arun District Council for updated information post 2015.

Key Plan



Legend

-  Arun District SFRA boundary
-  Historic flood outline
- Source of flooding**
-  Fluvial
-  Coastal
-  Tidal
-  Surface Water
-  Feature
-  Unknown



REF	Date	Comments
A	June 2015	-
B		
C		

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ARUN DISTRICT COUNCIL
LEVEL 1 SFRA: APPENDIX H
HISTORIC FLOODING RECORDS

Sheet No: 6 of 46 Index Number: AGC_06

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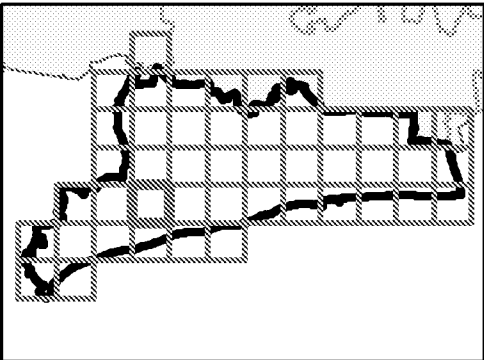
Notes

The Historic Flooding Map shows the recorded incidents and flood outlines provided by Arun District Council, West Sussex County Council, Southern Water and Environment Agency. Historical flood extent was obtained from the Environment Agency

Flooding incidents provided have been categorised based upon the details provided in the records. Unknown flood points could not be determined from the information provided, and therefore could be from a number of sources.

Please note that not all historical records may be shown on this map, and that it is therefore advised you contact Arun District Council for updated information post 2015.

Key Plan



Legend

- Arun District SFRA boundary
- Historic flood outline
- Source of flooding

Fluvial

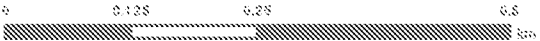
Coastal

Tidal

Surface Water

Feature

Unknown



REF	Date	Comments
A	June 2015	-
B		
C		

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ARUN DISTRICT COUNCIL
LEVEL 1 SFRA: APPENDIX H
HISTORIC FLOODING RECORDS

Sheet No. 11 of 48 Index Number: AGC_11

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Appendix E Southern Water Sewer Records

99025



SZ9398NW



Southern
Water

ARUN DISTRICT COUNCIL BR/282/19/PL

SEWER RECORDS PAGE 2 OF 2

	Node	Cover	Invert	Size	Material	Shape		Node	Cover	Invert	Size	Material	Shape		Node	Cover	Invert	Size	Material	Shape		Node	Cover	Invert	Size	Material	Shape
	2005X	6.3	4.32	300	VC	CIRC		4851Y	5.68	3.66	225	VC	CIRC	*													
	2006X	6.45	4.35	300	VC	CIRC		4851X	5.68	3.65	225	VC	CIRC	*													
	2009X	5.96	4.21	375	VC	CIRC		4852X	5.74	3.15	600	BAC	CIRC														
	2011X			150	VC	CIRC		4853X	5.46	3.13	600	BAC	CIRC														
	2058X	6.52	4.86	225	VC	CIRC		4854X	5.49	2.72	600	CI	CIRC														
	2059X	6.4	4.84	225	VC	CIRC		4901X	6.06	3.09	375	VC	CIRC	*													
	2703X	5.07		450	BRE	CIRC		4901Y	6.06	4.64	225	VC	CIRC	*													
	2756X	5.27	2.26	600	CI	CIRC		4902X	5.82	3.47	375	VC	CIRC														
	2803X	5.82		300	VC	CIRC		4903X	5.83	3.56	225	VC	CIRC														
	2804X			UNK	UNK	UNK		4904X			150	VC	CIRC														
	2805X			150	VC	CIRC		4951X	5.96	3.97	225	VC	CIRC														
	280DX			300	VC	CIRC		4952X	5.88	3.42	600	BAC	CIRC														
	281DX			300	VC	CIRC		4953X	6.01		600	BAC	CIRC														
	2852X	5.83	4.7	225	VC	CIRC		4954X	5.99		600	BAC	CIRC														
	2904X	5.77	3.99	375	VC	CIRC		4955X	6.1	3.86	600	BAC	CIRC														
	2905X	6.13	4.05	375	VC	CIRC		4956X	5.93	4.59	225	VC	CIRC														
	2954X	5.72	4.66	225	VC	CIRC		4957X	5.82	4.18	225	VC	CIRC														
	2955X	6.02	4.54	300	VC	CIRC		5005X	5.41	3.18	400	VC	CIRC														
	3001X	6.28	4.41	300	VC	CIRC		5006X	5.17	3.15	400	VC	CIRC														
	3002X	6.66	4.61	300	VC	CIRC		5008X	5.15	3.18	400	VC	CIRC														
	3051X	6.24	5.04	300	VC	CIRC		5054X	5.14	3.75	225	VC	CIRC														
	3057X	6.31	5.53	150	VC	CIRC		5055X			150	VC	CIRC	*													
	3701X			225	VC	CIRC		5055Y			150	VC	CIRC	*													
	3702X			450	BRE	CIRC		5801X	5.5	2.13	450	BRE	CIRC														
	3703X			450	BRE	CIRC		5802X	5.31	2.07	500	BRE	CIRC														
	371DX			450	BRE	CIRC		5803X	5.49	4.14	225	VC	CIRC														
	3751X	5.3	2.9	300	CP	CIRC		5804X			UNK	UNK	UNK														
	3752X	5.14	3.14	300	CP	CIRC		580DX			500	BRE	CIRC														
	3753X	5.28	3.24	300	VC	CIRC		5851X	5.43	3.33	225	VC	CIRC														
	3754X	5.4	3.34	300	VC	CIRC		5852X	5.25	3.47	225	VC	CIRC														
	3801X	5.44	2.38	450	BRE	CIRC		5853X	5.32	3.72	225	VC	CIRC														
	3802X	5.81		300	VC	CIRC		5902X	5.39		600	BAC	CIRC														
	3803X	5.86		225	VC	CIRC		5904X			225	UNK	CIRC														
	3804X			300	VC	CIRC		590DX			UNK	UNK	UNK														
	3805X			300	VC	CIRC		591DX			500	BRE	CIRC														
	3806X			100	VC	CIRC		592DX			UNK	UNK	UNK														
	3807X			225	VC	CIRC		593DX			225	UNK	CIRC														
	3808X			100	VC	CIRC		594DX			600	BAC	CIRC														
	3809X			150	VC	CIRC		5951X	5.43	3.99	225	VC	CIRC														
	380DX			225	VC	CIRC		596DX			UNK	UNK	UNK														
	3811X			100	VC	CIRC		6006X			UNK	VC	CIRC														
	381DX			150	VC	CIRC		604DX			UNK	UNK	UNK														
	382DX			150	VC	CIRC		680AX			600	DI	CIRC														
	383DX			100	VC	CIRC		6901X	4.88	1.94	600	BAC	CIRC														
	384DX			225	VC	CIRC		6902X	4.42	1.82	OTHER	BAC	CIRC														
	3851X	5.36	3.8	225	VC	CIRC		690DX			UNK	UNK	UNK														
	3852X	5.82	4.23	225	VC	CIRC		691DX			600	BAC	CIRC														
	3853X	5.84	3.74	225	VC	CIRC		6951X	4.88	3.42	225	VC	CIRC														
	3901X	6.3	4.22	225	VC	CIRC		6952X	4.47	2.97	300	VC	CIRC														
	3902X	6.21	4.18	375	VC	CIRC	*	7001X	4.5	1.76	OTHER	BAC	CIRC														
	3902Y	6.21	4.18	300	VC	CIRC	*	700DX			UNK	UNK	UNK														
	3903X	6.34	4.34	300	VC	CIRC		701DX			OTHER	BAC	CIRC														
	3951X	6.18	4.79	225	VC	CIRC		7956X	4.69	3.7	450	VC	CIRC														
	3954X	6.14	4.77	225	VC	CIRC																					
	3955X	6.17	4.69	225	VC	CIRC																					
	4003X	6.1	3.41	375	VC	CIRC																					
	4006X	6.14	3.61	150	VC	CIRC																					
	4007X			225	VC	CIRC																					
	4052X	5.88	4.1	525	BAC	CIRC																					
	4053X	5.91	4.02	525	BAC	CIRC																					
	4054X	6.08	4.5	225	VC	CIRC																					
	4055Y	6.04	4.57	225	VC	CIRC																					
	470DX			UNK	UNK	UNK																					
	480AX			600	DI	CIRC																					
	481DX			450	BRE	CIRC																					

LINE STYLES / COLOURS

Brown	----- Foul
	----- Foul Syphon Sewer
	----- Foul Vacuum Main
Red	----- Foul Rising Main
	----- Combined
	----- Combined Syphon Sewer
	----- Combined Rising Main
Orange	----- Lateral Drain
	----- Building Over Agreement Area
Dark Blue	----- Treated Effluent
Purple	----- Sludge
	----- Sewer Catchment
	----- Section 104 Area
Light Blue	----- Surface Water
	----- Surface Water Rising Main
Yellow	----- Private
Green	----- Access Shaft
	----- Decommissioned

MATERIALS

AK	Alkaline
BAC	Bonded Asbestos Cement
BRC	Brcs (Common)
BRE	Brcs (Engineering)
CC	Concrete Box Culvert
CI	Cast Iron
CO	Concrete (In-Situ)
CP	Concrete (Pre-Cast)
CSB	Concrete Segments (bolted)
CSU	Concrete Segments (unbolted)
DI	Ductile Iron
GRG	Glass Reinforced Concrete
GRP	Glass Reinforced Plastic
MAC	Masonry in regular Courses
MAR	Masonry in random Courses
PE	Polyethylene
PF	Pitch Fibre
PP	Polypropylene
PVC	Polyvinyl Chloride
RFW	Reinforced Plastic Matrix
SI	Spun Iron
ST	Steel
VC	Verified Clay
XXX	Other
ZZZ	Unknown

Manhole (SW)
Manhole (F&C)
Lamp hole (SW)
Lamp hole (F&C)
Pumping Station (SW)
Pumping Station (F&C)
Side entry manhole (SW)
Side entry manhole (F&C)
Blind shaft (SW)
Blind shaft (F&C)
Ejector station (SW)
Ejector station (F&C)
Watertight door (SW)
Watertight door (F&C)
Flushing ch. Min-e (SW)
Flushing ch. Min-e (F&C)
Flushing ch. No-e (SW)
Flushing ch. No-e (F&C)
Demonstration Chamber

LEGEND - SEWERS

Washout (SW)
Washout (F&C)
Rodding Eye (SW)
Rodding Eye (F&C)
Gauging point (SW)
Gauging point (F&C)
Intercept chamber (SW)
Intercept chamber (F&C)
Storm Tank (SW)
Storm Tank (F&C)
Vortex chamber (SW)
Vortex chamber (F&C)
Label ellipse
Dummy/S24 manhole
Outfall
Penstock chamber
Demiboards
Storm Overflow
Backdrop manhole

Other (s)
Other
Change In sewer (s)
Change In sewer
Rafflux valve
Flap valve
Cascade
Anode
Valve
Closed Valve
Air Valve
Hatch box (SW)
Hatch box (F&C)
Direction arrow
Emptying valve
Catchpit
Soakaway
Inlet
Balancing Pond

SHAPES (S)

A	Arched	R	Rectangular
B	Barrel	S	Square
C	Circular	T	Trapezoidal
E	Egg	U	U Shape
H	Horseshoe	X	Other

NODE REFERENCING SYSTEM

1st digit:	hundred metre easting identifier
2nd digit:	hundred metre northing identifier
3rd digit:	sewer type identifier
4th digit:	next sequential node

Drawn by:	rohandas	
Title:	361411_Waterloo Square, Bognor	
Date:	26/11/2019	

Appendix F The Environment Agency Product 4 Response



Environment
Agency



N

● Site_Nodes

 Site_Boundary

Scale: 1:1,000

00.02250.045

Kilometers



Product 4 Flood Risk Data Requested by: Bright Plan Civils

Site: Waterloo Square, Bognor Regis, PO21 1SU

Table 1: Water Levels: Tidal Undefended

Node Ref	NGR		Modelled Flood Levels in Metres AOD			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			0.5%	0.5% (2070)	0.5% (2115)	0.1%
1	493481	98899	-	5.82	5.90	5.82
2	493494	98867	5.67	5.69	5.77	5.68

Table 2: Water Levels: Tidal Defended

Node Ref	NGR		Modelled Flood Levels in Metres AOD			
	Eastings	Northings	Defended Annual Exceedance Probability			
			0.5%	0.5% (2070)	0.5% (2115)	0.1%
1	493481	98899	-	5.80	5.87	5.87
2	493494	98867	-	5.64	5.68	-

Table 3: Water Depths: Tidal Undefended

Node Ref	NGR		Modelled Flood Depths in Metres			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			0.5%	0.5% (2070)	0.5% (2115)	0.1%
1	493481	98899	-	0.11	0.18	0.11
2	493494	98867	0.01	0.03	0.10	0.03

Table 4: Water Depths: Tidal Defended

Node Ref	NGR		Modelled Flood Depths in Metres			
	Eastings	Northings	Defended Annual Exceedance Probability			
			0.5%	0.5% (2070)	0.5% (2115)	0.1%
1	493481	98899	-	0.09	0.15	-
2	493494	98867	-	0.01	0.01	-

All levels taken from: River Arun to East Head (2D)

Produced on: 26/11/2019

There is no additional information or health warnings for these levels/depths or the model from which they have been produced.







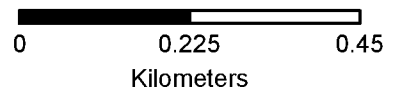
Environment
Agency

N
▲

- Legend**
- Site_Boundary
 - 0.5% AEP (Defended Tidal)
 - 0.5% AEP (2070) NPPF (Defended Tidal)
 - 0.5% AEP (2115) NPPF (Defended Tidal)
 - 0.1% AEP (Defended Tidal)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:10,000



Appendix G MicroDrainage Calculations

RGP Design Limited					Page 1
2 West Barn Norton Lane Chichester PO20 3AF					
Date 11/12/2019 17:01			Designed by DanLytton		
File D1832 DRAINAGE STRATEGY...			Checked by		
Innovyze			Source Control 2017.1		
<u>Summary of Results for 1 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	4.046	0.046	9.9	0.1	O K
30 min Summer	4.048	0.048	10.1	0.1	O K
60 min Summer	4.033	0.033	8.5	0.0	O K
120 min Summer	4.009	0.009	6.2	0.0	O K
180 min Summer	4.000	0.000	5.0	0.0	O K
240 min Summer	4.000	0.000	4.2	0.0	O K
360 min Summer	4.000	0.000	3.3	0.0	O K
480 min Summer	4.000	0.000	2.7	0.0	O K
600 min Summer	4.000	0.000	2.3	0.0	O K
720 min Summer	4.000	0.000	2.1	0.0	O K
960 min Summer	4.000	0.000	1.7	0.0	O K
1440 min Summer	4.000	0.000	1.3	0.0	O K
2160 min Summer	4.000	0.000	1.0	0.0	O K
2880 min Summer	4.000	0.000	0.8	0.0	O K
4320 min Summer	4.000	0.000	0.6	0.0	O K
5760 min Summer	4.000	0.000	0.5	0.0	O K
7200 min Summer	4.000	0.000	0.4	0.0	O K
8640 min Summer	4.000	0.000	0.4	0.0	O K
10080 min Summer	4.000	0.000	0.3	0.0	O K
15 min Winter	4.056	0.056	11.0	0.1	O K
30 min Winter	4.048	0.048	10.1	0.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	28.110	0.0	5.8	12	
30 min Summer	18.645	0.0	7.7	19	
60 min Summer	12.084	0.0	10.0	34	
120 min Summer	7.690	0.0	12.7	64	
180 min Summer	5.881	0.0	14.6	0	
240 min Summer	4.857	0.0	16.0	0	
360 min Summer	3.685	0.0	18.2	0	
480 min Summer	3.020	0.0	19.9	0	
600 min Summer	2.589	0.0	21.4	0	
720 min Summer	2.283	0.0	22.6	0	
960 min Summer	1.872	0.0	24.7	0	
1440 min Summer	1.416	0.0	28.0	0	
2160 min Summer	1.071	0.0	31.8	0	
2880 min Summer	0.878	0.0	34.8	0	
4320 min Summer	0.664	0.0	39.4	0	
5760 min Summer	0.545	0.0	43.2	0	
7200 min Summer	0.468	0.0	46.3	0	
8640 min Summer	0.412	0.0	49.0	0	
10080 min Summer	0.370	0.0	51.3	0	
15 min Winter	28.110	0.0	6.5	12	
30 min Winter	18.645	0.0	8.6	19	
©1982-2017 XP Solutions					

RGP Design Limited				Page 2	
2 West Barn Norton Lane Chichester PO20 3AF					
Date 11/12/2019 17:01 File D1832 DRAINAGE STRATEGY...		Designed by DanLytton Checked by			
Innovyze		Source Control 2017.1			
<u>Summary of Results for 1 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	4.023	0.023	7.4	0.0	O K
120 min Winter	4.000	0.000	4.9	0.0	O K
180 min Winter	4.000	0.000	3.8	0.0	O K
240 min Winter	4.000	0.000	3.1	0.0	O K
360 min Winter	4.000	0.000	2.4	0.0	O K
480 min Winter	4.000	0.000	2.0	0.0	O K
600 min Winter	4.000	0.000	1.7	0.0	O K
720 min Winter	4.000	0.000	1.5	0.0	O K
960 min Winter	4.000	0.000	1.2	0.0	O K
1440 min Winter	4.000	0.000	0.9	0.0	O K
2160 min Winter	4.000	0.000	0.7	0.0	O K
2880 min Winter	4.000	0.000	0.6	0.0	O K
4320 min Winter	4.000	0.000	0.4	0.0	O K
5760 min Winter	4.000	0.000	0.4	0.0	O K
7200 min Winter	4.000	0.000	0.3	0.0	O K
8640 min Winter	4.000	0.000	0.3	0.0	O K
10080 min Winter	4.000	0.000	0.2	0.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	12.084	0.0	11.2	34	
120 min Winter	7.690	0.0	14.2	0	
180 min Winter	5.881	0.0	16.3	0	
240 min Winter	4.857	0.0	18.0	0	
360 min Winter	3.685	0.0	20.4	0	
480 min Winter	3.020	0.0	22.3	0	
600 min Winter	2.589	0.0	23.9	0	
720 min Winter	2.283	0.0	25.3	0	
960 min Winter	1.872	0.0	27.7	0	
1440 min Winter	1.416	0.0	31.4	0	
2160 min Winter	1.071	0.0	35.6	0	
2880 min Winter	0.878	0.0	38.9	0	
4320 min Winter	0.664	0.0	44.2	0	
5760 min Winter	0.545	0.0	48.3	0	
7200 min Winter	0.468	0.0	51.9	0	
8640 min Winter	0.412	0.0	54.8	0	
10080 min Winter	0.370	0.0	57.4	0	
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Innovyze	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 5.500

Pipe Structure

Diameter (m) 0.150 Length (m) 10.000
Slope (1:X) 100.000 Invert Level (m) 4.000

Pipe Outflow Control

Diameter (m) 0.150 Entry Loss Coefficient 0.500
Slope (1:X) 100.0 Coefficient of Contraction 0.600
Length (m) 5.000 Upstream Invert Level (m) 3.900
Roughness k (mm) 0.600

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Innovyze			Source Control 2017.1					
<u>Summary of Results for 1 year Return Period</u>								
Half Drain Time : 9 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m³)	Status	
15 min Summer	5.210	0.060	0.0	2.1	2.1	1.6	Flood	Risk
30 min Summer	5.218	0.068	0.0	2.5	2.5	1.8	Flood	Risk
60 min Summer	5.220	0.070	0.0	2.7	2.7	1.8	Flood	Risk
120 min Summer	5.218	0.068	0.0	2.5	2.5	1.8	Flood	Risk
180 min Summer	5.221	0.071	0.0	2.8	2.8	1.9	Flood	Risk
240 min Summer	5.220	0.070	0.0	2.7	2.7	1.8	Flood	Risk
360 min Summer	5.216	0.066	0.0	2.4	2.4	1.7	Flood	Risk
480 min Summer	5.211	0.061	0.0	2.1	2.1	1.6	Flood	Risk
600 min Summer	5.208	0.058	0.0	1.9	1.9	1.5	Flood	Risk
720 min Summer	5.204	0.054	0.0	1.7	1.7	1.4	Flood	Risk
960 min Summer	5.200	0.050	0.0	1.5	1.5	1.3	Flood	Risk
1440 min Summer	5.194	0.044	0.0	1.1	1.1	1.2	O K	
2160 min Summer	5.188	0.038	0.0	0.9	0.9	1.0	O K	
2880 min Summer	5.185	0.035	0.0	0.7	0.7	0.9	O K	
4320 min Summer	5.180	0.030	0.0	0.5	0.5	0.8	O K	
5760 min Summer	5.177	0.027	0.0	0.4	0.4	0.7	O K	
7200 min Summer	5.175	0.025	0.0	0.4	0.4	0.6	O K	
8640 min Summer	5.173	0.023	0.0	0.3	0.3	0.6	O K	
10080 min Summer	5.172	0.022	0.0	0.3	0.3	0.6	O K	
15 min Winter	5.216	0.066	0.0	2.4	2.4	1.7	Flood	Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)				
15 min Summer	28.110	0.0	2.3	16				
30 min Summer	18.645	0.0	4.0	24				
60 min Summer	12.084	0.0	6.1	40				
120 min Summer	7.690	0.0	8.6	78				
180 min Summer	5.881	0.0	10.3	108				
240 min Summer	4.857	0.0	11.6	136				
360 min Summer	3.685	0.0	13.5	194				
480 min Summer	3.020	0.0	14.9	254				
600 min Summer	2.589	0.0	16.1	312				
720 min Summer	2.283	0.0	17.1	374				
960 min Summer	1.872	0.0	18.7	492				
1440 min Summer	1.416	0.0	21.2	738				
2160 min Summer	1.071	0.0	23.9	1100				
2880 min Summer	0.878	0.0	25.7	1468				
4320 min Summer	0.664	0.0	28.3	2204				
5760 min Summer	0.545	0.0	30.1	2936				
7200 min Summer	0.468	0.0	31.3	3648				
8640 min Summer	0.412	0.0	32.2	4288				
10080 min Summer	0.370	0.0	33.0	5136				
15 min Winter	28.110	0.0	3.0	16				
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<u>Summary of Results for 1 year Return Period</u>									
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status		
30 min Winter	5.222	0.072	0.0	2.9	2.9	1.9	Flood	Risk	
60 min Winter	5.220	0.070	0.0	2.7	2.7	1.8	Flood	Risk	
120 min Winter	5.223	0.073	0.0	3.0	3.0	1.9	Flood	Risk	
180 min Winter	5.221	0.071	0.0	2.8	2.8	1.9	Flood	Risk	
240 min Winter	5.217	0.067	0.0	2.5	2.5	1.8	Flood	Risk	
360 min Winter	5.210	0.060	0.0	2.0	2.0	1.6	Flood	Risk	
480 min Winter	5.204	0.054	0.0	1.7	1.7	1.4	Flood	Risk	
600 min Winter	5.201	0.051	0.0	1.5	1.5	1.3	Flood	Risk	
720 min Winter	5.198	0.048	0.0	1.3	1.3	1.3	O K		
960 min Winter	5.193	0.043	0.0	1.1	1.1	1.1	O K		
1440 min Winter	5.187	0.037	0.0	0.8	0.8	1.0	O K		
2160 min Winter	5.183	0.033	0.0	0.6	0.6	0.9	O K		
2880 min Winter	5.179	0.029	0.0	0.5	0.5	0.8	O K		
4320 min Winter	5.175	0.025	0.0	0.4	0.4	0.7	O K		
5760 min Winter	5.173	0.023	0.0	0.3	0.3	0.6	O K		
7200 min Winter	5.171	0.021	0.0	0.3	0.3	0.5	O K		
8640 min Winter	5.169	0.019	0.0	0.2	0.2	0.5	O K		
10080 min Winter	5.167	0.017	0.0	0.2	0.2	0.4	O K		
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)					
30 min Winter	18.645	0.0	4.9	24					
60 min Winter	12.084	0.0	7.2	40					
120 min Winter	7.690	0.0	10.0	78					
180 min Winter	5.881	0.0	11.9	108					
240 min Winter	4.857	0.0	13.3	138					
360 min Winter	3.685	0.0	15.5	196					
480 min Winter	3.020	0.0	17.1	258					
600 min Winter	2.589	0.0	18.4	312					
720 min Winter	2.283	0.0	19.6	380					
960 min Winter	1.872	0.0	21.5	500					
1440 min Winter	1.416	0.0	24.4	738					
2160 min Winter	1.071	0.0	27.4	1104					
2880 min Winter	0.878	0.0	29.7	1460					
4320 min Winter	0.664	0.0	32.8	2192					
5760 min Winter	0.545	0.0	35.1	2832					
7200 min Winter	0.468	0.0	36.7	3632					
8640 min Winter	0.412	0.0	37.8	4296					
10080 min Winter	0.370	0.0	38.6	5136					
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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.052

Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:
0	4 0.025	4	8 0.027

Green Roof

Area (m³)	497	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:	From:	To:	From:	To:
0	4 0.009031	32	36 0.001823	64	68 0.000368	96	100 0.000074
4	8 0.007394	36	40 0.001493	68	72 0.000301	100	104 0.000061
8	12 0.006054	40	44 0.001222	72	76 0.000247	104	108 0.000050
12	16 0.004957	44	48 0.001001	76	80 0.000202	108	112 0.000041
16	20 0.004058	48	52 0.000819	80	84 0.000165	112	116 0.000033
20	24 0.003322	52	56 0.000671	84	88 0.000135	116	120 0.000027
24	28 0.002720	56	60 0.000549	88	92 0.000111		
28	32 0.002227	60	64 0.000450	92	96 0.000091		

Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area (ha)
From:	To:
0	4 0.000

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Innovyze	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 5.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr) 0.00000	Width (m) 8.2
Membrane Percolation (mm/hr) 1000	Length (m) 10.0
Max Percolation (l/s) 22.8	Slope (1:X) 0.0
Safety Factor 1.0	Depression Storage (mm) 5
Porosity 0.32	Evaporation (mm/day) 3
Invert Level (m) 5.150	Membrane Depth (m) 0

Pipe Outflow Control

Diameter (m) 0.150	Entry Loss Coefficient 0.500
Slope (1:X) 100.0	Coefficient of Contraction 0.600
Length (m) 5.000	Upstream Invert Level (m) 5.150
Roughness k (mm) 0.600	

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Date 11/12/2019 17:01		Designed by DanLytton			
File D1832 DRAINAGE STRATEGY...		Checked by			
Innovyze		Source Control 2017.1			
Summary of Results for 30 year Return Period					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	4.239	0.239	24.1	0.4	O K
30 min Summer	4.250	0.250	24.6	0.4	O K
60 min Summer	4.169	0.169	20.5	0.3	O K
120 min Summer	4.089	0.089	14.7	0.1	O K
180 min Summer	4.061	0.061	11.6	0.1	O K
240 min Summer	4.043	0.043	9.5	0.1	O K
360 min Summer	4.021	0.021	7.2	0.0	O K
480 min Summer	4.005	0.005	5.9	0.0	O K
600 min Summer	4.000	0.000	5.0	0.0	O K
720 min Summer	4.000	0.000	4.3	0.0	O K
960 min Summer	4.000	0.000	3.5	0.0	O K
1440 min Summer	4.000	0.000	2.6	0.0	O K
2160 min Summer	4.000	0.000	1.9	0.0	O K
2880 min Summer	4.000	0.000	1.5	0.0	O K
4320 min Summer	4.000	0.000	1.1	0.0	O K
5760 min Summer	4.000	0.000	0.9	0.0	O K
7200 min Summer	4.000	0.000	0.8	0.0	O K
8640 min Summer	4.000	0.000	0.7	0.0	O K
10080 min Summer	4.000	0.000	0.6	0.0	O K
15 min Winter	4.304	0.304	26.9	0.5	O K
30 min Winter	4.250	0.250	24.6	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	68.836	0.0	14.2	12	
30 min Summer	45.828	0.0	18.9	19	
60 min Summer	29.238	0.0	24.1	34	
120 min Summer	18.112	0.0	29.9	64	
180 min Summer	13.534	0.0	33.5	94	
240 min Summer	10.952	0.0	36.1	124	
360 min Summer	8.106	0.0	40.1	186	
480 min Summer	6.544	0.0	43.2	244	
600 min Summer	5.539	0.0	45.7	0	
720 min Summer	4.832	0.0	47.8	0	
960 min Summer	3.892	0.0	51.4	0	
1440 min Summer	2.866	0.0	56.8	0	
2160 min Summer	2.108	0.0	62.6	0	
2880 min Summer	1.693	0.0	67.0	0	
4320 min Summer	1.242	0.0	73.8	0	
5760 min Summer	0.996	0.0	78.9	0	
7200 min Summer	0.839	0.0	83.1	0	
8640 min Summer	0.730	0.0	86.7	0	
10080 min Summer	0.648	0.0	89.9	0	
15 min Winter	68.836	0.0	15.9	12	
30 min Winter	45.828	0.0	21.2	19	
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Innovyze		Source Control 2017.1			
<u>Summary of Results for 30 year Return Period</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	4.128	0.128	17.8	0.2	O K
120 min Winter	4.061	0.061	11.5	0.1	O K
180 min Winter	4.035	0.035	8.7	0.0	O K
240 min Winter	4.020	0.020	7.1	0.0	O K
360 min Winter	4.000	0.000	5.3	0.0	O K
480 min Winter	4.000	0.000	4.2	0.0	O K
600 min Winter	4.000	0.000	3.6	0.0	O K
720 min Winter	4.000	0.000	3.1	0.0	O K
960 min Winter	4.000	0.000	2.5	0.0	O K
1440 min Winter	4.000	0.000	1.9	0.0	O K
2160 min Winter	4.000	0.000	1.4	0.0	O K
2880 min Winter	4.000	0.000	1.1	0.0	O K
4320 min Winter	4.000	0.000	0.8	0.0	O K
5760 min Winter	4.000	0.000	0.6	0.0	O K
7200 min Winter	4.000	0.000	0.5	0.0	O K
8640 min Winter	4.000	0.000	0.5	0.0	O K
10080 min Winter	4.000	0.000	0.4	0.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	29.238	0.0	27.0	34	
120 min Winter	18.112	0.0	33.5	64	
180 min Winter	13.534	0.0	37.5	96	
240 min Winter	10.952	0.0	40.5	124	
360 min Winter	8.106	0.0	44.9	0	
480 min Winter	6.544	0.0	48.4	0	
600 min Winter	5.539	0.0	51.2	0	
720 min Winter	4.832	0.0	53.6	0	
960 min Winter	3.892	0.0	57.5	0	
1440 min Winter	2.866	0.0	63.6	0	
2160 min Winter	2.108	0.0	70.1	0	
2880 min Winter	1.693	0.0	75.1	0	
4320 min Winter	1.242	0.0	82.6	0	
5760 min Winter	0.996	0.0	88.4	0	
7200 min Winter	0.839	0.0	93.0	0	
8640 min Winter	0.730	0.0	97.1	0	
10080 min Winter	0.648	0.0	100.7	0	
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Model Details

Storage is Online Cover Level (m) 5.500

Pipe Structure

Diameter (m) 0.150 Length (m) 10.000
Slope (1:X) 100.000 Invert Level (m) 4.000

Pipe Outflow Control

Diameter (m) 0.150 Entry Loss Coefficient 0.500
Slope (1:X) 100.0 Coefficient of Contraction 0.600
Length (m) 5.000 Upstream Invert Level (m) 3.900
Roughness k (mm) 0.600

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Innovyze			Source Control 2017.1					
<u>Summary of Results for 30 year Return Period</u>								
Half Drain Time : 6 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	
15 min Summer	5.276	0.126	0.0	7.8	7.8	3.3	Flood	Risk
30 min Summer	5.294	0.144	0.0	9.6	9.6	3.8	Flood	Risk
60 min Summer	5.304	0.154	0.0	10.7	10.7	4.0	Flood	Risk
120 min Summer	5.293	0.143	0.0	9.6	9.6	3.8	Flood	Risk
180 min Summer	5.280	0.130	0.0	8.1	8.1	3.4	Flood	Risk
240 min Summer	5.269	0.119	0.0	7.0	7.0	3.1	Flood	Risk
360 min Summer	5.252	0.102	0.0	5.6	5.6	2.7	Flood	Risk
480 min Summer	5.241	0.091	0.0	4.8	4.8	2.4	Flood	Risk
600 min Summer	5.234	0.084	0.0	4.2	4.2	2.2	Flood	Risk
720 min Summer	5.230	0.080	0.0	3.7	3.7	2.1	Flood	Risk
960 min Summer	5.224	0.074	0.0	3.1	3.1	1.9	Flood	Risk
1440 min Summer	5.214	0.064	0.0	2.3	2.3	1.7	Flood	Risk
2160 min Summer	5.204	0.054	0.0	1.7	1.7	1.4	Flood	Risk
2880 min Summer	5.199	0.049	0.0	1.4	1.4	1.3		O K
4320 min Summer	5.192	0.042	0.0	1.0	1.0	1.1		O K
5760 min Summer	5.187	0.037	0.0	0.8	0.8	1.0		O K
7200 min Summer	5.184	0.034	0.0	0.7	0.7	0.9		O K
8640 min Summer	5.182	0.032	0.0	0.6	0.6	0.8		O K
10080 min Summer	5.180	0.030	0.0	0.5	0.5	0.8		O K
15 min Winter	5.285	0.135	0.0	8.7	8.7	3.6	Flood	Risk
Storm Event			Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)		
15 min Summer			68.836	0.0	10.1	15		
30 min Summer			45.828	0.0	14.4	24		
60 min Summer			29.238	0.0	19.2	40		
120 min Summer			18.112	0.0	24.5	70		
180 min Summer			13.534	0.0	27.8	100		
240 min Summer			10.952	0.0	30.1	130		
360 min Summer			8.106	0.0	33.7	190		
480 min Summer			6.544	0.0	36.4	250		
600 min Summer			5.539	0.0	38.5	310		
720 min Summer			4.832	0.0	40.4	370		
960 min Summer			3.892	0.0	43.4	490		
1440 min Summer			2.866	0.0	47.8	736		
2160 min Summer			2.108	0.0	52.3	1100		
2880 min Summer			1.693	0.0	55.6	1468		
4320 min Summer			1.242	0.0	60.1	2184		
5760 min Summer			0.996	0.0	63.1	2912		
7200 min Summer			0.839	0.0	65.2	3640		
8640 min Summer			0.730	0.0	66.8	4352		
10080 min Summer			0.648	0.0	68.0	5128		
15 min Winter			68.836	0.0	11.6	15		
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Innovyze			Source Control 2017.1				
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	5.307	0.157	0.0	11.1	11.1	4.1	Flood Risk
60 min Winter	5.307	0.157	0.0	11.1	11.1	4.1	Flood Risk
120 min Winter	5.285	0.135	0.0	8.7	8.7	3.5	Flood Risk
180 min Winter	5.269	0.119	0.0	7.0	7.0	3.1	Flood Risk
240 min Winter	5.255	0.105	0.0	5.9	5.9	2.8	Flood Risk
360 min Winter	5.238	0.088	0.0	4.6	4.6	2.3	Flood Risk
480 min Winter	5.230	0.080	0.0	3.8	3.8	2.1	Flood Risk
600 min Winter	5.225	0.075	0.0	3.2	3.2	2.0	Flood Risk
720 min Winter	5.221	0.071	0.0	2.8	2.8	1.9	Flood Risk
960 min Winter	5.214	0.064	0.0	2.3	2.3	1.7	Flood Risk
1440 min Winter	5.204	0.054	0.0	1.7	1.7	1.4	Flood Risk
2160 min Winter	5.197	0.047	0.0	1.3	1.3	1.2	O K
2880 min Winter	5.191	0.041	0.0	1.0	1.0	1.1	O K
4320 min Winter	5.185	0.035	0.0	0.7	0.7	0.9	O K
5760 min Winter	5.182	0.032	0.0	0.6	0.6	0.8	O K
7200 min Winter	5.179	0.029	0.0	0.5	0.5	0.7	O K
8640 min Winter	5.177	0.027	0.0	0.4	0.4	0.7	O K
10080 min Winter	5.175	0.025	0.0	0.4	0.4	0.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	45.828	0.0	16.5	25			
60 min Winter	29.238	0.0	21.9	40			
120 min Winter	18.112	0.0	27.8	70			
180 min Winter	13.534	0.0	31.5	102			
240 min Winter	10.952	0.0	34.1	132			
360 min Winter	8.106	0.0	38.1	192			
480 min Winter	6.544	0.0	41.2	254			
600 min Winter	5.539	0.0	43.6	312			
720 min Winter	4.832	0.0	45.7	374			
960 min Winter	3.892	0.0	49.1	496			
1440 min Winter	2.866	0.0	54.1	740			
2160 min Winter	2.108	0.0	59.3	1096			
2880 min Winter	1.693	0.0	63.1	1464			
4320 min Winter	1.242	0.0	68.3	2168			
5760 min Winter	0.996	0.0	71.9	2904			
7200 min Winter	0.839	0.0	74.6	3592			
8640 min Winter	0.730	0.0	76.6	4408			
10080 min Winter	0.648	0.0	78.3	5160			
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Innovyze	Source Control 2017.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.052

Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:
0	4 0.025	4	8 0.027

Green Roof

Area (m³)	497	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:	From:	To:	From:	To:
0	4 0.009031	32	36 0.001823	64	68 0.000368	96	100 0.000074
4	8 0.007394	36	40 0.001493	68	72 0.000301	100	104 0.000061
8	12 0.006054	40	44 0.001222	72	76 0.000247	104	108 0.000050
12	16 0.004957	44	48 0.001001	76	80 0.000202	108	112 0.000041
16	20 0.004058	48	52 0.000819	80	84 0.000165	112	116 0.000033
20	24 0.003322	52	56 0.000671	84	88 0.000135	116	120 0.000027
24	28 0.002720	56	60 0.000549	88	92 0.000111		
28	32 0.002227	60	64 0.000450	92	96 0.000091		

Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area (ha)
From:	To:
0	4 0.000

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Model Details

Storage is Online Cover Level (m) 5.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr) 0.00000	Width (m) 8.2
Membrane Percolation (mm/hr) 1000	Length (m) 10.0
Max Percolation (l/s) 22.8	Slope (1:X) 0.0
Safety Factor 1.0	Depression Storage (mm) 5
Porosity 0.32	Evaporation (mm/day) 3
Invert Level (m) 5.150	Membrane Depth (m) 0

Pipe Outflow Control

Diameter (m) 0.150	Entry Loss Coefficient 0.500
Slope (1:X) 100.0	Coefficient of Contraction 0.600
Length (m) 5.000	Upstream Invert Level (m) 5.150
Roughness k (mm) 0.600	

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<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	4.837	0.837	43.6	1.0	O K
30 min Summer	4.883	0.883	44.8	1.1	O K
60 min Summer	4.618	0.618	37.7	0.8	O K
120 min Summer	4.304	0.304	26.9	0.5	O K
180 min Summer	4.178	0.178	21.0	0.3	O K
240 min Summer	4.121	0.121	17.3	0.2	O K
360 min Summer	4.075	0.075	13.1	0.1	O K
480 min Summer	4.053	0.053	10.6	0.1	O K
600 min Summer	4.038	0.038	9.0	0.0	O K
720 min Summer	4.027	0.027	7.8	0.0	O K
960 min Summer	4.010	0.010	6.3	0.0	O K
1440 min Summer	4.000	0.000	4.6	0.0	O K
2160 min Summer	4.000	0.000	3.3	0.0	O K
2880 min Summer	4.000	0.000	2.6	0.0	O K
4320 min Summer	4.000	0.000	1.9	0.0	O K
5760 min Summer	4.000	0.000	1.5	0.0	O K
7200 min Summer	4.000	0.000	1.3	0.0	O K
8640 min Summer	4.000	0.000	1.1	0.0	O K
10080 min Summer	4.000	0.000	1.0	0.0	O K
15 min Winter	5.037	1.037	48.4	1.2	O K
30 min Winter	4.883	0.883	44.7	1.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	124.633	0.0	25.7	12	
30 min Summer	83.789	0.0	34.6	20	
60 min Summer	53.779	0.0	44.4	34	
120 min Summer	33.337	0.0	55.0	64	
180 min Summer	24.832	0.0	61.5	94	
240 min Summer	20.006	0.0	66.0	124	
360 min Summer	14.706	0.0	72.8	184	
480 min Summer	11.818	0.0	78.0	244	
600 min Summer	9.966	0.0	82.2	304	
720 min Summer	8.665	0.0	85.8	368	
960 min Summer	6.943	0.0	91.7	482	
1440 min Summer	5.071	0.0	100.4	0	
2160 min Summer	3.696	0.0	109.8	0	
2880 min Summer	2.949	0.0	116.8	0	
4320 min Summer	2.142	0.0	127.2	0	
5760 min Summer	1.705	0.0	135.0	0	
7200 min Summer	1.427	0.0	141.3	0	
8640 min Summer	1.235	0.0	146.7	0	
10080 min Summer	1.093	0.0	151.5	0	
15 min Winter	124.633	0.0	28.8	12	
30 min Winter	83.789	0.0	38.7	20	
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<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	4.461	0.461	32.7	0.6	O K
120 min Winter	4.181	0.181	21.2	0.3	O K
180 min Winter	4.103	0.103	16.0	0.2	O K
240 min Winter	4.074	0.074	13.0	0.1	O K
360 min Winter	4.043	0.043	9.5	0.1	O K
480 min Winter	4.026	0.026	7.7	0.0	O K
600 min Winter	4.012	0.012	6.5	0.0	O K
720 min Winter	4.002	0.002	5.7	0.0	O K
960 min Winter	4.000	0.000	4.5	0.0	O K
1440 min Winter	4.000	0.000	3.3	0.0	O K
2160 min Winter	4.000	0.000	2.4	0.0	O K
2880 min Winter	4.000	0.000	1.9	0.0	O K
4320 min Winter	4.000	0.000	1.4	0.0	O K
5760 min Winter	4.000	0.000	1.1	0.0	O K
7200 min Winter	4.000	0.000	0.9	0.0	O K
8640 min Winter	4.000	0.000	0.8	0.0	O K
10080 min Winter	4.000	0.000	0.7	0.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	53.779	0.0	49.7	34	
120 min Winter	33.337	0.0	61.6	64	
180 min Winter	24.832	0.0	68.8	94	
240 min Winter	20.006	0.0	73.9	124	
360 min Winter	14.706	0.0	81.5	186	
480 min Winter	11.818	0.0	87.4	244	
600 min Winter	9.966	0.0	92.1	306	
720 min Winter	8.665	0.0	96.1	370	
960 min Winter	6.943	0.0	102.6	0	
1440 min Winter	5.071	0.0	112.5	0	
2160 min Winter	3.696	0.0	122.9	0	
2880 min Winter	2.949	0.0	130.8	0	
4320 min Winter	2.142	0.0	142.5	0	
5760 min Winter	1.705	0.0	151.2	0	
7200 min Winter	1.427	0.0	158.2	0	
8640 min Winter	1.235	0.0	164.3	0	
10080 min Winter	1.093	0.0	169.7	0	
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Model Details

Storage is Online Cover Level (m) 5.500

Pipe Structure

Diameter (m) 0.150 Length (m) 10.000
Slope (1:X) 100.000 Invert Level (m) 4.000

Pipe Outflow Control

Diameter (m) 0.150 Entry Loss Coefficient 0.500
Slope (1:X) 100.0 Coefficient of Contraction 0.600
Length (m) 5.000 Upstream Invert Level (m) 3.900
Roughness k (mm) 0.600

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<u>Summary of Results for 100 year Return Period (+40%)</u>							
Half Drain Time : 5 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m³)	Status
15 min Summer	5.385	0.235	0.0	18.3	18.3	6.2	Flood Risk
30 min Summer	5.423	0.273	0.0	20.7	20.7	7.2	Flood Risk
60 min Summer	5.422	0.272	0.0	20.7	20.7	7.1	Flood Risk
120 min Summer	5.377	0.227	0.0	17.7	17.7	5.9	Flood Risk
180 min Summer	5.344	0.194	0.0	15.2	15.2	5.1	Flood Risk
240 min Summer	5.325	0.175	0.0	13.1	13.1	4.6	Flood Risk
360 min Summer	5.300	0.150	0.0	10.3	10.3	3.9	Flood Risk
480 min Summer	5.285	0.135	0.0	8.7	8.7	3.5	Flood Risk
600 min Summer	5.274	0.124	0.0	7.5	7.5	3.3	Flood Risk
720 min Summer	5.264	0.114	0.0	6.6	6.6	3.0	Flood Risk
960 min Summer	5.249	0.099	0.0	5.4	5.4	2.6	Flood Risk
1440 min Summer	5.234	0.084	0.0	4.1	4.1	2.2	Flood Risk
2160 min Summer	5.223	0.073	0.0	3.0	3.0	1.9	Flood Risk
2880 min Summer	5.216	0.066	0.0	2.4	2.4	1.7	Flood Risk
4320 min Summer	5.205	0.055	0.0	1.8	1.8	1.4	Flood Risk
5760 min Summer	5.199	0.049	0.0	1.4	1.4	1.3	O K
7200 min Summer	5.195	0.045	0.0	1.2	1.2	1.2	O K
8640 min Summer	5.192	0.042	0.0	1.0	1.0	1.1	O K
10080 min Summer	5.189	0.039	0.0	0.9	0.9	1.0	O K
15 min Winter	5.414	0.264	0.0	20.2	20.2	6.9	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	124.633	0.0	20.7	16			
30 min Summer	83.789	0.0	28.9	23			
60 min Summer	53.779	0.0	37.9	38			
120 min Summer	33.337	0.0	47.7	68			
180 min Summer	24.832	0.0	53.6	98			
240 min Summer	20.006	0.0	57.7	128			
360 min Summer	14.706	0.0	63.9	190			
480 min Summer	11.818	0.0	68.5	250			
600 min Summer	9.966	0.0	72.3	310			
720 min Summer	8.665	0.0	75.5	372			
960 min Summer	6.943	0.0	80.6	492			
1440 min Summer	5.071	0.0	88.1	736			
2160 min Summer	3.696	0.0	95.9	1100			
2880 min Summer	2.949	0.0	101.5	1468			
4320 min Summer	2.142	0.0	109.5	2184			
5760 min Summer	1.705	0.0	114.9	2920			
7200 min Summer	1.427	0.0	119.0	3632			
8640 min Summer	1.235	0.0	122.3	4384			
10080 min Summer	1.093	0.0	125.0	5096			
15 min Winter	124.633	0.0	23.6	16			
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<u>Summary of Results for 100 year Return Period (+40%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	5.445	0.235	0.0	22.0	22.0	7.7	Flood Risk
60 min Winter	5.419	0.269	0.0	20.5	20.5	7.1	Flood Risk
120 min Winter	5.355	0.205	0.0	16.1	16.1	5.4	Flood Risk
180 min Winter	5.324	0.174	0.0	13.0	13.0	4.6	Flood Risk
240 min Winter	5.305	0.155	0.0	10.9	10.9	4.1	Flood Risk
360 min Winter	5.281	0.131	0.0	8.3	8.3	3.5	Flood Risk
480 min Winter	5.267	0.117	0.0	6.8	6.8	3.1	Flood Risk
600 min Winter	5.254	0.104	0.0	5.8	5.8	2.7	Flood Risk
720 min Winter	5.245	0.095	0.0	5.1	5.1	2.5	Flood Risk
960 min Winter	5.234	0.084	0.0	4.1	4.1	2.2	Flood Risk
1440 min Winter	5.223	0.073	0.0	3.0	3.0	1.9	Flood Risk
2160 min Winter	5.212	0.062	0.0	2.2	2.2	1.6	Flood Risk
2880 min Winter	5.205	0.055	0.0	1.8	1.8	1.4	Flood Risk
4320 min Winter	5.197	0.047	0.0	1.3	1.3	1.2	O K
5760 min Winter	5.192	0.042	0.0	1.0	1.0	1.1	O K
7200 min Winter	5.188	0.038	0.0	0.8	0.8	1.0	O K
8640 min Winter	5.185	0.035	0.0	0.7	0.7	0.9	O K
10080 min Winter	5.183	0.033	0.0	0.7	0.7	0.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	83.789	0.0	32.7	24			
60 min Winter	53.779	0.0	42.8	40			
120 min Winter	33.337	0.0	53.8	70			
180 min Winter	24.832	0.0	60.4	102			
240 min Winter	20.006	0.0	65.1	130			
360 min Winter	14.706	0.0	72.0	194			
480 min Winter	11.818	0.0	77.2	254			
600 min Winter	9.966	0.0	81.4	314			
720 min Winter	8.665	0.0	85.0	372			
960 min Winter	6.943	0.0	90.8	494			
1440 min Winter	5.071	0.0	99.3	736			
2160 min Winter	3.696	0.0	108.1	1104			
2880 min Winter	2.949	0.0	114.6	1464			
4320 min Winter	2.142	0.0	123.6	2184			
5760 min Winter	1.705	0.0	130.0	2920			
7200 min Winter	1.427	0.0	134.8	3584			
8640 min Winter	1.235	0.0	138.7	4360			
10080 min Winter	1.093	0.0	142.0	5000			
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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.052

Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:
0	4 0.025	4	8 0.027

Green Roof

Area (m³)	497	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:	From:	To:	From:	To:
0	4 0.009031	32	36 0.001823	64	68 0.000368	96	100 0.000074
4	8 0.007394	36	40 0.001493	68	72 0.000301	100	104 0.000061
8	12 0.006054	40	44 0.001222	72	76 0.000247	104	108 0.000050
12	16 0.004957	44	48 0.001001	76	80 0.000202	108	112 0.000041
16	20 0.004058	48	52 0.000819	80	84 0.000165	112	116 0.000033
20	24 0.003322	52	56 0.000671	84	88 0.000135	116	120 0.000027
24	28 0.002720	56	60 0.000549	88	92 0.000111		
28	32 0.002227	60	64 0.000450	92	96 0.000091		

Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area (ha)
From:	To:
0	4 0.000

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Model Details

Storage is Online Cover Level (m) 5.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr) 0.00000	Width (m) 8.2
Membrane Percolation (mm/hr) 1000	Length (m) 10.0
Max Percolation (l/s) 22.8	Slope (1:X) 0.0
Safety Factor 1.0	Depression Storage (mm) 5
Porosity 0.32	Evaporation (mm/day) 3
Invert Level (m) 5.150	Membrane Depth (m) 0

Pipe Outflow Control

Diameter (m) 0.150	Entry Loss Coefficient 0.500
Slope (1:X) 100.0	Coefficient of Contraction 0.600
Length (m) 5.000	Upstream Invert Level (m) 5.150
Roughness k (mm) 0.600	

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