

HOOK LANE, PAGHAM

FLOOD RISK ASSESSMENT



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HOOK LANE, PAGHAM FLOOD RISK ASSESSMENT

Hallam Land Management Ltd

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TABLE OF CONTENTS

1	EXECUTIVE SUMMARY	5
2	INTRODUCTION.....	6
3	ASSESSMENT OF FLOOD RISK	11
4	EXISTING DRAINAGE	24
5	DRAINAGE STRATEGY	26
6	CONCLUSIONS.....	32

TABLES

TABLE 1-1	EXECUTIVE SUMMARY	5
TABLE 2-1	BGS BOREHOLE SUMMARY	9
TABLE 2-2	CALCULATED INFILTRATION RATES	10
TABLE 3-1	FLOOD ZONES (PPG TABLE 1)	11
TABLE 3-2	FLOOD RISK VULNERABILITY AND FLOOD ZONE COMPATIBILITY (PPG TABLE 3)	16
TABLE 5-1	IOH124 ASSESSMENT.....	27
TABLE 5-2	EXISTING SITE RUN-OFF ASSESSMENT	27
TABLE 5-3	SITE ATTENUATION REQUIREMENTS	28
TABLE 5-4	DEVELOPMENT CREEP ASSESSMENT.....	29

FIGURES

FIGURE 2-1	SITE LOCATION	7
FIGURE 2-2	BGS BEDROCK GEOLOGY MAP EXTRACT	8
FIGURE 2-3	BGS SUPERFICIAL GEOLOGY MAP EXTRACT	9
FIGURE 3-1	ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING.....	18
FIGURE 3-2	ON-SITE DRAINAGE DITCH.....	19
FIGURE 3-3	450MM DIA. CULVERT	19
FIGURE 3-4	ENVIRONMENT AGENCY RISK OF FLOODING FROM SURFACE WATER MAP	22
FIGURE 3-5	CROSS SECTION THROUGH SITE	22
FIGURE 4-1	SOUTHERN WATER NETWORK PLAN.....	25

APPENDICES

APPENDIX A	DRAWINGS
APPENDIX B	CALCULATIONS
APPENDIX C	CORRESPONDENCE
APPENDIX D	SOUTHERN WATER RECORDS
APPENDIX E	SOAKAWAY REPORT
APPENDIX F	SUDS DESIGN STATEMENT

1

EXECUTIVE SUMMARY

1.1.1

This Flood Risk Assessment has been undertaken to accompany the outline planning application for the proposed residential development at Hook Lane, Pagham

1.1.2

This report has been prepared by WSP UK Limited on behalf of Hallam Land Management Ltd in accordance with the guidelines set out in the National Planning Policy Framework (NPPF) published July 2018.

Table 1-1 Executive Summary

ITEM	RESPONSE
Site Location	The site is located between Pagham Road to the west, Hook Lane to the south and east and Sefter Lane to the north of the site in the Hook Lane area of Pagham. NGR: 489600, 99200
Proposed Development	The construction of up to 300 new homes, a care home of up to 80 beds, a 2 form entry primary school, the formation of new means of access onto Hook Lane and Pagham Road, new pedestrian and cycle links, the laying out of open space, new strategic landscaping, habitat creation, drainage features and associated ground works and infrastructure.
Environment Agency Flood Zone	The site lies wholly within Flood Zone 1; being land assessed as having less than a 1 in 1,000 year annual exceedance probability (0.1% AEP) of river or sea flooding and thus, the most appropriate location for development when appraised against the DCLG National Planning Practice Guidance 2014.
Flood Risk Vulnerability Classification	More Vulnerable
Fluvial Flood Risk	Low risk of fluvial flooding
Tidal Flood Risk	Low risk of tidal flooding
Surface Water Flood Risk	Low risk of surface water flooding
Groundwater Flood Risk	Low risk of groundwater flooding
Artificial Flood Risk	Low risk of flooding from artificial sources
Sequential and Exception Test	In accordance with current National, Local and Environment Agency guidance, the site lies in Flood Zone 1, being the preferred location for development and as such the sequential and exception test are not required and considered passed.
Storm Drainage	A Sustainable Drainage Scheme (SuDS) is proposed to deal with surface water run-off from the proposed development site in line with current best practice recommendations. Through utilisation of a number of above ground, naturally landscaped features such as attenuation basins, it will be possible to reduce run-off to a rate below the current baseline during extreme storms.
Foul Drainage	Foul drainage will discharge to the existing Southern Water network in the vicinity of the site. Southern Water has proposed a connection point but has stated there is insufficient capacity within the current network. Southern Water has provided an indication of required reinforcement work which will be required to provide capacity for foul flows.

2 INTRODUCTION

2.1 BACKGROUND

2.1.1 WSP has been appointed by Hallam Land Management Ltd to prepare a Flood Risk Assessment (FRA) in accordance with the National Planning Policy Framework (NPPF) for a proposed development at Hook Lane, Pagham (Post Code: PO21 3PB), which is to have a residential end use.

2.1.2 The objective of the study is to demonstrate that the site can be developed safely, without exposing the development to an unacceptable degree of flood risk or increasing the flood risk to third parties. The objectives are to:

- » Confirm the sources of flooding which may affect the site;
- » Provide an appraisal of the availability and adequacy of existing information;
- » Provide a drainage strategy for the proposed development; and
- » Undertake an appraisal of the flood risk posed to the site and potential impact of the development on flood risk elsewhere.

2.2 LIMITATIONS

2.2.1 WSP has prepared this report in accordance with the instructions of their client, Hallam Land Management Ltd, for their sole and specific use. Any persons who use any information contained herein do so at their own risk. © WSP UK Ltd 2019.

2.2.2 The conclusions and recommendations contained herein are limited by the availability of background information and the planned use for the site

2.2.3 Third party information has been used in the preparation of this report, which WSP UK Ltd, by necessity assumes is correct at the time of writing. Whilst all reasonable checks have been made on data sources and the accuracy of the data, WSP UK Ltd accepts no liability for same.

2.3 SITE LOCATION

2.3.1 The site is located in the Hook Lane area of Pagham. The site is bounded by Hook Lane to the west and south along with existing residential development. Sefter Road forms the northern boundary, beyond which are agricultural fields. Pagham Road forms the western boundary beyond which is Pagham Rife.

2.3.2 The site is currently used for agriculture with tree lines and hedgerows marking the site boundaries. The site is currently allocated as part of the Pagham North site within the Local Plan.

2.3.3 The site location plan is shown in Figure 2-1 below.

Figure 2-1 Site Location



2.4 DEVELOPMENT PROPOSALS

- 2.4.1 The construction of up to 300 new homes, a care home of up to 80 beds, a 2 form entry primary school, the formation of new means of access onto Hook Lane and Pagham Road, new pedestrian and cycle links, the laying out of open space, new strategic landscaping, habitat creation, drainage features and associated ground works and infrastructure.
- 2.4.2 The site masterplan is contained in **Appendix A**; the development proposals are planned over a gross area of circa 17.5ha.

2.5 TOPOGRAPHY

- 2.5.1 A detailed topographical survey was undertaken by Interlock Surveys in September 2015. This identified shallow gradients falling generally in a westerly direction towards Pagham Road. The site falls from a high point of approximately 6.68mAOD along the eastern boundary adjacent to Hook lane to a low point of approximately 4.2m in the north-west of the site, adjacent to the site boundary.
- 2.5.2 The full topographical survey is contained in **Appendix A**.

2.6 INFORMATION REVIEWED

- 2.6.1 The appraisal process consisted of a desk study, data research, site visit and consultation with regulatory bodies and third parties.
- 2.6.2 The following information has been used in the preparation of this report:
- » Environment Agency Flood Mapping

- » BGS Published Data
- » Local Planning Policy
- » National Planning Policy (NPPF, PPG)
- » Good Practice Guidance (CIRIA 609, CIRIA 753)
- » Site Masterplanning Information
- » Topographic survey in **Appendix A**
- » General correspondence in **Appendix C**
- » Southern Water sewer records **Appendix D**

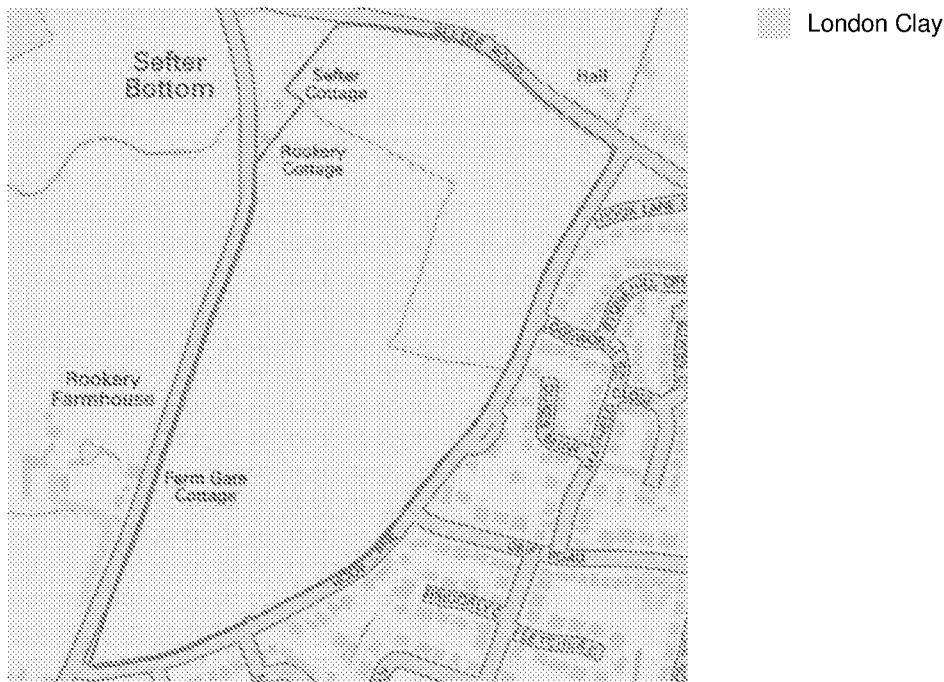
2.7

GEOLOGY

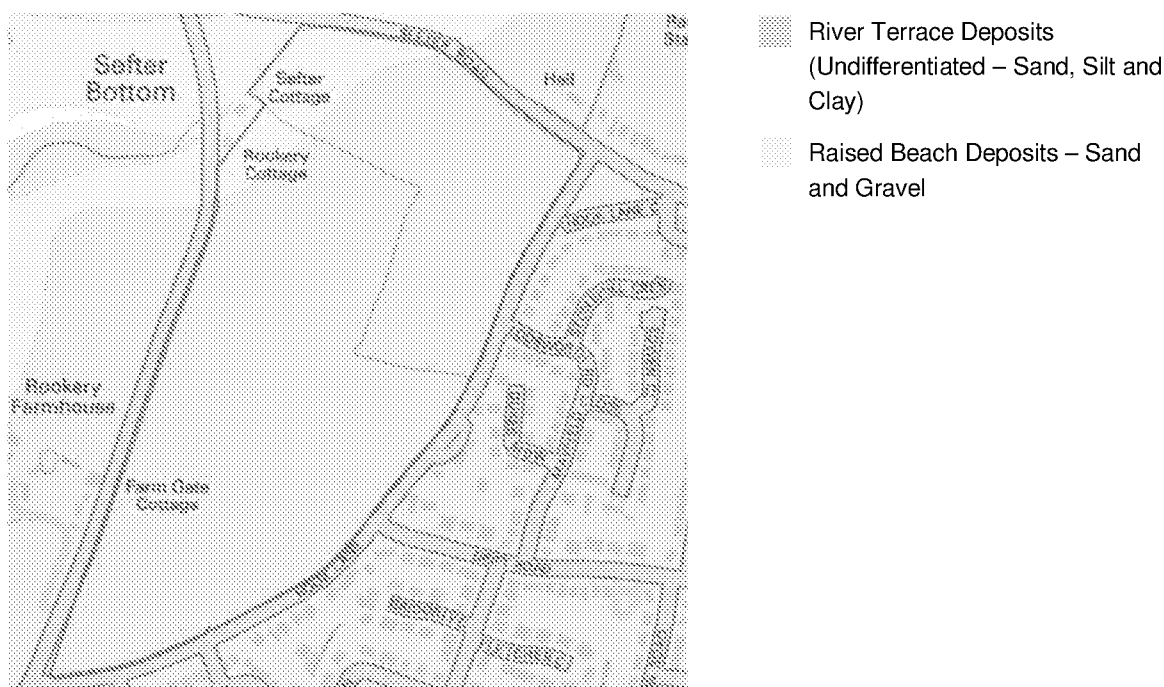
2.7.1

Reference to the BGS published mapping identifies the site to be underlain by bedrock of London Clay. Superficial deposits of predominantly River Terrace Deposits with a small amount of Raised Beach Deposits in the far northern corner are also identified. An extract of the BGS maps shown in Figure 2-2 and Figure 2-3 below.

Figure 2-2 BGS Bedrock Geology Map Extract¹



¹ Contains British Geological Survey materials ©NERC [2013]

Figure 2-3 BGS Superficial Geology Map Extract²

2.7.2

There is a single borehole registered to the north-west of the site boundary; no other boreholes are located close to the site. The following general ground profile is recorded:

Table 2-1 BGS Borehole Summary

DESCRIPTION	APPROXIMATE DEPTH (m BGL.)
Drift Deposits	Up to 5.5m
London Clay	5.5-53.3m
Reading Beds	53.3-85m
Upper Chalk	85m+

2.7.3

According to the Source Protection Zone map provided by the Environment Agency, the site does not lie within any Source Protection Zone.

2.7.4

The online Environment Agency Groundwater map (Superficial Deposits Designation) indicates the site is underlain by a secondary aquifer. This aquifer has been characterised as a 'Secondary A' aquifer. That is permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.'

2.7.5

The online Environment Agency Groundwater map (Bedrock Designation) indicates that the site comprises stratum that is considered 'Unproductive Strata'. That is, impermeable layers incapable of supporting water supplies.

2.7.6

Site investigations completed by WSP indicates the site geology consists of River Terrace Deposits, supporting the information provided by the BGS superficial geology map.

² Contains British Geological Survey materials ©NERC [2013]

2.7.7

Testing to BRE Digest 365 was conducted on site. Testing indicated that the underlying geology was relatively impermeable. The Soakaway Report produced by WSP is included in **Appendix E**. The calculated infiltration rates are summarised below in Table 2-2.

Table 2-2 Calculated Infiltration Rates

EXPLORATORY LOCATION	STRATUM DESCRIPTION	TOTAL TEST TIME (M)	TOTAL FALL IN WATER LEVEL (M)	INFILTRATION RATE (M/S)
SA01C	Stiff grey brown slightly sandy CLAY	240	0.12	N/A
SA02B	Stiff light brown CLAY	180	0.05	N/A
SA03	Firm orange brown mottle grey brown CLAY	210	0.00	N/A
SA04	Stiff to firm orange brown slightly sandy CLAY	180	0.05	N/A
SA05	Firm orange brown CLAY	180	0.00	N/A
SA06C	Stiff orange brown CLAY	240	0.02	N/A

2.7.13

Quoting the Soakaway Report: *"Infiltration rates could not be calculated in accordance with BRE guidance for any of the test locations due to slow drainage rates and the absence of 75% effective depth soakage within the timeframe of the tests."* As such, it is unfeasible to drain the site via infiltration.

3

ASSESSMENT OF FLOOD RISK

3.1 NATIONAL PLANNING POLICY FRAMEWORK

3.1.1 The Updated National Planning Policy Framework (NPPF) was published in July 2018 and sets out the Government's national policies for flood risk management in a land use planning context within England.

3.1.2 Paragraph 155 of the NPPF states "Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere"

3.1.3 The guidance further states that local planning authorities should "ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment."

3.1.4 Allocation and planning of development must therefore be considered against a risk based search sequence as provided by the guidance.

3.2 PLANNING PRACTICE GUIDANCE

3.2.1 The Planning Practice Guidance (PPG) expands and details the Government's national policies for flood risk management in a land use planning context within England.

3.2.2 The guidance states that local planning authorities should '*apply a sequential approach to the site selection so that development is, as far as reasonably possible, located where the risk of flooding (from all sources) is lowest, taking account of climate change and the vulnerability of future site uses to flood risk*'.

3.2.3 Allocation and planning of development must therefore be considered against a risk based search sequence as provided by the guidance. With regards to fluvial and tidal flooding, the guidance categorises the risk in four principal levels as shown in Table 3-1 below.

Table 3-1 Flood Zones (PPG Table 1)

FLOOD ZONE	PROBABILITY	DEFINITION
Flood Zone 1	Low <0.1% AEP	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown without colour (clear) on the Flood Map for Planning – all land outside Zones 2 and 3).
Flood Zone 2	Medium 0.1% - 1.0% AEP	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 for Planning).
Flood Zone 3a	High >1.0% AEP	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 for Planning).

Flood Zone 3b	Functional Floodplain >5% AEP	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. (Land that is also within the dark blue on the Flood Map for Planning – as not separately distinguished from Zone 3a).
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3.2.4 Table 2 of the PPG gives the flood risk vulnerability classification of the development proposals as 'More Vulnerable'. Therefore according to Table 3 of the PPG Flood Risk Guidance, the proposals are appropriate for development within Flood Zone 1.

3.3 STRATEGIC FLOOD RISK ASSESSMENT

3.3.1 Arun District Council published a joint Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) in August 2016 to replace the Level 1 and Level 2 SFRA originally published in February 2008. This document will be used in decision making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

3.3.2 The site is directly referenced in the SFRA as Pagham North 2a. Table 12-1 of the SFRA is included in **Appendix A** and states the majority of the site, 75%-100%, lies within Flood Zone 1 and 0%-25% lies within Flood Zone 2. Table 12-1 of the SFRA also states the site lies outside the Environment Agency's Historic Flood Map.

3.3.3 Pagham Harbour defences have been evaluated to determine the Standard of Protection provided to coastal flooding. The seaward defence provides protection from a flood event of an annual probability 1 in 200 however it was considered that the open beach may act to alter this defence standard. As such, the defences in Pagham Harbour provide a lower standard of protection with the raised wall defence also providing a standard of protection of 1 in 80.

3.3.4 The current preferred Shoreline Management Plan is to 'hold the line' where funds are available to maintain the current Standard of Protection. Without this approach it has been estimated that the first properties to be affected by coastal flooding would be in approximately 20 years' time.

DETAILED SITE SUMMARY

3.3.5 Further analysis of flood risk to the site is provided in the Level 2 Detailed Site Summary Tables in Appendix J of the SFRA. Relevant parts of the SFRA site specific assessment are quoted below.

"The site is entirely located within Flood Zone 1, the lowest flood risk zone for flooding from the Rivers and Sea. It is clear that the mixture of defences located along the Pagham Rife and the western section of Pagham village are influential at protecting the land adjacent to the western parcel of the site. However, in the absence of such defences, it is predicted that flooding will not affect the site area during the undefended Flood Zone 2 and 3a events. Therefore, Flood Zones are considered to represent the actual flood risk at the site."

"Groundwater flooding may be more likely, with the available datasets showing that the site is located within a 1km grid square where more than 75% of the 1km² area may be susceptible to groundwater flooding."

3.3.6 With regards to flood history, the Detailed Site Summary states

"There are no recorded flood incidents within this site, although incidences of flooding have been reported beyond the site boundary. Water sits on site adjacent to Elizabeth Close. Flooding of properties/highways in Elizabeth Close, Lincoln Avenue, Seftor Road, Hook Lane, Pagham Road"

3.3.7 It was determined by the SFRA that at the 100 year horizon, due to climate change, 1% of the site would be impacted by Flood Zone 3a which was modelled as a 45% increase in flood risk over the current flood extents. The area at risk of flooding due to climate change is shown in **Appendix A** and is outside of the proposed residential development area.

3.3.8 To ensure the proposed development remains safe and at a low risk of flooding from this source, it is proposed to keep this area clear of development, utilising it solely for SuDS and Open space.

3.4 STRATEGIC SURFACE WATER MANAGEMENT STUDY

3.4.1 In July 2016, Arun District Council published a Stage 1 Strategic Surface Water Management Study (SSWMS). This document was produced to develop an understanding of the current surface water catchments, identifying the required storage volumes at six strategic development site locations to mitigate surface water flood risk and outline options for surface water management schemes which may provide the necessary storage.

3.4.2 This document directly refers to the site as Pagham North and summarises the findings of a review of existing GIS and modelling data, published literature, consultations with Arun district Council and the Environment Agency, as well as a visit to the site and surrounding catchments.

3.4.3 In terms of historic flooding the document states *"Very few records of historic flooding have been found for the Pagham North strategic site. The extent of the major flood in June 2012 is one of them."* It was established that flooding had occurred at Sefter Cottage, Pagham Road after which alleviation works were carried out to mitigate the risks.

3.4.4 Further flood concerns also include surface water flooding on the northern side of Sefter Road due to a lack of maintenance by the landowner as well as regular highway flooding taking place. Drainage repairs have been carried out in Hook Lane to mitigate flood risk to property and highway which were caused by a number of issues including; highway drainage, land drainage and lack of maintenance of culverts and ditches by the landowner.

3.4.5 Further locations that are at risk to flooding include Hook Lane Close and Elizabeth Close from surface water flooding from water which is known to lie on the fields near Elizabeth Avenue. Exact causes of flooding at either location are unknown yet it is considered to be a combination of highway drainage issues, poor land drainage, lack of maintenance, blocked ditches and culvert issues.

3.4.6 The SSWMS makes a number of recommendations as to make best use of currently available drainage options to enhance future land drainage including an anti-tank ditch (culvert) that currently runs along the northern side of the site which could be utilised as part of future developments to convey flows off-site.

3.4.7 The Pagham North site was considered to be adequate to develop across the whole of the previously designated area with none of the land needed to be taken for additional flood storage.

3.5 BEACHY HEAD TO SELSEY BILL SHORELINE MANAGEMENT PLAN

3.5.1 The coastline is also covered by the Beachy Head to Selsey Bill Shoreline Management Plan, (2006) (SMP2), in which the following defence policy has been identified

"The recommended long-term plan for Felpham to Aldwick (including Felpham and Bognor Regis) is to continue to protect assets within the area through defending the present position; villages along the frontage act as a service centre for the sub region, providing a range of facilities and infrastructure that support surrounding communities. The frontage itself is an important tourist resort, offering a range of amenities for recreation, whilst the surrounding area is environmentally important, both geologically and biologically. The long term policy is considered sustainable in socio-economic, environmental and also technical terms, since the most number of assets will be protected, without detrimental loss of the beach."

3.5.2

This is summarised as 'Hold the Line' and is the recommended policy for each of the three epochs covered by the SMP: 2005-2025, 2025-2055 and 2055-2105. This policy includes continued management of the defences in the short-term, with works to maintain the standard of defence in the future. This offers reassurance that the defences will be maintained over the lifetime of the development, and that flood risk will be managed adequately.

3.6

LOCAL PLAN

3.6.1

Arun District Council published the Local Plan Publication Version in October 2014 and submitted to the Planning Inspectorate in January 2015. It was further adopted in July 2018. The plan outlines development policies up to 2031. Relevant policies from the Local Plan are included below. Where relevant, information on how the proposed development complies with the policies is also provided.

"Policy ECC SP1 – Adapting to climate change

- » The Council will support development which is located and appropriately designed to adapt to impacts arising from climate change such as the increased probability of tidal and fluvial flooding; water stress; health impacts as a result of extreme temperatures and a decline in the quality of habitats and richness of biodiversity.*
- » In order to achieve this, development must be designed to take account of the following issues:*

 - » Location (in relation to flood risk and vulnerability to coastal erosion);*
 - » Water efficiency;*
 - » Shade, cooling, ventilation, solar gain;*
 - » Connectivity to the green infrastructure network;*
 - » Layout and massing;*
 - » Resilience of buildings and building materials to extreme weather events; and*
 - » Capacity of drainage systems and incorporation of Sustainable urban Drainage Systems (SuDS)"*

3.6.2

The site is located within Flood Zone 1 and is therefore the best place to locate development. The SuDS features incorporated within the site have been sized appropriately to attenuate the critical 1 in 100 year + climate change event.

"Policy W DM2 – Flood risk

- » All development proposals must take account of relevant Surface Water Management Plans, Catchment Flood Management Plans and related Flood Defence Plans and strategies such as the Lower Tidal River Arun Strategy. The council may require financial contributions from development on sites where measures to address flood risk or to improve the environmental quality of watercourses have been identified by these Plans and Strategies."*

3.6.3

Information provided by the Strategic Flood Risk Assessment, Strategic Surface Water Management Strategy and Shoreline Management Plan are provided above in Sections 3.3, 3.4 and 3.5 respectively.

“Policy W DM3 – Sustainable Urban Drainage Systems

- ⌘ *To increase the levels of water capture and storage and improve water quality, all development must identify opportunities to incorporate a range of Sustainable Urban Drainage Systems (SUDS), appropriate to the size of development, at an early stage of the design process.*
- ⌘ *Proposals for both major and minor development proposals must incorporate SuDS within the private areas of the development in order to provide source control features to the overall SUDS design. These features include:*

 - ⌘ *Green roofs*
 - ⌘ *Permeable driveways and parking*
 - ⌘ *Soakaways*
 - ⌘ *Water harvesting and storage features including water butts.*
- ⌘ *Proposals for major development must also integrate SUDS within public open spaces and roads, in liaison with West Sussex County Council, (the SUDS Approval Body) or its agent. SUDS must therefore be integrated into the overall design of a development and must:*

 - ⌘ *Contribute positively to the appearance of the area*
 - ⌘ *Effectively manage water (including its quality)*
 - ⌘ *Accommodate and enhance biodiversity by making connections to existing Green Infrastructure assets and*
 - ⌘ *Provide amenity for local residents (ensuring a safe environment)*
 - ⌘ *Retain the existing drainage network of the site and the wider area,*
 - ⌘ *Be maintained in perpetuity, supported through a Maintenance and Management Plan/Regime, including its financing, agreed with the Local Planning Authority.*
- ⌘ *In order to ensure that SUDS discharge water from the development at the same or lesser rate, as prior to construction, developers must:*

 - ⌘ *Follow the hierarchy of preference for different types of surface water drainage disposal systems as set out in Approved Document H of the Building Regulations and the SUDS manual produced by CIRIA.*
 - ⌘ *Undertake up to six months groundwater monitoring within the winter period.*
 - ⌘ *Undertake winter percolation testing in accordance with BRE365.*
 - ⌘ *The proposed drainage system must be designed to ensure that there is no flooding on a 1 in 30 year storm event.*
 - ⌘ *The design must also take account of the 1 in 100 year storm event plus 30% allowance for climate change, on stored volumes, to ensure that there is no flooding of properties or the public highway or inundation of the foul sewerage system. Any excess flows must be contained within the site boundary, and within designated storage areas.*

3.6.4

The proposed drainage strategy provides a disbursed system of above ground storage of surface water runoff providing both water quantity and water quality benefits along with wider bio-diversity benefits. Further information on the proposed drainage strategy is provided below in Section 5.

3.7 SEQUENTIAL AND EXCEPTION TESTS

SEQUENTIAL TEST

- 3.7.1 The PPG and NPPF Guidance states that Local Planning Authorities should complete a risk based “Sequential Test” when developing Local Plans, to ascertain areas most suitable, from a flood risk perspective, for future development.
- 3.7.2 The essence of the “Sequential Test” is to “steer new developments to areas with the lowest probability of flooding” (Paragraph 158 of the NPPF guidance)
- 3.7.3 In accordance with Table 3 of the PPG, the development is considered “*More Vulnerable*” which is defined as follows:

“More Vulnerable

- ⌘ *Hospitals*
- ⌘ *Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels.*
- ⌘ *Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.*
- ⌘ *Non-residential uses for health services, nurseries and educational establishments.*
- ⌘ *Landfill* and sites used for waste management facilities for hazardous waste.*
- ⌘ *Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.”*

EXCEPTION TEST

- 3.7.4 The Sequential Test should be employed on all sites to direct development to locations having the lowest probability of flooding. Whereas, the Exception Test is to be used on selected sites where it is shown necessary, through the Sequential Test, to apply development of a given Flood Risk Vulnerability in a Flood Zone that is ordinarily reserved for a less vulnerable use.
- 3.7.5 Table 3 of the PPG identifies four circumstances where the combination of a given Vulnerability of Use and Flood Zone justify the application of the Exception Test. Table 3 is reprinted below:

Table 3-2 Flood Risk Vulnerability and Flood Zone Compatibility (PPG Table 3)

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	✗	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	✗	✗	✗

✓ Development is appropriate

✗ Development should not be permitted

- 3.7.6 If identified above, any development required to complete the Exception Test must demonstrate compliance with the following requirements:

- » It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- » A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall

3.7.7 The site lies wholly within Flood Zone 1, being the area of lowest possible flood risk and therefore the most appropriate location for development. As such, the Sequential and Exception tests are not required and considered passed.

3.8 SOURCES OF FLOOD RISK

HISTORIC FLOODING

3.8.1 Historic flooding is shown in the SFRA's Appendix H included below in **Appendix A**. There are a number of historic flood events that have occurred in the immediate vicinity of the site:

- » Two to the south of the site are classified as failure however the exact details are unknown.
- » To the north-west of the site, there is a historic flood event recorded as a result of surface water while to the north-east of the site there are two flood events recorded as a result of surface water and sewer flooding.
- » A number of unknown flood events have also been recorded to the west of the site.

3.8.2 The Detailed Site Summary within Appendix J of the SFRA states

"There are no recorded flood incidents within this site, although incidences of flooding have been reported beyond the site boundary. Water sits on site adjacent to Elizabeth Close. Flooding of properties/highways in Elizabeth Close, Lincoln Avenue, Sefter Road, Hook Lane, Pagham Road"

3.8.3 In addition, anecdotal evidence obtained from public consultation has also suggested flooding to Hook Lane.

3.8.4 The Environment Agency has been contacted for any information with regards to flood events in the vicinity of the site. The Environment Agency stated that due to the location of the site in Flood Zone 1, they have limited information with regards to flooding.

3.8.5 Arun District Council in their role as Local Planning Authority was contacted for any information regarding flooding in the vicinity of the site. The LPA provided details, included in **Appendix C**, regarding flooding at Sefter Cottage, to the immediate west of the site during the flood event during June 2012. West Sussex County Council in its role as LLFA produced a Section 19 Flood Incident report for the flood event which affected most of the County.

3.8.6 Heavy rain fell between the 10th and 12th June causing significant surface water flooding. Rainfall was highly localised with areas measuring between 58mm at Shoreham and 171mm recorded at Sefter Farm, adjacent to the site. The return period for the Bognor Regis area was estimated at approx. 1 in 212 years.

FLUVIAL FLOODING

3.8.7 The SFRA mentions the watercourse Pagham Rife that is in close proximity to the west of the site without discussing flood impact zones. It does however mention the flood defences present towards Pagham Harbour with it stating:

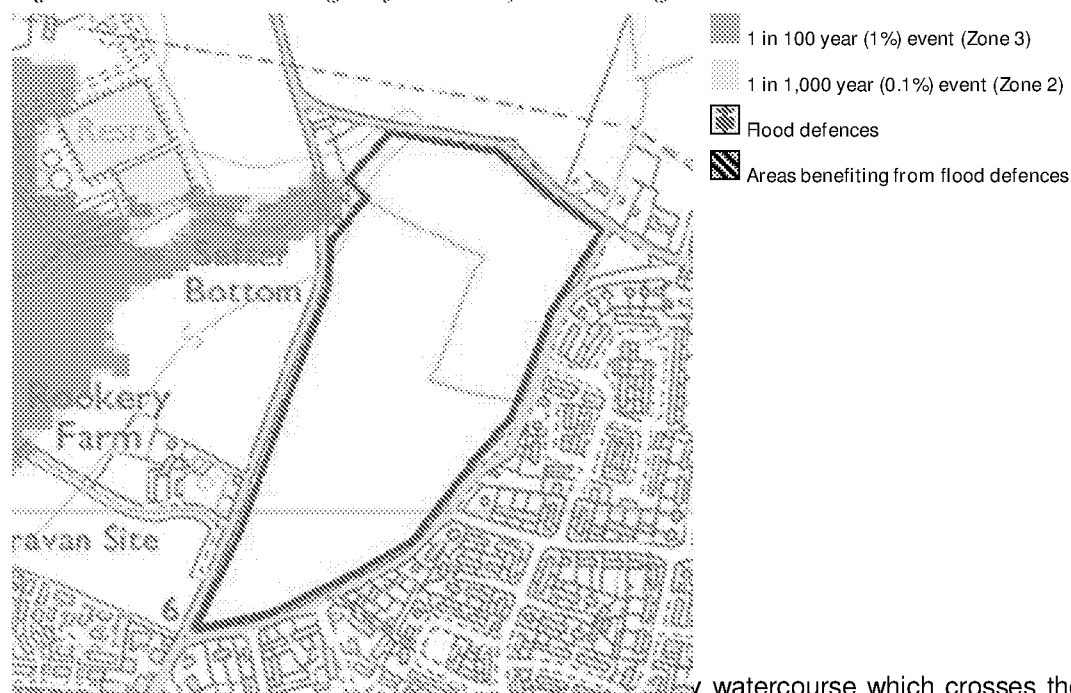
"This has been established to be the only Rife that lies within the Arun District boundary, with the others located within Chichester District Council's boundary. There are several defences in place along the western part of Pagham village. These defences are a mixture of embankment and raised walls, with shingle beaches bordering the coastal stretch of Pagham Harbour."

The condition grade for the embankment defence along Church Lane is rated as 'Good'. The condition grade recorded for the raised walls and shingles beaches is 'Fair', although given the Inner Harbour Bunds have only been recently completed it is expected the condition grade may be lower (better condition) than reported in the current available dataset."

3.8.8 Fluvial flood zones were produced as part of the SFRA and included in **Appendix A**. The map shows the site to be located within Flood Zone 1 with regards to fluvial flooding.

3.8.9 The Environment Agency's Flood Map for Planning shows flood zones from both fluvial and tidal flood sources as per the risk extents set out in Table 3-1; the Flood Map for Planning is reprinted below as Figure 3-1. The mapping shows the site lies wholly within Flood Zone 1 outside of both the 1 in 1,000 year fluvial and tidal flood extents of the nearby Pagham Rife and Harbour. This has also been confirmed by the Environment Agency; correspondence has been included in **Appendix C**.

Figure 3-1 Environment Agency Flood Map for Planning



3.8.10 The map shows a watercourse which crosses the site in east-west direction, discharging into the Pagham Rife near Sefter Bottom. Further photographs of the ditch other drainage infrastructure is shown below in Figure 001 in Section 4.

3.8.11 Ground topography was assessed using the Environment Agency's LiDAR data, available online. From this, a catchment watershed to the north of Sefter Road was calculated with the catchment estimated to be approx. 67ha.

3.8.12 From studying the ditch network in the vicinity of the site, the catchment is believed to drain south towards Sefter Road then eastwards around the playground adjacent to Hook Lane Close. From there, it is believed surface water drains southwards in a highway ditch adjacent to Hook Lane and then westwards along the on-site drainage ditch.

3.8.13

The drainage ditch which cross the site is shown below in Figure 3-2 and is well incised. Topographical survey of the site has concluded the ditch is approximately 1.0m to 2.0m deep with side slopes of between 1 in 1 and 1 in 2.

3.8.14

At the western end of the ditch, flow is controlled by a 450mm diameter culvert; this culvert is estimated to have a maximum capacity of 164l/s and is shown in Figure 3-3.

Figure 3-2 On-Site Drainage Ditch



Figure 3-3 450mm Dia. Culvert



3.8.15

The discharge rate from the site is discussed later in the report in Section 5, alongside the drainage strategy. However, the greenfield runoff rate was assessed using the loH124 methodology.

3.8.16 The site is approximately 17.5ha and the calculated greenfield runoff rate during the 1 in 100 year event is 11.24l/s/ha which equates to approximately 197l/s runoff from the site. Post development, surface water runoff will be attenuated in a number of attenuation basins and collectively discharged at the greenfield QBar runoff rate, approximately 18.5l/s.

3.8.17 Alongside the above, a sequential based approach has been employed in masterplan development, locating areas of residential development away from areas most at risk of flooding. The masterplan also proposes to widen the on-site drainage ditch and provide a blue-green corridor providing some additional flood risk protection along with bio-diversity and ecological benefits.

3.8.18 As such, fluvial flood risk does not pose a risk to the proposed development and alongside this the proposed development provides some flood risk protection measures to downstream properties in reduced runoff rates.

TIDAL FLOODING

3.8.19 The risk of tidal flooding is shown alongside fluvial flood risk on the Flood Map for Planning, shown above in Figure 3-1. The risk of tidal flooding was also assessed as part of the 2016 SFRA.

3.8.20 As discussed previously, the site is located within Flood Zone 1 and is therefore deemed to have less than a 0.1% annual probability of tidal flooding as per the definitions in Table 3-1.

3.8.21 It should be noted that all Flood Zone maps, both those produced by the SFRA and those shown on the Flood Map for Planning are produced without the influence of any flood defences. As noted in the Shoreline Management Plan (Section 3.5), the policy for the coastal defences is 'hold the line.' As such the actual extents of the flooding with the defences in place may be lower.

3.8.22 A sequential based approach has been employed in masterplan development, locating areas of residential development away from areas most at risk of flooding. As such, tidal flooding is not considered a significant risk to the built development at this location and the overall flood risk is classified as low.

GROUNDWATER FLOODING

3.8.23 The risk of groundwater flooding was assessed within the SFRA. Appendix F, of the SFRA, shows the site to be at medium to high risk of groundwater flooding. BGS records indicate the site is underlain by London Clay with the nearest chalk outcrop located approximately two miles to the north of the site. It should be noted that the advice given with the map is that *"this data should only be used in combination with other information, for example with 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."*

3.8.24 Online maps provided by the Environment Agency show that there are no Source Protect Zones in the immediate vicinity (1.5km radius) of the site. Infiltration from the proposed basins, albeit negligible will not pose a pollution risk to groundwater.

3.8.25 During public consultation, residents raised concerns with the proposed development due to shallow groundwater. Groundwater levels have been monitored on site over the course of a year with further analysis provided in report 70014147-R02 – *Land at Pagham Groundwater Monitoring Report* prepared by WSP. This report is summarised here.

3.8.26 Groundwater levels were monitored on site by eight groundwater monitoring wells installed across the site in November 2015 and a number of visits were undertaken between January and June 2016 to record groundwater levels within the wells. Further to this, dedicated level loggers were installed in two boreholes to obtain detailed groundwater elevation data between monitoring visits.

3.8.27 The results indicate the presence of a shallow sub-artesian groundwater body beneath the site with depths of groundwater typically recorded at depths of less than 1.0m below ground level.

3.8.28 Given the results of the monitoring, the risk of flooding from groundwater is initially considered medium. However, in order to ensure surface water runoff is adequately managed, minor earthworks will be required to provide surface water flow paths and as a result, the proposed development areas will be raised above the current ground levels. These surface water flow routes will also direct any groundwater flooding away from the proposed properties towards the attenuation basins.

3.8.29 The monitoring showed groundwater levels are typically responsive to rainfall events. An increase in impermeable area will decrease the responsiveness of the groundwater thereby reducing groundwater flood risk.

3.8.30 The drainage system has also been designed to utilise shallow drainage features, located above the level of any groundwater. Any deeper drainage features such as basins will require lining to prevent groundwater ingress and ensuring the attenuation features remain functional when required.

3.8.31 Given the mitigation measures to be employed on site, the risk of groundwater flooding to the proposed built development is considered low.

SURFACE WATER FLOODING

3.8.32 The site is undeveloped however; the Environment Agency's Risk of Flooding from Surface Water mapping identifies a number of areas that are at high risk of surface water flooding. The flood mapping is reprinted as Figure 3-2 below.

3.8.33 The mapping shows that there is a low to medium risk of surface water flooding from the ditches on site. There is a high risk area in the south-east of the site, adjacent to Pagham Road, corresponding to a low area on the topographical survey.

3.8.34 The production of this mapping has been undertaken at a national scale to provide the first publically available generation of surface water flood risk mapping. The two previous generations were primarily developed for regulator use as the approach and risk was refined. For example the first did not include any allowance for sewers, whilst the second incorporated a national loss coefficient.

3.8.35 Although this generation incorporates local estimates of the sewer infiltration loss along with various other refinements in runoff estimation, generally at an LLFA level, it does not allow for local improvements to the underlying DTM. This means that local features are represented as obtained from the LiDAR without any consideration to drainage features such as culverts which typically provide the associated surface water drainage.

3.8.36 As a result, this leads to the localised ponding in the south-west corner of the site as can be observed in Figure 3-2. However, as shown later in this report, during a site visit a gully grate was discovered in this location, likely to allow surface water runoff to drain beneath Pagham Road.

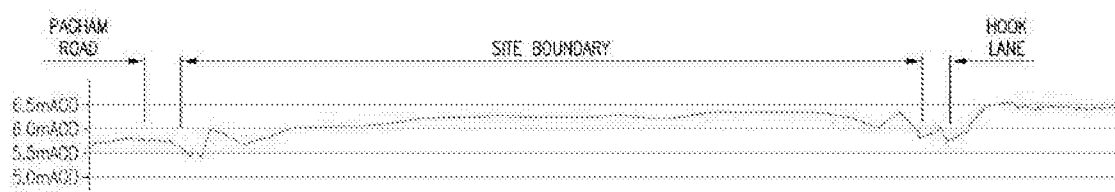
Figure 3-4 Environment Agency Risk of Flooding from Surface Water map



3.8.37

Through public consultations, local residents and the Parish Council have raised concerns regarding surface water flooding in the vicinity of the site. Anecdotal evidence provided by residents on Hook Lane suggests highway flooding occurs on a semi-regular basis.

Figure 3-5 Cross Section through site



3.8.38

Figure 3-5 shows a cross section through the site, near to where the flooding is observed in Hook Lane. As can be seen in the cross section, the site is quite flat however there is a gentle fall to the west. As such, surface water runoff will drain westwards and hence the proposed development will not exacerbate flooding in Hook Lane.

3.8.39

Minor earthworks will also be required to provide gradients to ensure surface water drains in the correct direction, towards the proposed attenuation features. Once implemented, this ground raising will provide some flood risk reduction in ensuring surface water runoff from the proposed development is not directed into Hook Lane.

3.8.40

Within the development, a sequential based approach has been employed, locating areas of development outside of areas most at risk of surface water flooding.

3.8.41

Given that the highest risk areas are in the low points of the site where SuDS drainage is to be situated, the sequential approach to masterplan development and the minor earthworks required to ensure catchments fall towards the basins, the risk of flooding from surface water sources will be low.

DEVELOPMENT EXCEEDANCE FLOWS

- 3.8.42 Careful regard has to be made in respect of potential exceedance flows, being events that are more extreme than current design criteria. Various national guidance has been published on the matter of exceedance flows and measures that should be incorporated into a development to ensure the safety of occupiers and those using the infrastructure.
- 3.8.43 Published guidance, in the form of Sewers for Adoption (7th Edition) and the Environment Agency document “Improving the Flood Performance of New Buildings: Flood Resilient Construction,” states the design of developments should implement infrastructure routes that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors.
- 3.8.44 The principal aim is to direct exceedance flows away from properties and along defined corridors. At a local level, this may mean water being conveyed along a length of highway, as long as the predicted flow depths and velocities are acceptable. More strategically, the implementation of conveyance corridors are important in avoiding deep and high velocity flows that present a high risk.
- 3.8.45 Careful and considered design in other areas can also reduce the risk. For example the strategic SuDS system being promoted for the site, provides a layered and disbursed system of treatment across the site, thereby avoiding a traditional and more risky design that might, for example, have all storm water being collected in a strategic spine sewer that conveys flows to a large basin at the bottom of the catchment. This latter system concentrates peak discharges into a single corridor, that if blocked can have unacceptable consequences.
- 3.8.46 Clearly, whilst many of the measures for dealing with exceedance flows must be dealt with at detailed design stage, the strategic layout for the site provides the framework of a network that can effectively deal with any future exceedance problems.
- 3.8.47 Drawing 4147-D-02 in **Appendix A** shows the principal exceedance strategy.
- 3.8.48 The detailed design stage should comply with national standards for protection against exceedance flows. Given the baseline site characteristics and further mitigation measures to be implemented, the risk of flooding from exceedance flows is considered low.

FLOODING FROM OTHER SOURCES

RESERVOIRS

- 3.8.49 There are no reservoirs in the local area that would have an impact on the flood risk to the site. Therefore, the flood risk associated with reservoirs to the site is considered to be Low.

CANALS

- 3.8.50 There are no canals in the local area. Therefore, canal flooding is not considered a risk to this site.

SEWERS

- 3.8.51 Sewer flooding occurs as a result of a number of influencing factors. It's most likely to occur during storms, when large volumes of rainwater enter the sewers, however, it can also occur when pipes become blocked or damaged.

3.8.52 Existing sewerage systems are present on land surrounding the site, by way of existing private, highway and adopted public sewers serving built development. There are public sewer systems in the existing residential development to the north and east of the.

3.8.53 Should sewer flooding occur, the proposed exceedance flow routes will direct any flooding towards the attenuation basins. As such, the risk associated with sewer flooding is considered to be low.

4 EXISTING DRAINAGE

4.1 SURFACE WATER

4.1.1 Southern Water sewer record plans can be seen in **Appendix D**. These show public surface water gravity sewers located to the west, south and east of the site, collecting run-off from the existing residential areas. No surface water sewers are located within the site boundary.

4.1.2 To the east of the site, the surface water sewers drain in an easterly direction towards a drain located to the rear of properties in Mayfield Close. This drain appears to flow in southerly direction however its ultimate outfall is unknown. Surface water sewers to the south-east of the site also appear to discharge into this drain.

4.1.3 A surface water sewer to the south-west of the site in Pagham Road runs in a northerly direction and discharges into a ditch to the west of the site, adjacent to Rookery Farm.

4.1.4 Within and adjacent to the site, there are a number of highway drains and ordinary watercourses. The locations of these are shown below on Figure 001.

4.1.5 To the north of the site, land drainage ditches convey surface water runoff southwards towards Sefter Road. Alongside Sefter Road there is a highway ditch with headwalls at each end. It is assumed that the eastern end of this highway ditch enters a culvert and is connected with a small section of ditch to the east of the playground adjacent to Hook Lane Close.

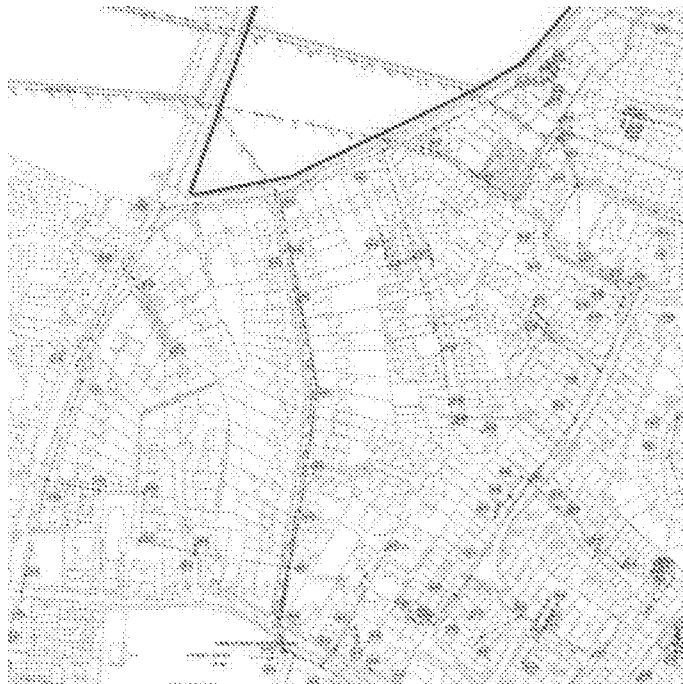
4.1.6 From there, this ditch is culverted and connects into the highway drain running north to south adjacent to Hook Lane. It is then assumed this ditch discharges into the drainage ditch located on site.

4.1.7 The drainage ditch located within the site boundary flows in a westerly direction. The ditch begins at a headwall adjacent to Hook Lane which was submerged during the site visit undertaken. At the western boundary of the site, this ditch enters a 450mm diameter culvert and emerges on the far side of Pagham Road out of a 450mm culvert.

4.2 FOUL WATER

4.2.1 Southern water records indicated an extensive foul water network serving the residential development to the south and east of the site. The Southern Water asset records are included in **Appendix D**. An extract showing the foul network arrangement in the southern part of the site is included in Figure 4-1 below.

Figure 4-1 Southern Water Network Plan



4.2.2 Due to the flat topography of the site, there are two foul water pumping stations located to the south of the site in Nyetimber Crescent and Nyetimber Lane. Rising mains from these two pumping stations cross the site near the southern boundary. A third overflow rising main crosses the site in a westerly direction slightly to the north of the other rising mains; this discharges into a ditch to the west of the site. No other foul sewers are located within the site boundary.

4.2.3 The locations of these rising mains are shown on the drainage strategy drawing 4147-D-002. Basin C has been sized to avoid the rising mains. Further consultation will be required with Southern Water to determine the required easements.

5 DRAINAGE STRATEGY

5.1 SURFACE WATER

5.1.1 The site topographic survey was used to assess where water flows across the existing site. This indicates where water will naturally collect and gives a good indication of where SuDS features such as basins should be positioned. This shows that all surface water on-site flows generally towards the western side of the site.

5.1.2 Current guidance requires that all new developments implement means of storm water attenuation and control referred to as Sustainable Drainage systems (SuDS) in order to maintain flow rates and volumes discharged to the identified receptor post development.

5.1.3 Coupled with this, **Policy W DM3 – Sustainable Urban Drainage Systems** from the Local Plan states:

- « *Proposals for both major and minor development proposals must incorporate SuDS within the private areas of the development in order to provide source control features to the overall SUDS design*

5.1.4 In addition to the water control benefits, SuDS features also provide water quality, landscape, ecology and biodiversity benefits. National guidance in the form of CIRIA 609 outlines that by implementing SUDS, storm water from the site can be polished to an improved standard thus ensuring the development proposals have no adverse effects on the wider hydrology and ecology.

DISCHARGE LOCATION

5.1.5 In order to determine the most appropriate receptor for storm water discharges from the proposed development, the new PPG guidance provides the following order of priority, supported by the Environment Agency and Local Authority:

“Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:

- « *into the ground (infiltration);*
- « *to a surface water body;*
- « *to a surface water sewer, highway drain, or another drainage system;*
- « *to a combined sewer.”*

5.1.6 As part of the site investigation, infiltration testing to BRE Digest 365 was conducted; infiltration rates are provided in Table 2-2 and **Appendix E**. The testing confirmed that infiltration is unfeasible as a means of draining the site.

5.1.7 Following the search sequence in order of priority, the next most appropriate receptor for storm water discharges is a watercourse or suitable water body subject to appropriate attenuation measures to ensure peak discharges are not increased.

5.1.8 Running through the northern part of the site is a land drainage ditch which crosses the site in a westerly direction before discharging into Pagham Rife. As part of the proposals for the site, this ditch is to be naturalised into a sinuous green corridor and watercourse. This represents a suitable receptor for post development run-off once attenuated to below the baseline greenfield rates.

5.1.9 In accordance with the above search sequence, it is proposed to discharge surface water flows to the existing naturalised watercourse on site.

DISCHARGE RATE

5.1.10 National policy dictates that new developments control the peak discharge of storm water from a site to the baseline, undeveloped site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the Flood Estimation Handbook (FEH) guidance states:

“The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km². The flood estimation procedure can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data”

5.1.11 On undeveloped and ungauged catchments of less than 0.5km in area, the accepted methodology is to complete baseline site discharge assessments using the nationally accepted loH124 methodology for small rural catchments in a manner set out by the Environment Agency document SC030219 Rainfall Runoff Management for Developments and CIRIA C697.

5.1.12 This methodology requires that, for catchments of less than 50ha, the loH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.

5.1.13 The overall application boundary is below the 50ha threshold, thus the loH124 methodology is therefore the most appropriate for appraising the baseline run-off from the development.

5.1.14 The baseline loH run-off rates are shown on Table 5-1 below.

Table 5-1 loH124 Assessment

EVENT	IOH124 (50HA)	IOH124 SCALED TO 1HA
1 in 1 Year (l/s)	149.70	2.99
QBar (l/s)	176.10	3.52
1 in 100 Year (l/s)	561.80	11.24

5.1.15 As the site is currently undeveloped, the proposals will result in an increase in impermeable area, which will increase the overall rate of water discharging from the site if left un-attenuated.

5.1.16 The strategy drawing 4147-D-002 in **Appendix A** indicates the site catchments based on the site topography as confirmed in Table 5-2 below.

5.1.17 In order to mitigate for the increased volume of run-off associated with built development, peak flows in the 1 in 100 year event must be attenuated to the mean annual flow (QBar).

Table 5-2 Existing Site Run-off Assessment

CATCHMENT	CATCHMENT DEVELOPMENT AREA (HA)	IMPERMEABLE AREA (HA)	1 IN 1 YEAR EVENT (L/S)	QBAR (L/S)	1 IN 100 YEAR EVENT (L/S)
1	2.70	1.62	8.07	9.51	30.34
2	2.69	1.61	8.04	9.47	30.22
3	4.51	2.71	13.48	15.88	50.67
Total	9.90	5.94	29.60	34.87	111.23

5.1.18 Assessments have thereafter been completed to determine the characteristics of the SuDS features required. The Micro Drainage Source Control module has been utilised to provide routing calculations for the 1 in 100 year flood event to identify the size and nature of storage required, ensuring the peak outflows are in line with those identified in Table 5-2 above.

5.1.19 Calculations demonstrate that attenuation storage extending to 3078m³ will be required to attenuate storm water discharges from the site during the critical 1 in 100 year storm event to the above baseline rates based on the current site proposals.

5.1.20 A summary of the nature of SuDS proposed is contained in Table 5-3 below whilst the drainage strategy is shown on 4147-D-002 in **Appendix A** and Micro Drainage summary calculations are contained in **Appendix B**.

Table 5-3 Site Attenuation Requirements

CATCHMENT	CONTRIBUTING AREA (HA)	QBAR DISCHARGE RATE (L/S)	STORAGE AREA REQUIREMENT (M ²)	STORAGE VOLUME (M ³)
1	1.62	5.7	2316	857
2	1.61	5.7	1557	831
	2.71	9.5	4137	1390
Total	5.94	18.5	8010	3078

5.1.21 In accordance with legislative requirements, the detention proposals have also been assessed for the potential effects of climate change. The 1 in 100 year (1% AEP) return events have been modelled for 40% climate change (including peak rainfall intensity). Calculations for the climate change scenarios are also contained in the **Appendix B**.

5.1.22 Climate change assessments show each attenuation feature to perform adequately by retaining the additional flows within the system without overflow or unacceptable consequences.

5.1.23 The drainage system will be designed in accordance with Sewers for Adoption (7th Edition) such that the proposed network will not surcharge during the critical 1 in 2 year event and will not flood during the 1 in 30 year event. For the 1 in 100 year return period, the sewer network will be designed so that surface flooding will be contained and conveyed within the highway boundary and directed to the attenuation basin.

5.1.24 The 1 in 30 year criterion meets the requirements of BS EN 752 and is also in accordance with Sewers for Adoption 7th Edition. However, the design of the system exceeds the requirements of these documents by accommodating the volumes and flow rates generated by the 1 in 100 year event.

5.1.25 The drainage strategy is based upon the site masterplanning details at the time of production. Changes to the site development profile, impermeable areas across the site or other such aspects of the scheme will result in the need to revise the calculations.

DEVELOPMENT CREEP

5.1.26 Over the lifetime of a development, it is possible that the overall impermeable area within the site could increase by as much as 10% through the house buyers undertaking activities such as property extensions and introducing paved gardens.

5.1.27 Table 5-4 below shows how this increase in impermeable area relates to the three primary catchments within the site.

Table 5-4 Development Creep Assessment

CATCHMENT	CONTRIBUTING AREA [HA]	+10% [HA]	TOTAL IMPERMEABLE AREA [HA]
A	1.62	0.161	1.782
B	1.61	0.162	1.771
C	2.71	0.271	2.981
Total	5.94	0.594	6.534

5.1.28 Micro Drainage calculations contained in **Appendix B** confirm that the proposed SuDS system has sufficient capacity to accommodate a 10% increase in impermeable area during the 1 in 100 year +40% event without overflow.

5.1.29 In addition to this, during the detailed design phase, the positive impacts of the potential source control measures (permeable paving et al.,) should be further considered.

5.1.30 Without the benefit of a detailed plot level masterplan, it is not possible to appraise the function of the individual source control systems down to plot level. Source control measures should be further considered during detailed design and implemented as far as reasonably practicable in accordance with **Policy W DM3** of the Local Plan.

5.1.31 As such, the impacts of development creep on the proposed SuDS system are not considered to pose a significant risk to the site.

SITE LEVELS

5.1.32 Given the aforementioned groundwater levels the proposed SuDs levels will need to remain shallow and will need to be lined with impermeable materials.

5.1.33 Currently the site is relatively flat, and as such in order to achieve sufficient pipe depths and connections into the proposed SuDS it is likely that earthworks will be required within the site boundary to ensure that the site drains via gravity and will not need to rely on a pumped solution.

RESIDUAL RISK

5.1.34 Management of extreme event flood risk can be achieved through ensuring the finished floor levels of the proposed buildings are set above adjacent roads and open spaces in areas where designated overland flood routes are identified.

5.1.35 Safe access and egress will be available to and from the site for events in excess of the 1 in 100 year plus climate change (+40%) rainfall event via all proposed site entrances.

5.1.36 The above strategy shows that the proposed development can be undertaken in a sustainable manner without increasing the flood risk either at the site or to any third party land in line with NPPF requirements.

5.2 FOUL WATER

5.2.1 The site lies within the catchment of Pagham Wastewater Treatment Works which lies circa 1.1km west of the site. Asset locations maps and the existing drainage network are discussed above in Section 4.

- 5.2.2 The proposed pumped and gravity drainage network across the site will be designed to current Sewers for Adoption Standards. A sewer capacity check was submitted to Southern Water to assess the capacity of both the treatment works and the sewer network and determine an appropriate connection point.
- 5.2.3 A point of connection has been provided on the existing network in Drift Road. However, due to insufficient capacity to accommodate the increased flow from the proposed development enhancements to the downstream system are required.
- 5.2.4 Reinforcement works consisting of a 150m length of 150mm diameter sewer is required, running parallel to existing sewers to provide additional capacity. Further information is available in Southern Water's response, included in Appendix C.
- 5.2.5 Southern Water has been consulted in relation to this application and has advised that their initial investigations indicate that they cannot currently provide foul sewage disposal to service the proposed development as the wastewater works at Summer Lane do not have capacity to accommodate the development.
- 5.2.6 However, this was considered as part of the Arun Local Plan Examination in Public and it was identified that the agreed approach for addressing waste water treatment capacity for the strategic allocations at Pagham in the Arun Local Plan, is to divert flows to Lidsey and Ford WWTW, with reinforcement works (funded by developer contributions) to plants and pumping mains to be brought forward over time in line with housing delivery.
- 5.2.7 Southern Water will need to work with the developer to understand the development program and review if the delivery of network reinforcement aligns with the occupation of the development. A condition would secure this and it is considered that this will be necessary to avoid any unacceptably adverse impact upon Pagham Harbour SPA/Ramsar in accordance with policy ENV DM2 of the Arun Local Plan.
- 5.2.8 Occupation of the proposed dwellings will not be permitted other than in accordance with such improvements.
- 5.2.9 Whilst the above is the current stance with regard to the previously submitted application for this scheme (planning ref: P/6/17/OUT), as of 1st April 2018 the regulations regarding site wastewater have been amended.
- 5.2.10 Southern Water has identified capacity constraints with the existing foul sewerage serving Pagham, however under the revised charging regulations implemented on 1 April 2018, it is now their responsibility for capacity studies and any necessary offsite reinforcements.
- 5.2.11 In their new policy documentation, network reinforcement is work that needs to be carried out to the existing network to support development-related growth. This work is needed to ensure there is enough capacity in both the water and wastewater network to serve the new homes that are built without impacting on the service to our existing customers.
- 5.2.12 Network reinforcement includes enlarging existing pipes or installing larger new pipes to increase capacity for a specific development, or further expected growth in the future along with upgrading other infrastructure, such as Sewage Treatment Works (Pagham) required to provide capacity for growth resulting from new development
- 5.2.13 The cost for these is recouped via the fixed infrastructure charge paid when each property is connected. Southern Water has recently published its revised infrastructure charges for 2019/2020 which can be viewed online (<https://www.southernwater.co.uk/infrastructure-charges>)
- 5.2.14 Southern Water are however unable to reserve capacity at the treatment works. As the site lies close to the Lidsey Treatment Works, Southern Water has confirmed there is available capacity at this treatment works. It is possible to redirect flows to this location if the need arises.

- 5.2.15 Accordingly, the increase in foul water flows will be accommodated within the sewerage network in accordance with Policy W DM1.

5.3 ADOPTION AND MAINTENANCE

- 5.3.1 The proposed on-site surface water and foul drainage sewerage networks will be designed in accordance with Sewers for Adoption 7th Edition and will be offered for adopted by Southern Water.
- 5.3.2 With regards to SuDS, in view of the recent central government decision not to create SABS, some uncertainty remains regarding by whom and how these features will be adopted and maintained.
- 5.3.3 Correspondence with Arun District Council indicates they are unlikely to adopt any SuDS features. Also, Southern Water has stated they will not adopt any SuDS devices. This correspondence is included in **Appendix C**.
- 5.3.4 As an alternative, it is becoming increasingly common for SuDS features to be operated and maintained by a third party private maintenance company. Should this be necessary, a third party management company would be established to maintain the features in perpetuity. An adoption agreement between the developer and Maintenance Company would be based upon the CIRIA ICoP MA2 SuDS Maintenance Framework Agreement.

6

CONCLUSIONS

- 6.1.1 The risk of flooding to and from the proposed development has been assessed in accordance with the NPPF July 2018.
- 6.1.2 This assessment demonstrates that the site lies within Flood Zone 1 and is an appropriate location for the proposed residential land use. This is in accordance with the vulnerability classifications of the NPPF and is supported by the Local Planning Authority and the Environment Agency.
- 6.1.3 Management of extreme event flood risk can be achieved through ensuring the finished floor levels of the proposed buildings are set above adjacent roads and open space levels in areas where designated overland flood routes are identified.
- 6.1.4 In addition to NPPF, the proposed drainage strategy complies in drainage terms with local policy and site specific requirements.
- 6.1.5 The proposed drainage strategy aims to mimic the existing drainage regime of the site. Discharge from the site will provide betterment by maintaining existing discharge rates while allowing for a climate change increase in rainfall of up to 40%.
- 6.1.6 Safe access and egress will be available to and from the site for events up to and including the 1 in 100 year plus climate change (40%) rainfall events.
- 6.1.7 This report demonstrates that the proposed development can be undertaken in a sustainable manner without increasing the flood risk either at the site or to any third party land in line with NPPF requirements.

Appendix A

DRAWINGS



Application Boundary (17.5ha)

Housing - up to 7.2ha
216 Residential Dwellings at an Average of 30 Dwellings Per Hectare (dph).

Primary School or Housing - 2.4ha
Land safeguarded for the provision of a Two Form Entry Primary School to include access, car parking and external play space - should this area not be required the development is to comprise up to 72 Residential Dwellings at an Average of 30dph.

Proposed D1 Use - 0.4ha
Potential for a Children's Day Nursery and / or Health Centre as required - should this area not be required the development is to comprise up to 12 Residential Dwellings at an Average of 30dph.

Care Home or Specialist Housing for the Elderly - 0.55ha

Vehicular Access

Primary Vehicular Route
Masterplan Option 1&2.

Potential Vehicular Access
This is not required if the Two Form Entry Primary School is to be constructed.

Pedestrian Access
Proposed footpath connections onto Hook Lane

Potential Pedestrian Access
Potential footpath / Cycle link onto Sefter Road

Potential Vehicular Route
This is not required if the Two Form Entry Primary School is to be constructed.

Areas of Interest
Viewing Mound - provides views towards the South Downs

Areas of Interest
Formal Equipped Children's Play Space

Green Infrastructure - 6.95ha
Framework of structural planting, open spaces (both hard and soft) and habitats - includes road infrastructure with single frontage development (excluding Semi-Private Drives)

Waterways & Ponds
Sustainable Drainage Systems Planted for Amenity Benefit

All areas shown on this development framework are approximate



All dimensions to be verified on site. Do not scale this drawing. All discrepancies to be clarified with project Landscape Architect. This drawing is the property of Urban Wilderness Ltd and is issued on the condition it is not reproduced, retained or disclosed to any unauthorised person, either wholly or in part without written consent of Urban Wilderness Ltd. Ordnance Survey material is used with the permission of The Controller of HMSO. Crown copyright LAN1001412.

B	22.12.16	gi added to the key	AJK
A	20.12.16	minor alterations to the key text	NJE
rev	date	details	



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client
Hallam Land Management Ltd

project
Hook Lane, Pagham

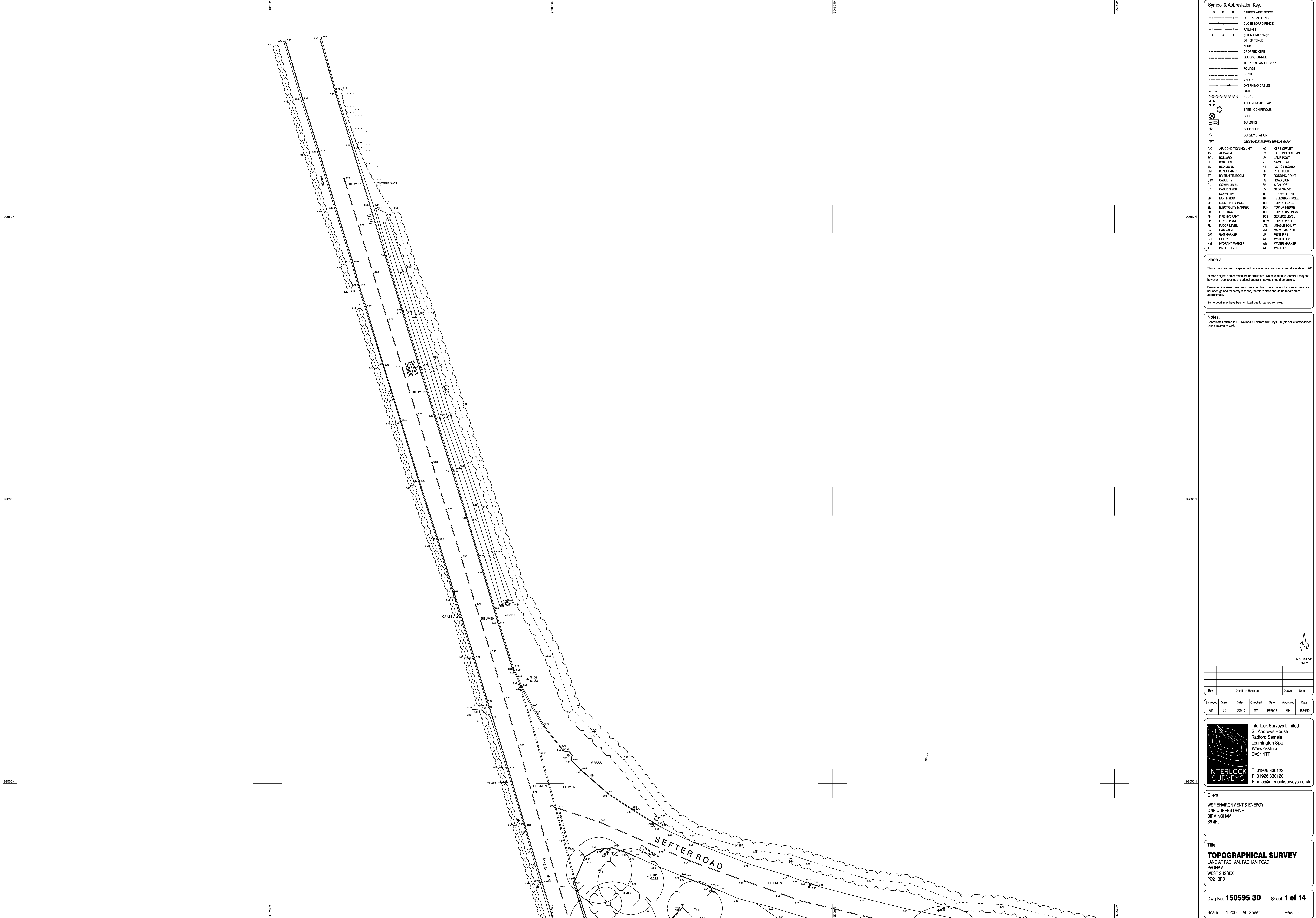
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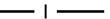
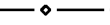
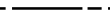
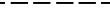
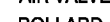
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PLANNING

drawn by	checked by	date
AJK	NJE	19 Dec 16

scale	paper size
1:1250	A1

job/dwg no.	rev.
167/P/006	B



Symbol & Abbreviation Key.	
	BARBED WIRE FENCE
	POST & RAIL FENCE
	CLOSE BOARD FENCE
	RAILINGS
	CHAIN LINK FENCE
	OTHER FENCE
	KERB
	DROPPED KERB
	GULLY CHANNEL
	TOP - BOTTOM OF BANK
	FOLIAGE
	DITCH
	VERGE
	OVERHEAD CABLES
	GATE
	HEDGE
	TREE - BROAD LEAVED
	TREE - CONIFEROUS
	BUSH
	BUILDING
	BOREHOLE
	SURVEY STATION
	ORDNANCE SURVEY BENCH MARK
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AV	AIR VALVE
BOL	BOLLARD
BH	BORHOLE
BL	BED LEVEL
BM	BENCH MARK
BT	BRITISH TELECOM
CTV	CABLE TV
CL	COVER LEVEL
CR	CABLE RISER
DP	DOWN PIPE
ES	EARTH ROD
EP	ELECTRICITY POLE
EM	ELECTRICITY MARKER
FB	FUSE BOX
FI	FIRE HYDRANT
FP	FENCE POST
FL	FLOOR LEVEL
GV	GAS VALVE
GM	GAS MARKER
GU	GULLY
HM	HYDRANT MARKER
L	INVERT LEVEL
KO	KERB OFFLET
LC	LIGHTING COLUMN
LP	LAMP POST
NP	NAME PLATE
NB	NOTICE BOARD
PR	PIPE RISER
RP	ROAD SIGN
RS	ROAD SIGN
SP	SIGN POST
SV	STOP VALVE
TL	TRAFFIC LIGHT
TP	TELEGRAPH POLE
TOP	TOP OF FENCE
TOH	TOP OF HEDGE
TOR	TOP OF RAILINGS
TDS	SERVICE LEVEL
TOW	TOP OF WALL
UTL	UNABLE TO LIFT
VM	VALVE MARKER
VP	VENT PIPE
WL	WATER LEVEL
WM	WATER MARKER
WO	WASH OUT

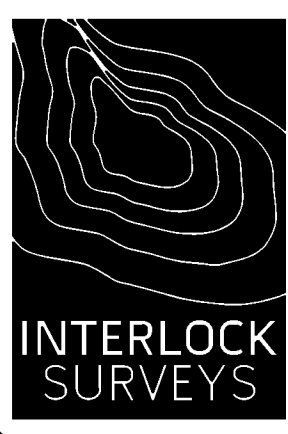
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Notes.
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Levels related to GPS.



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Title,
TOPOGRAPHICAL SURVEY
LAND AT PAGHAM, PAGHAM ROAD
PAGHAM
WEST SUSSEX
PO21 3PD

Dwg No. **150595 3D** Sheet **1 of 14**
Scale 1:200 A0 Sheet Rev. -



Symbols & Abbreviation Key.

	BARBED WIRE FENCE		LIGHTING COLUMN
	POST & RAIL FENCE		LP LUMP POST
	CLOSE BOARD FENCE		NP NAME PLATE
	MOUNDS		NB NOTCHED BOARD
	CHAIN-LINK FENCE		PR PIPE RISER
	OTHER FENCE		PP PONDING POST
	KERB		RS ROAD SIGN
	DIPPED KERB		SP SIGN POST
	KERB CHANNEL		SW STOP WALK
	TOP / BOTTOM OF BANK		TL TRAFFIC LIGHT
	FOULAGE		TP TELEGRAPH POLE
	DITCH		TOF TOP OF FENCE
	VERSE		TOF TOP OF FALLINGS
	OVERHEAD CABLES		TOB TOP OF BRIDGE LEVEL
	GATES		TOW TOP OF WALL
	HEDGE		UPL UPLAND
	TREE - BROADLEAF		VM VALUE MARKER
	TREE - CONIFEROUS		VP VENT PIPE
	BUSH		WL WATER LEVEL
	BUILDING		WM WATER MARKER
	BOREHOLE		WO WASH OUT
	SURVEY STATION		
	ORANGE SURVEY BENCH MARK		

General.

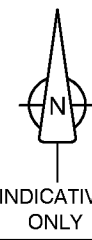
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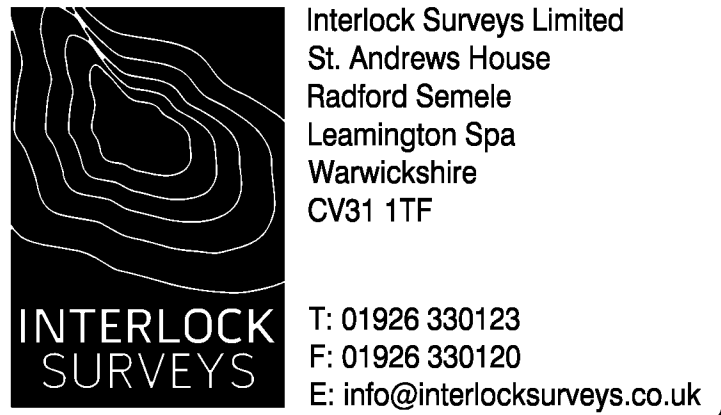
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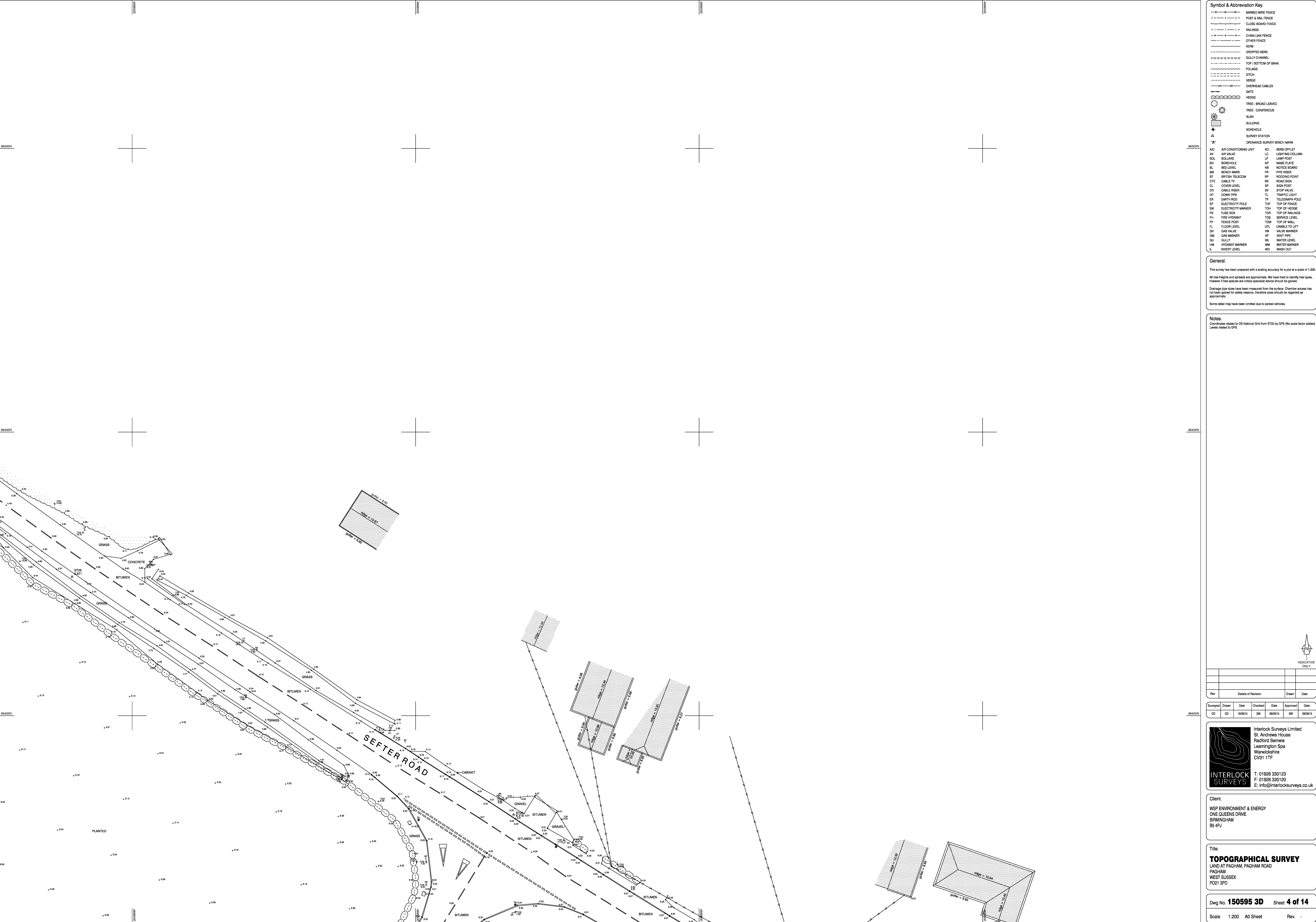
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TOPOGRAPHICAL SURVEY

LAND AT PAGHAM, PAGHAM ROAD
PAGHAM
WEST SUSSEX
PO21 3PD

Dwg No. **150595 3D** Sheet **2 of 14**

Scale 1:200 A0 Sheet Rev. -



Symbol & Abbreviation Key		
	BARBED WIRE FENCE	
	POST & RAIL FENCE	
	CLOSE BOARD FENCE	
	RAILINGS	
	CHAIN LINK FENCE	
	OTHER FENCE	
	KERB	
	DROPPED KERB	
	GULLY CHANNEL	
	TOP & BOTTOM OF BANK	
	FOLIAGE	
	DITCH	
	VERGE	
	OVERHEAD CABLES	
	GATE	
	HEDGE	
	TREE - BROAD LEAVED	
	TREE - CONIFEROUS	
	BUSH	
	BUILDING	
	BENCHHOLE	
	SURVEY STATION	
	ORDNANCE SURVEY BENCH MARK	

A/C	AIR CONDITIONING UNIT	KO	KERB OFFLET
AV	AIR VALVE	LC	LIGHTING COLUMN
BOL	BOLLARD	LP	LAMP POST
BN	BORERHOLE	NP	NAME PLATE
BL	BED LEVEL	NB	NOTICE BOARD
BM	BENCH MARK	PR	PIPE RISER
BT	BRITISH TELECOM	RP	RODDING POINT
CTV	CABLE TV	RS	ROAD SIGN
CL	COVER LEVEL	SP	SIGN POST
CR	CABLE RISER	SV	STOP VALVE
DP	DOWN PIPE	TL	TRAFFIC LIGHT
ER	EARTH ROD	TP	TELEGRAPH POLE
EP	ELECTRICITY POLE	TOP	TOP OF FENCE
EM	ELECTRICITY MARKER	TOB	TOP OF BEDGE
FB	FUSE BOX	TOR	TOP OF RAILINGS
FR	FIRE RISER	TOS	SERVICE LEVEL
FP	FENCE POST	TOW	TOP OF WALL
FL	FLOOR LEVEL	UTL	UNABLE TO LIFT
GV	GAS VALVE	VM	VALVE MARKER
GM	GAS MARKER	VP	VENT PIPE
GU	GULLY	WL	WATER LEVEL
HM	HYDRANT MARKER	WM	WATER MARKER
L	INVERT LEVEL	WO	WASH OUT

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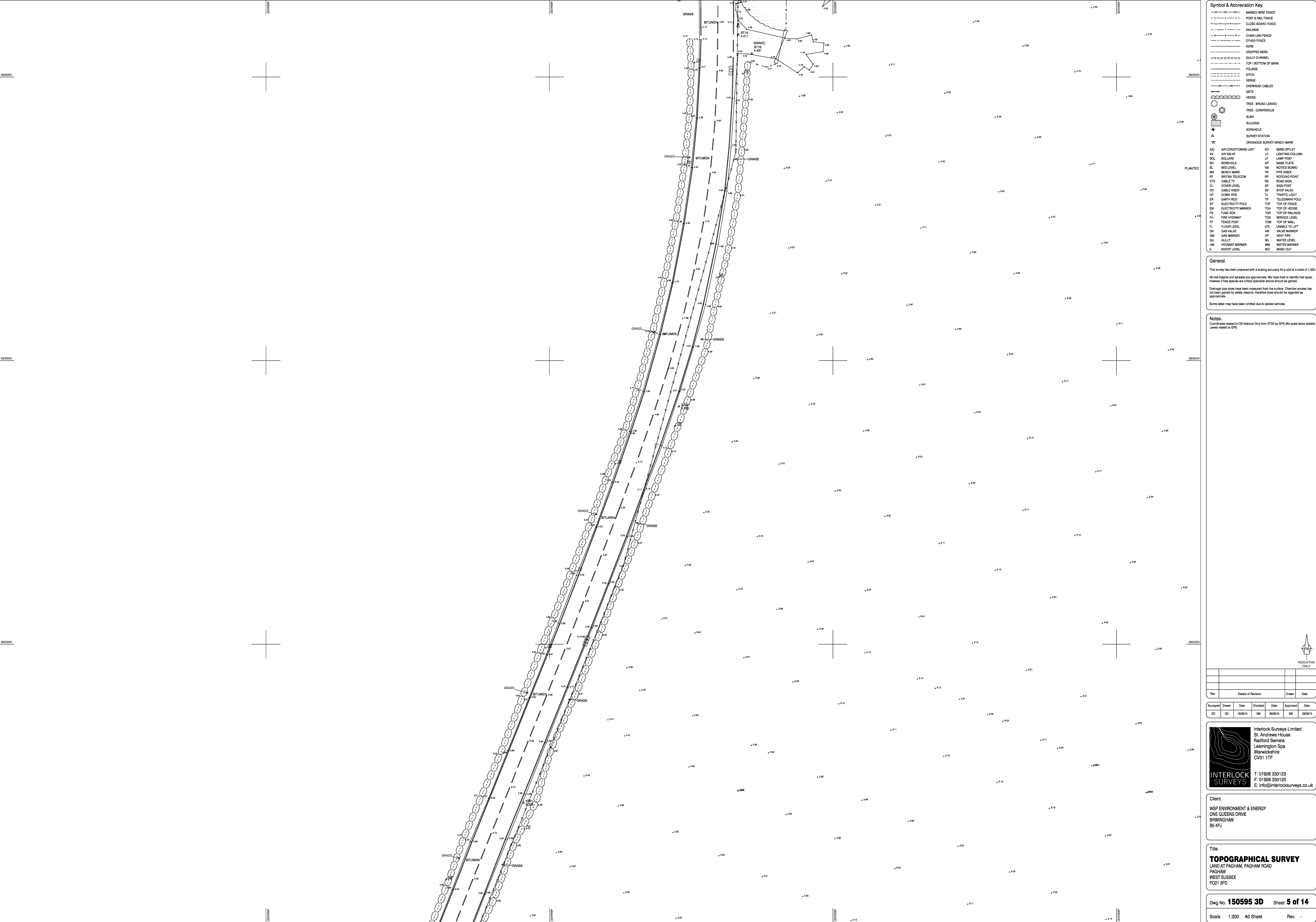
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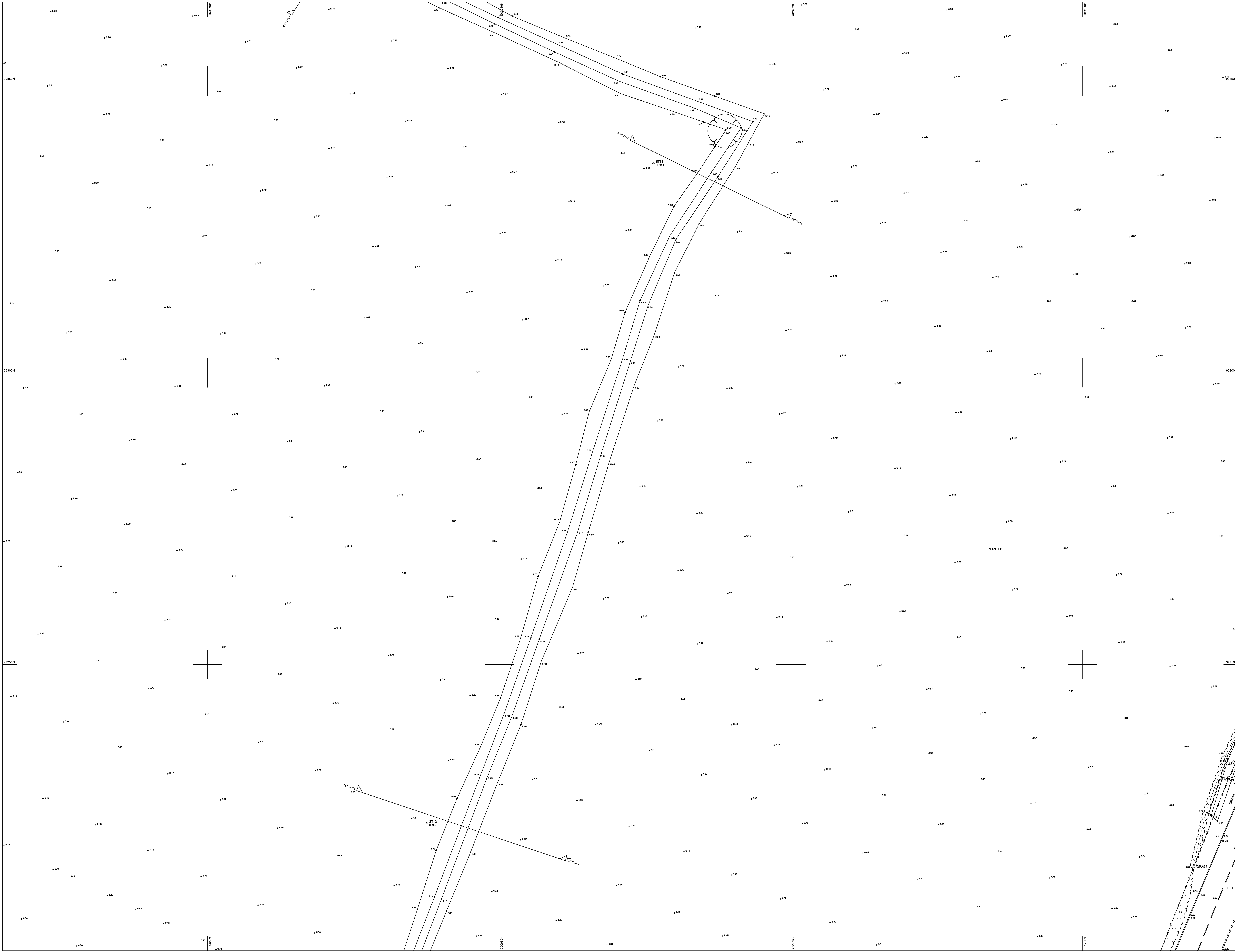
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PO21 3PD





Symbols & Abbreviation Key.

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	POST & RAIL FENCE		LP LUMP POST
	CLOSE BOARD FENCE		NP NAME PLATE
	MOUNDS		NB NOTCHED BOARD
	CHAIN LINK FENCE		PR PIPE RISER
	OTHER FENCE		PP PONDING POST
	KERB		RS ROAD SIGN
	DIPPED KERB		SP SIGN POST
	KERB CHANNEL		SW STOP WALK
	TOP / BOTTOM OF BANK		TL TRAFFIC LIGHT
	FOULAGE		TP TELEGRAPH POLE
	DITCH		TOF TOP OF FENCE
	VERSE		TOF TOP OF FALLINGS
	OVERHEAD CABLES		TOB TOP OF BRIDGE LEVEL
	GATES		TOW TOP OF WALL
	HEDGE		UPL UPLAND
	TREE - BROADLEAF		VM VALUE MARKER
	TREE - CONIFEROUS		VP VENT PIPE
	BUSH		WL WATER LEVEL
	BUILDING		WM WATER MARKER
	BOREHOLE		WO WASH OUT
	SURVEY STATION		
	ORANGE SURVEY BENCH MARK		

General.

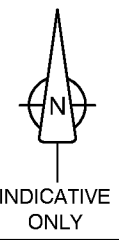
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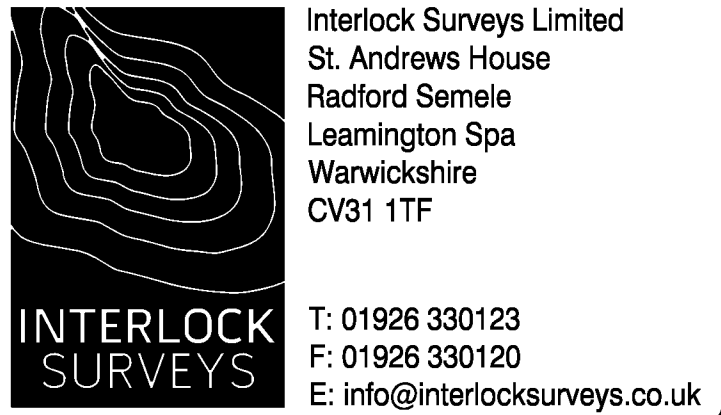
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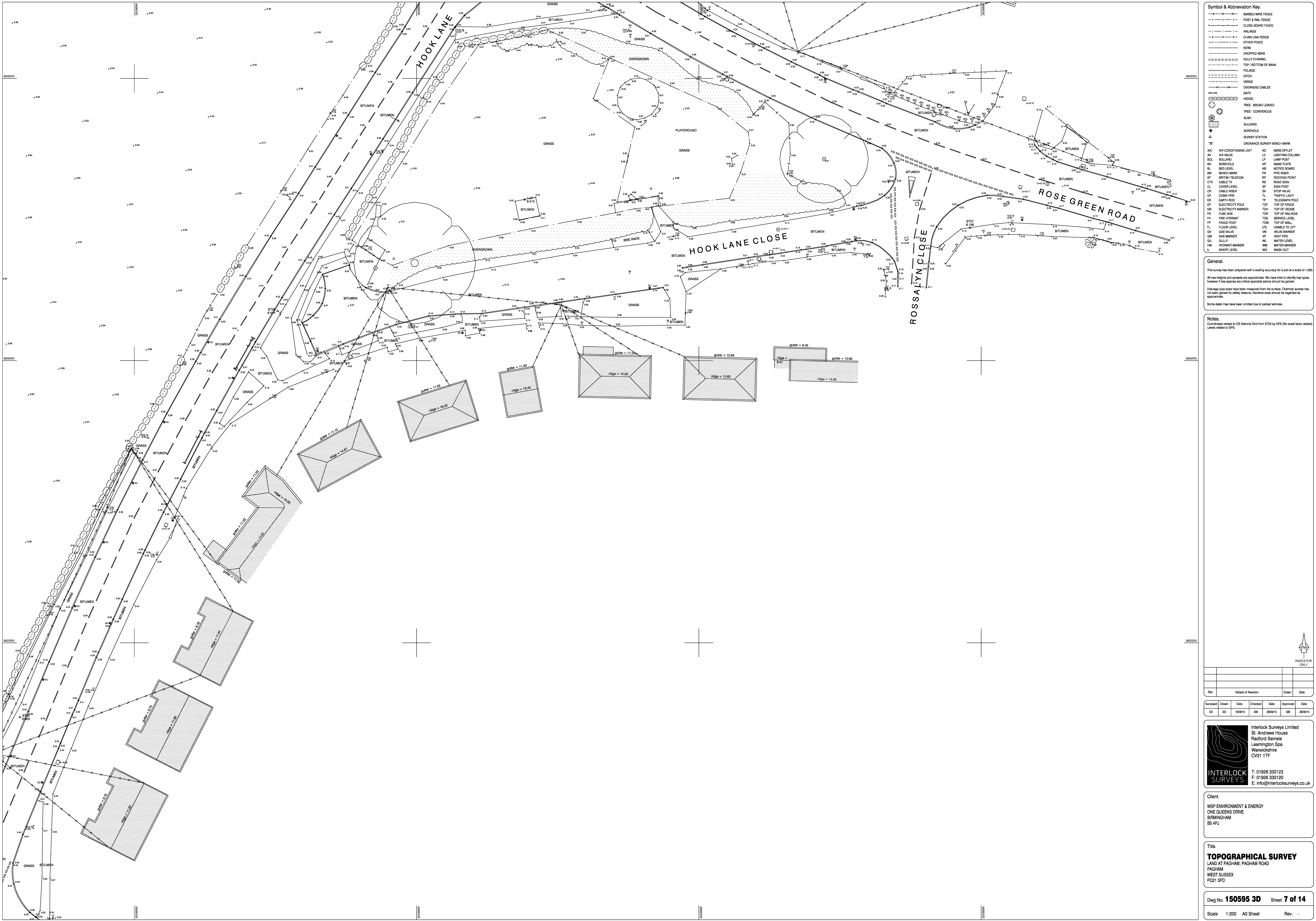
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TOPOGRAPHICAL SURVEY

LAND AT PAGHAM, PAGHAM ROAD
PAGHAM
WEST SUSSEX
PO21 3PD

Dwg No. **150595 3D** Sheet **1 of 14**

Scale 1:200 A0 Sheet Rev. -



- Symbol & Abbreviation Key.**
- BARBED WIRE FENCE
 - PORT & RAIL FENCE
 - CLOSE BOARD FENCE
 - RAILINGS
 - CHAIN LINK FENCE
 - OTHER FENCE
 - KERB
 - DROPPED KERB
 - GULLY CHAMBER
 - TOP / BOTTOM OF BANK
 - FOULAGE
 - DITCH
 - VERGE
 - OVERHEAD CABLES
 - GATE
 - HEDGE
 - TREE - BROAD LEAVED
 - TREE - CONIFEROUS
 - BUSH
 - BUILDINGS
 - BOULEVARD
 - SURVEY STATION
 - ORDNANCE SURVEY BENCH MARK
 - A/C AIR CONDITIONING UNIT
 - AV AIR VALVE
 - BOL LAMP POST
 - BN BOREHOLE
 - BL BED LEVEL
 - BM BENCH MARK
 - BT BRITISH TELECOM
 - CTV CABLE TV
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 - DP DOWN PIPE
 - ER EARTH ROD
 - EP ELECTRICITY POLE
 - EM ELECTRICITY MARKER
 - FB FUSE BOX
 - FH FIRE HYDRANT
 - FP FORCE POST
 - FL FLOOR LEVEL
 - GV GAS VALVE
 - GM GAS MARKER
 - GU GULLY
 - HM HYDRANT MARKER
 - IL INVERT LEVEL
 - KO KERB OFFSET
 - LC LIGHTING COLUMN
 - LP LAMP POST
 - NP NAME PLATE
 - NB NOTICE BOARD
 - PR PIPE RISER
 - RP RAILING POINT
 - RS ROAD SIGN
 - SP SIGN POST
 - SV STOP VALVE
 - TL TRAFFIC LIGHT
 - TP TELEGRAPH POLE
 - TOP TOP OF FENCE
 - TOT TOP OF TOWER
 - TOR TOP OF RAILINGS
 - TOS SERVICE LEVEL
 - TOW TOP OF WALL
 - UTL UNABLE TO LIFT
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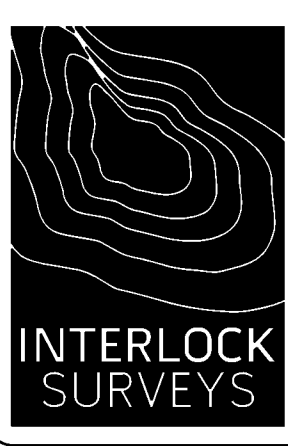
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Notes.

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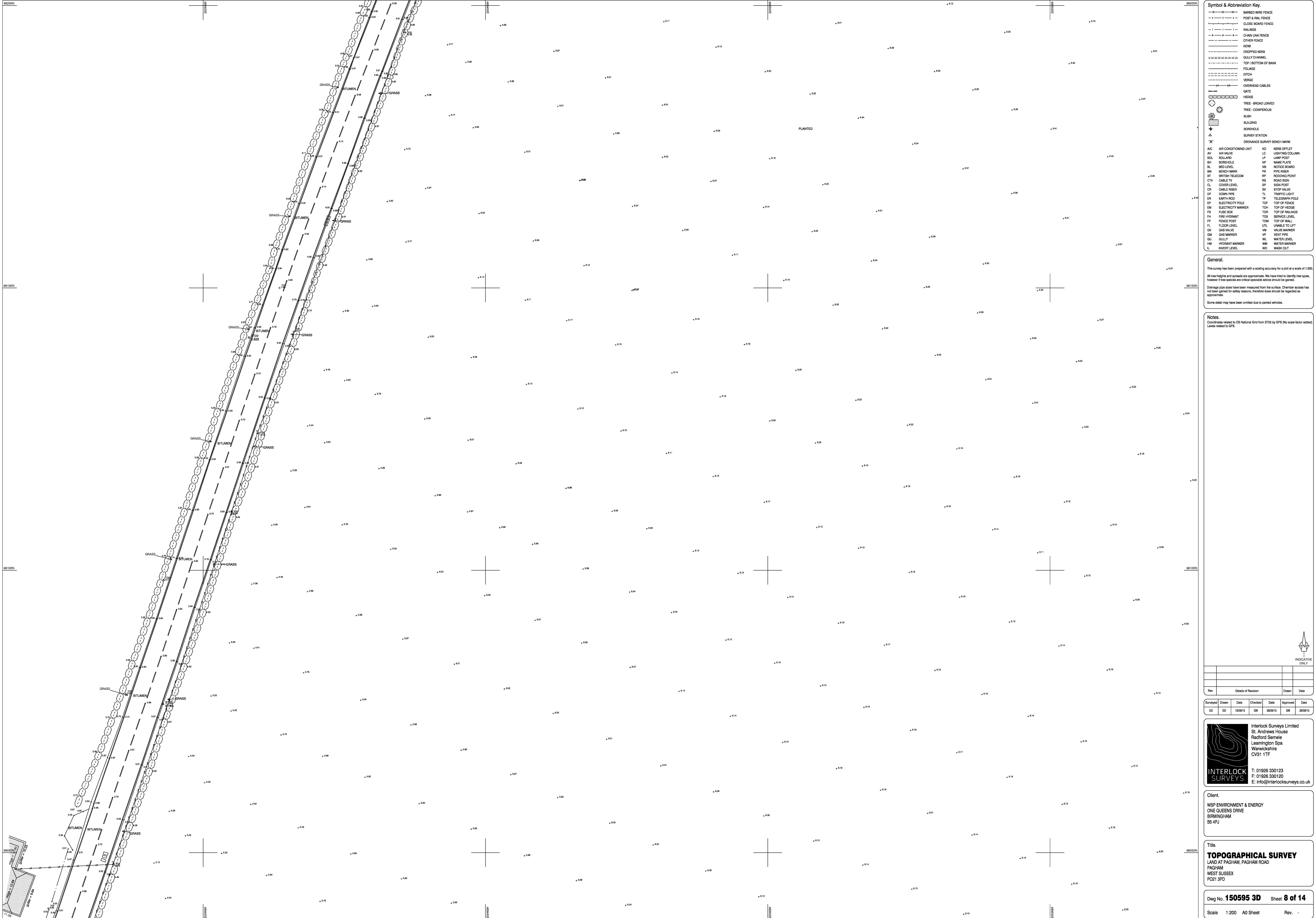
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	OTHER FENCE		DITCH
	KERB		VERGE
	OVERHEAD CABLES		GATE
	HEDGE		TREE - BROAD LEAVED
	TREE - CONIFEROUS		BUSH
	BUILDING		BOREHOLE
	SURVEY STATION		ORDNANCE SURVEY BENCH MARK
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	AV AIR VALVE		LC LIGHTING COLUMN
	BOL BOLLARD		LP LAMP POST
	BH BOREHOLE		NP NAME PLATE
	BL BED LEVEL		NB NOTICE BOARD
	BM BENCH MARK		PR PIPE RISE
	BT BRITISH TELECOM		RS ROAD SIGN
	CTV CABLE TV		RP ROADWORK POINT
	CL COVER LEVEL		SP SIGN POST
	CR CABLE RISER		SV STOP VALVE
	DP DOWN PIPE		TL TRAFFIC LIGHT
	ER EARTH ROD		TP TELEGRAPH POLE
	EP ELECTRICITY POLE		TOF TOP OF FENCE
	EM ELECTRICITY MARKER		TOH TOP OF HEDGE
	FB FUSE BOX		TOR TOP OF RAILINGS
	FH FIRE HYDRANT		TDS SERVICE LEVEL
	FP FENCE POST		TOW TOP OF WALL
	FL FLOOR LEVEL		UTL UNABLE TO LIFT
	GV GAS VALVE		VM VALVE MARKER
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	I INVERT LEVEL		WO WASH OUT

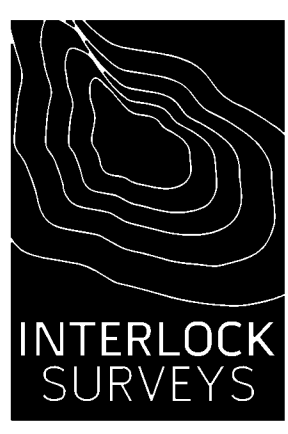
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