



john newton & partners

jnpgroup

Consulting Engineers

Report on **Flood Risk Assessment and Outline
Drainage Strategy**

**Additional 7 Units at Pollards Nursery,
Barnham**

For **Redrow Homes Ltd**

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Approved by **Mike Verity MCIHT, MILT**
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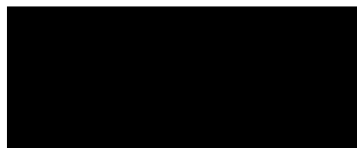
Date **22nd March 2016**

Ref: **RE003B**

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Project Name: Additional 7 Units at Pollards Nursery, Barnham
Project Number: C85102
Client: Redrow Homes Ltd
Report Title: Flood Risk Assessment & Drainage Strategy
Reference: RE003B



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FOR AND ON BEHALF OF JNP GROUP

Date: 22nd March 16

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Document Issue Record

Rev	Date	Description	Prepared	Reviewed	Approved
-	22.01.16	Draft Issue	J Sutton	M Moore	M Verity
A	17.02.16	First Issue	J Sutton	M Moore	M Verity
B	22.03.16	Site Boundary Updated	J Sutton	M Verity	M Verity

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Contents Page

1	INTRODUCTION	3
1.1	TERMS OF REFERENCE	3
1.2	SITE DESCRIPTION.....	3
1.3	EXISTING GEOLOGY.....	4
1.4	PROPOSED DEVELOPMENT	4
2	FLOOD RISK ASSESSMENT	5
2.1	FLOOD RISK GUIDANCE	5
2.2	SEQUENTIAL TEST	5
2.3	FLUVIAL AND TIDAL FLOOD RISK.....	5
2.4	GROUNDWATER FLOOD RISK	6
2.5	SURFACE WATER FLOOD RISK	7
2.6	DRAINAGE INFRASTRUCTURE/SEWER FLOOD RISK.....	8
2.7	RESERVOIR FLOOD RISK.....	9
2.8	MITIGATION MEASURES	11
3	SURFACE WATER MANAGEMENT	12
3.1	EXISTING RUNOFF CALCULATIONS.....	12
3.2	PROPOSED SURFACE WATER DRAINAGE STRATEGY	12
4	CONCLUSIONS AND RECOMMENDATIONS	14
	APPENDIX A: LOCATION PLAN.....	I
	APPENDIX B: TOPO SURVEY	II
	APPENDIX C: INDICATIVE SITE LAYOUT	III
	APPENDIX D: RESERVOIR LOCATION PLAN.....	IV
	APPENDIX E: SURFACE WATER DRAINAGE STRATEGY.....	V
	APPENDIX F: SFRA RIVER/TIDAL FLOOD MAPS.....	VI

LIST OF TABLES

<i>Table 1: Borehole Testing Results.....</i>	<i>4</i>
<i>Table 2: Environment Agency Surface Water Flood Risk Categories</i>	<i>7</i>
<i>Table 3: Rural Run-off Calculator Parameters.....</i>	<i>12</i>
<i>Table 4: Existing Greenfield Runoff Rates.....</i>	<i>12</i>

LIST OF FIGURES

<i>Figure 1: EA Fluvial Flood Map for Planning (Rivers and Sea)</i>	<i>6</i>
<i>Figure 2: EA Risk of Flooding by Surface Water</i>	<i>8</i>

1 INTRODUCTION

1.1 Terms of Reference

1.1.1 **jnp group** was commissioned by Redrow Homes Ltd to undertake a Flood Risk Assessment (FRA) and Outline Surface Water Drainage Strategy for the proposed development of an Additional 7 Units at Pollards Nursery, Barnham, PO22 0AE.

1.1.2 This FRA and Drainage Strategy is required to satisfy West Sussex County Council (WSCC) and Arun District Council (ADC) requirements and is compliant with relevant National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) policies. The objectives of this assessment are as follows:

- Identify the risk of flooding from all sources to the site (including fluvial, surface water, groundwater, sewer and reservoir);
- Reduce overall flood risk for the proposed development (on and off site) where possible;
- Assess all available information and provide recommendations for any drainage required to compensate for additional hardstanding that will be created as a result of the proposed development;
- Outline the drainage principles for the discharge of surface water run-off from the new hard surfaces in a manner, which will not increase the risk of flooding either on or off site, whilst considering climate change.

1.1.3 This report refers to relevant documents produced for an adjacent residential development, which has been granted planning consent, referred to as Land at Pollards Nursery (Planning Reference - APP/C3810/A/13/2193942). Documents used within this report are shown below:

- Cole Easden FRA (Report Reference – 2585/Issue 2)
- **jnp group** FRA Addendum (Report Reference - C85102/R001)
- Soils Limited Ground Investigation Report (Report Reference -14123/GIR)

1.2 Site Description

1.2.1 The application site (approximately 0.28 hectares) is located on Lake Lane in Barnham, West Sussex and comprises an existing horticultural nursery. The site is bounded to the north by existing terraced housing and to the south by a reservoir. The site is also bounded to the west by a residential development, mentioned above (refer to site location plan in Appendix A).

1.2.2 The site comprises a northern and southern parcel, which are separated by a proposed road leading from Lake Lane to the adjacent residential development. The southern parcel is currently occupied by an existing building with associated foul drainage infrastructure.

1.2.3 Both the northern and southern parcels are relatively flat and gently slope from south east to north west, with levels ranging from 9.93m Above Ordnance Datum (AOD) to 9.54m AOD. A topographic survey is provided in Appendix B.

1.3 Existing Geology

- 1.3.1 A Ground Investigation (GI) was undertaken by Soil Limited in April 2014 (report reference 14123/GIR) for the adjacent site whereby testing comprised of 7 No. boreholes to a maximum depth of 5m below existing ground level (bgl).
- 1.3.2 Borehole 3 was undertaken on the application site and results are summarised Table 1 below.

Table 1: Borehole Testing Results

Depth (bgl)	Strata Encountered
0.00 - 0.10m	Topsoil
0.10 - 1.10m	Head: Orange brown silty sandy CLAY
1.10 - 1.90m	Head: Orange brown silty sandy CLAY with fragments of fine to medium subangular gravel
1.90 - 4.30m	River Terrace Deposits: Orange brown very clayey fine SAND with fragments subangular to angular gravel
5.70 - 14.20m	London Clay Formation: Grey to dark fissured CLAY
14.20 - 15.00m	London Clay Formation: Band of CLAYSTONE

- 1.3.3 A brief summary of the strata encountered as part of the GI is described below:

- "Made Ground" was encountered in each of the boreholes from ground surface and comprised tarmac and concrete over brown, dark brown, dark grey, orange brown and light brown sandy silty clay, sandy clay and silty clayey sand with brick, concrete, ash, chalk fragments, timber, metal, glass and gravel to a depth of between 0.45 - 3.10m bgl.
- "Head" - Orange brown silty sandy CLAY, Orange brown silty sandy CLAY with fragments of fine to medium subangular gravel to a depth of between 1.90 - 4.50m bgl.
- "River Terrace Deposits" - Comprised Orange brown very clayey fine SAND with fragments of fine to medium subangular to angular gravel.
- "London Clay Formation" - Comprised Grey to dark fissured CLAY and CLAYSTONE at depth.
- Groundwater monitoring was undertaken in March 2014, when groundwater levels are typically considered to be rising to their annual maximum elevation.

- 1.3.4 Although no groundwater was observed within Borehole 3, groundwater is expected to be between 0.45m and 1.45m (based on monitoring undertaken on the adjacent site). Reference should be made to the GI Report (14123/GIR) for the complete set of findings.

1.4 Proposed Development

- 1.4.1 The proposed development will comprise of six residential units with associated gardens, landscaping and an access road through the site. An indicative site layout is shown in Appendix C.

2 FLOOD RISK ASSESSMENT

2.1 Flood Risk Guidance

2.1.1 The following resources have been reviewed to assist with the preparation of the FRA:

2.1.2 **Strategic Flood Risk Assessment (SFRA):** The West Sussex County Council (WSCC) SFRA Volume I, prepared in January 2010 and Volume II, prepared in August 2010 provide an overview of flood risk issues in the area.

2.1.3 **Preliminary Flood Risk Assessment (PFRA):** Following the introduction of the Flood Risk Regulations (2009) and the Flood and Water Management Act (2010), all unitary authorities were designated as a LLFA and allocated with key responsibilities in relation to local flood risk management. The Flood Risk Regulations (2009) implement the requirements of the European Flood Directive with the aim of providing a consistent approach to flood risk management; the first stage of the process is the preparation of the PFRA. The PFRA for ADC was prepared in February 2008, compiling information on significant local flood risk from past and potential floods.

2.1.4 The documents above were prepared some time ago and updated information has been used where possible.

2.2 Sequential Test

2.2.1 Paragraph 101 of the NPPF sets out guidance on the application of the Sequential Test. The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. Where areas of lower risk are not available, the Exception Test, as set out in paragraph 102 of the NPPF can be applied, to ensure that flood risk to people and property will be managed satisfactorily.

2.2.2 The Planning Practice Guidance (PPG), which supports NPPF, defines three flood zones in relation to river flooding, as follows:

- Flood Zone 1 (Low Probability): This zone comprises land assessed as having less than a 1 in 1000 annual probability of river flooding;
- Flood Zone 2 (Medium Probability): This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding; and
- Flood Zone 3 (High Probability): This zone comprises land assessed as having greater than a 1 in 100 annual probability of river flooding.

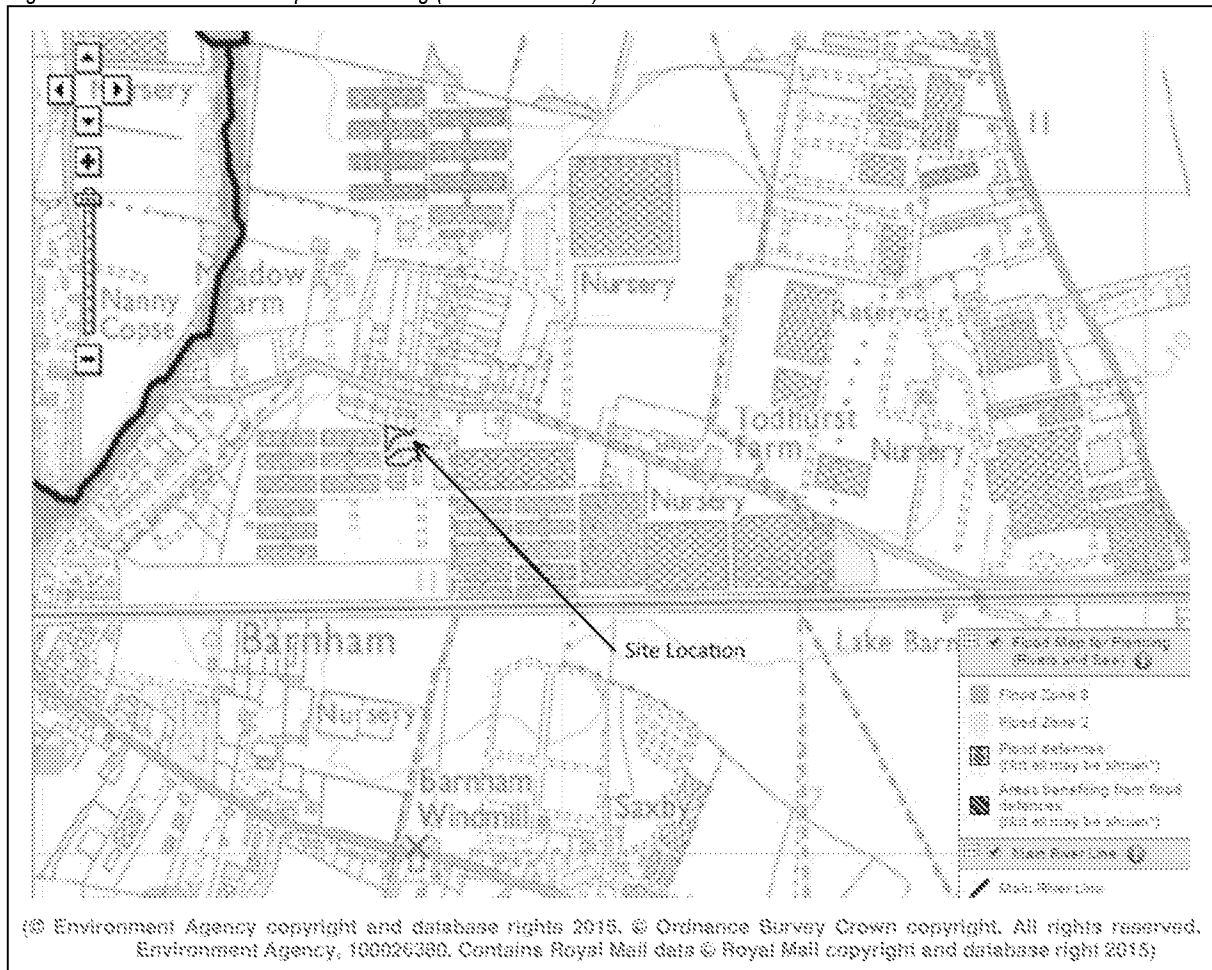
2.2.3 The EA's indicative flood map demonstrates that the site is located in Flood Zone 1. In accordance with Table 2 and 3 of the PPG, residential development is classified as 'more vulnerable' and is permitted in Flood Zone 1; therefore, a Sequential and Exception Test are not required.

2.3 Fluvial and Tidal Flood Risk

2.3.1 The Barnham Rife, classified as a Main River, drains the local catchment and is located approximately 400m west of the site. The watercourse flows South West towards Barnham.

- 2.3.2 This watercourse has been modelled by the EA and flood extents are shown on the EA's indicative flood map in Figure 1. The site is within Flood Zone 1, at risk of fluvial flooding with an annual probability of less than 0.1% (1 in 1000 year). Therefore, the risk of flooding from this source is low.

Figure 1: EA Fluvial Flood Map for Planning (Rivers and Sea)



- 2.3.3 The site is not located near to any tidally influenced watercourses; therefore, there is a low risk of tidal flooding.
- 2.3.4 Additional flood risk maps were produced as part of the WSCC SFRA (refer to Appendix F). These maps support the data shown on the EA maps and demonstrate that the site is not at risk from fluvial or tidal flooding.
- 2.4 Groundwater Flood Risk**
- 2.4.1 The geology comprises of London Clay Formation at a depth of 5.70m bgl, with River Terrace Deposits between 1.90 - 4.30m bgl overlain by deposits of clay rich Head and Made Ground.
- 2.4.2 The strata beneath the site is designated as a minor aquifer and EA maps shows that the site does not lie with a Source Protection Zone.

2.4.3 The site lies within the medium and high Risk Groundwater flood zone as defined in the ADC PFRA Figure 4 - Groundwater Flood Zone Map.

2.4.4 Although no groundwater was recorded at the application site, the GI report observed standing levels of groundwater at 0.45 - 1.55m bgl across the adjacent site. Due to the suspected high groundwater levels, there is potential for groundwater to rise to ground level and effect building foundations, thus posing a medium risk before the implication of mitigation measures (discussed in in detail in Chapter 2.9).

2.5 Surface Water Flood Risk

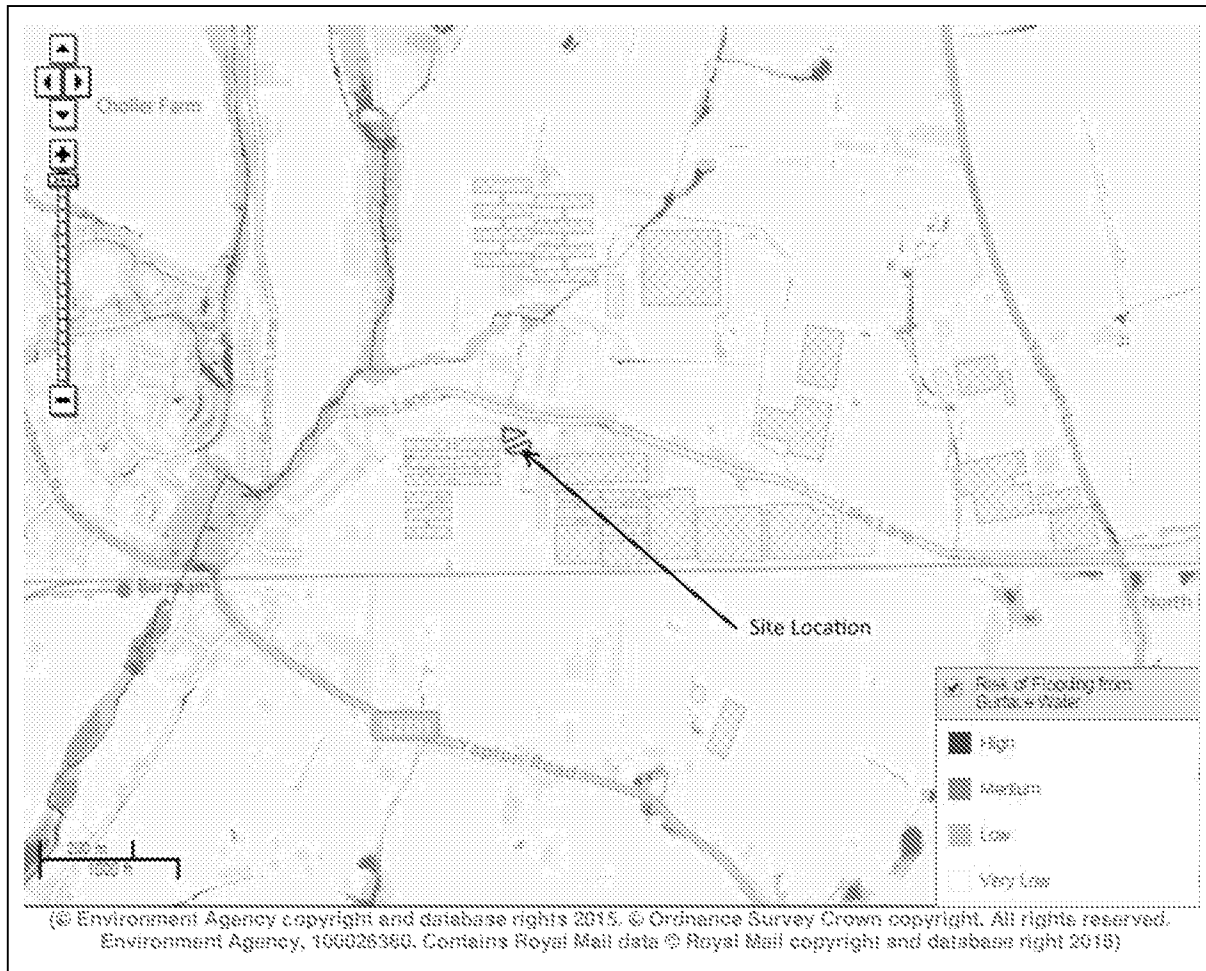
2.5.1 The EA's 'Risk of Flooding from Surface Water Map' prepared in December 2013 uses 'direct rainfall' modelling. Whilst this does not take into account any non-surface water influences such as rivers, the sea or groundwater, it does consider local drainage capacity.

2.5.2 The map shows the entire country within four different risk categories, defined below in Table 2.

Table 2: Environment Agency Surface Water Flood Risk Categories

Risk Category	Definition
High	Each year, there is a chance of flooding of greater than 1 in 30 (3.3%)
Medium	Each year, there is a chance of flooding of between 1 in 30 (3.3%) and 1 in 100 (1%)
Low	Each year, there is a chance of flooding of between 1 in 100 (1%) and 1 in 1000 (0.1%)
Very Low	Each year, there is a chance of flooding of less than 1 in 1000 (0.1%)

Figure 2: EA Risk of Flooding by Surface Water



2.5.3 According to EA map in Figure 2, a low risk of onsite surface water flooding is shown within a small portion of the northern region of the application site. From a review of the topographic survey, this is most likely caused by an existing depression in ground levels, allowing surface water to pond. The ponding caused from this depression in levels is small scale with a maximum depth of 15mm and therefore poses a low risk to the site.

2.5.4 To ensure that the risk of surface water flooding to the new development remains low, levels will be provided at the detailed design stage to ensure surface water flows via gravity into the proposed surface water network and prevent water ponding as per the current situation. Additional mitigation measures have been considered in Section 2.9.

2.5.5 In summary, the risk of flooding from this source is considered low.

2.6 Drainage Infrastructure/Sewer Flood Risk

2.6.1 Sewer flooding occurs when sewer capacity is exceeded and is often caused by excess surface water entering the drainage network and/or insufficient capacity in the surface and foul water network, but also due to 'one off' events such as blockages.

- 2.6.2 Cole Easdon Consultants FRA states that “although there is a history of flooding of both foul and surface water sewers in Barnham, these incidents have largely been confined to areas isolated from and to the west of the development site. There is no record of sewer flooding at the site”.
- 2.6.3 There are no existing surface water sewers in the vicinity of the site. The existing adopted sewer located beneath Lake Lane lies at a lower level than the application site therefore if it was to surcharge and flood, overland flow will follow the gradient of the highway in a westerly direction and away from the application site.
- 2.6.4 Based on the information currently available, the site is considered to have a low risk of flooding from this source.

2.7 Reservoir Flood Risk

- 2.7.1 Three reservoirs are located in close proximity to the application site, the locations of which are shown in Appendix D.
- 2.7.2 Information regarding the flood risk arising from a reservoir breach has been assessed within the Cole Easdon Consultants FRA (report reference: 2585/Issue 2) and subsequent **jnp group** FRA Addendum (report reference: C85102 R001). The information within these documents has been used to assess reservoir flood risk for the application site.
- 2.7.3 Reservoir 1 is a below ground earth bank reservoir located immediately south of the application site. As stated within the Cole Easdon Consultants FRA, the water level of Reservoir 1 is maintained at ground level via pumped abstraction from an adjacent borehole, with a risk of failure considered to be minimal.
- 2.7.4 Reservoir 2 is a 3.5m high above ground circular tank (constructed in 2011) and is located approximately 175m to the south of the application site.
- 2.7.5 **jnp group's** FRA Addendum states that Reservoir 2 has a capacity of approximately 2493m³ (the equivalent 1 in 100 + 20% run off volume of the adjacent glasshouse roof). In the event of overtopping or catastrophic failure, this will spread out and flow in a westerly and northern direction.
- 2.7.6 Within the FRA Addendum, the approximate depth of water was estimated in the event of catastrophic failure of Reservoir 2. The volume stored has been spread over the surrounding land (less the footprint of existing buildings):

Volume stored:	2,493m ³
Area of surrounding land (less the footprint of existing buildings):	26,170m ²
	$2,493\text{m}^3 / 26,170\text{m}^2 = 0.12\text{m}$

- 2.7.7 **jnp group's** FRA Addendum states that in the event of catastrophic failure of Reservoir 2, using a simplistic approach and assuming the nursery building itself is impenetrable, that the surrounding pathways and access road would have approximately 120mm depth of stored water. Floodwater from a catastrophic reservoir failure water would flow westerly and northerly towards the adjacent residential development, eventually dissipating in the direction of Lake Lane and towards the proposed development. Mitigation measures to minimise the impact of a catastrophic failure from Reservoir 2 are shown in Section 2.9.
- 2.7.8 Reservoir 3 is a below ground earth bank reservoir located approximately 850m east of the application site and has a 22500m³ storage capacity. Cole Easdon Consultants FRA states, “in the event of a breach of Reservoir 3, water will follow the route and gradient of Lake Lane and flow eastwards. Water flowing along Lake Lane will discharge into fields beyond the eastern end of Lake Lane and in to a watercourse

(at least 2m deep), where water will disperse.” Floodwater will therefore not impact upon the application site.

- 2.7.9 Following an assessment of the risk associated with Reservoir 3, **jnp group** agree with the statement above that the risk of flooding from Reservoir 3 is considered low.

2.8 Mitigation Measures

- 2.8.1 The following mitigation measures will be incorporated where appropriate to protect dwellings from groundwater, surface water flooding and reservoir:
- Finished floor levels (FFLs) will be set at least 300mm above the existing ground levels, where appropriate.
 - The low on-site surface water risk will be mitigated by ensuring that the surface water system is capable of accepting surface water flows generated by the proposed development and that the levels design is such that any excess flow (as a result of system failure or breakdown) can be routed away from dwellings and stored in areas of open space.
- 2.8.2 Raising levels 300mm above existing ground, where appropriate, will provide a minimum of 180mm buffer above estimated flood water levels as a result of catastrophic failure of Reservoir 2. By raising site levels, the risk of flooding to dwellings from Reservoir 2 will be mitigated.
- 2.8.3 Following the implementation of the above mitigation measures, all sources of flooding are considered to pose a low risk both on and offsite.

3 SURFACE WATER MANAGEMENT

3.1 Existing Runoff Calculations

- 3.1.1 The existing greenfield runoff rates can be estimated using the current industry 'best practice' guidelines as outlined in the Interim Code of Practice for SuDS. The recommended methodology for sites up to 50Ha is the Institute of Hydrology 124, Interim Code of Practice Method and the values have been calculated using the industry standard Micro Drainage WinDES software. The parameters and calculated greenfield rates for each field are provided in Table 3 and 4.

Table 3: Rural Run-off Calculator Parameters

Parameter	Value
Area (ha)	0.28
SAAR (mm)	764
Soil	0.450

- 3.1.2 The soil value has been determined by comparing the identified geological characteristics of the site with the MicroDrainage Soil Index. Due to the clay rich Made Ground and Head deposits, a value of 0.45 has been used, which relates to "Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Table 4: Existing Greenfield Runoff Rates

Return period (years)	Existing runoff rate (l/s)
QBAR	1.4
1 in 1	1.2
1 in 30	3.1
1 in 100	4.4

- 3.1.3 Existing greenfield volumes have been calculated using the FSR Rainfall model within the industry standard MicroDrainage 'Source Control' module. This model shows 243m³ greenfield runoff volume per ha during a 360 minute duration 1 in 100 year storm event plus 30% allowance for climate change (CC).

3.2 Proposed Surface Water Drainage Strategy

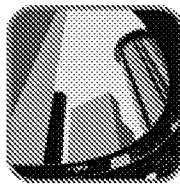
- 3.2.1 The proposed drainage strategy is to connect surface water flows generated from the application site into the main drainage system that is to be constructed as part of the adjacent residential development (Planning ref: APP/C3810/A/13/2193942). The surface water drainage from the proposed development will connect into the proposed network, as shown on JNP Drawing Ref: C85102-D-300 in Appendix E. The developer has confirmed that the adjacent development drainage system will be re-designed to accommodate the additional flows and loadings from the proposed development.

- 3.2.2 The adjacent developments drainage system (and associated attenuation) has been designed to restrict flows to no greater than the pre development run off rate.
- 3.2.3 The outflow from the adjacent site will not increase as a result of the proposed development. Attenuation will be increased to ensure that the outflow remains no greater than the pre development rate.
- 3.2.4 The overall system will be capable of accommodating flows from up to and including the 1 in 100 + 30% CC storm return period.

4 CONCLUSIONS AND RECOMMENDATIONS

- 4.1.1 The conclusions made within the Cole Easdon FRA and **jnp group's** Addendum for the adjacent site are still valid and can be applied to the proposed development.
- 4.1.2 This report has been produced for the application site and has been prepared in accordance with the NPPF and its associated PPG, which reviews all aspects of flood risk to the site.
- 4.1.3 The proposed development area of the site is located in Flood Zone 1 where land is assessed as having less than a 1 in 1000 annual probability of river and tidal flooding (low probability).
- 4.1.4 Suitable mitigation measures, such as raising FFL's 300mm above existing ground levels where appropriate, will be implemented to ensure that the flood risk posed by groundwater, reservoir and surface water flooding is low.
- 4.1.5 The site has been assessed as having a low flood risk from Reservoirs 1 and 3. Reservoir 2 has been assessed to pose a low risk to the site following the implementation of the mitigation measures above.
- 4.1.6 The comments stated above are based on information received from other consultees. The flood risk classification of this site has been based on the above observations, and the recommendations stated. This report is intended for the use of the developer of the site in support of their planning application for the site only.

Appendix A: Location Plan



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Site Location Map



Site Boundary is highlighted in Red Above.

Residential • Industrial • Commercial • Retail • Leisure • Education • Health • Rail • Drainage • Highways • Contaminated Land • Renewable Energy

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Peter L. Hurd
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David Hocking
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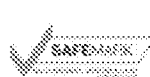
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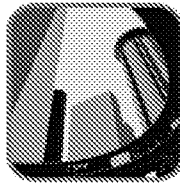
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Khai Tran
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Martin Hitchcock
Group Project Link, Local Authority and
Neil Goodman
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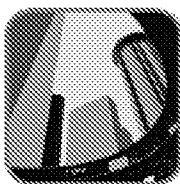
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Appendix B: Topo Survey



Appendix C: Indicative Site Layout



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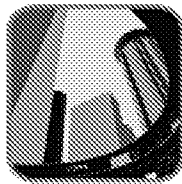


Pollards Nursery
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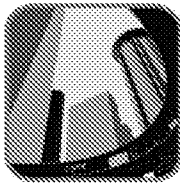
Site Layout

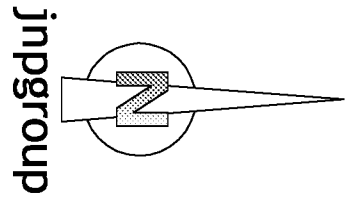
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Appendix D: Reservoir Location Plan



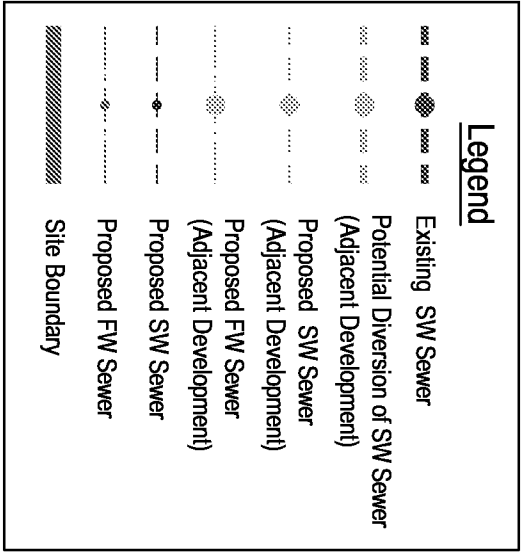
Appendix E: Surface Water Drainage Strategy





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Status	Preliminary			

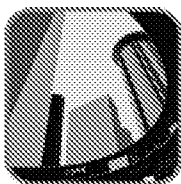


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Client	Redrow Homes
Job	Additional 7 Units at Poliers Nursery Lake Lane Barnham
Title	Schematic Drainage Strategy

Scale 1:200 @ A1 | Date January 2016
Drawn By JSS | Eng. Check MW | Tech. Check MM
BUTROAD
HAS
Approved Contractor
Drawing No. C85102-D-300
Rev. A

Appendix F: SFRA River/Tidal Flood Maps





Notes:

The Arun SFRA is a strategic assessment of flooding. Users of the SFRA should be aware of this when interpreting the information presented. The user is directed to the SFRA reports which outline the uncertainties associated with the studies. Particular attention is drawn to the following:

- Flood extent boundaries are not considered definitive. Land adjacent to these areas may also be at risk.
- Some flooding mechanisms have not been included in the assessment. The 'coastal risk area' is based on advice from LA Engineers and requires further assessment.

Arun District Council SFRA

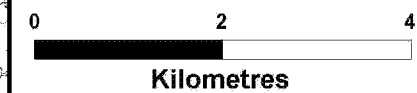
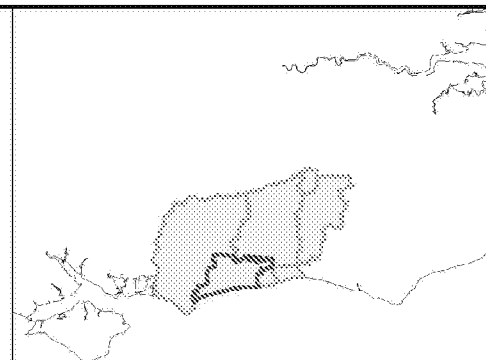
Map A1-T - Actual and Residual Flooding from the Sea



CAPITA SYMONDS

Legend

- Arun District Boundary
- Actual Defended Tidal Flood Risk (0.5% AEP, 2006)
- Residual Defended Tidal Flood Risk (0.1% AEP, 2006)
- Coastal Risk Area



Scale at A3: 1:80,000

Date: 31/01/2008

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Map_A1-T.wor



Notes:

The Arun SFRA is a strategic assessment of flooding. Users of the SFRA should be aware of this when interpreting the information presented. The user is directed to the SFRA reports which outline the uncertainties associated with the studies. Particular attention is drawn to the following:

- Flood extent boundaries are not considered definitive. Land adjacent to these areas may also be at risk.
- Some flooding mechanisms have not been included in the assessment. The 'coastal risk area' is based on advice from LA Engineers and requires further assessment.

Arun District Council SFRA

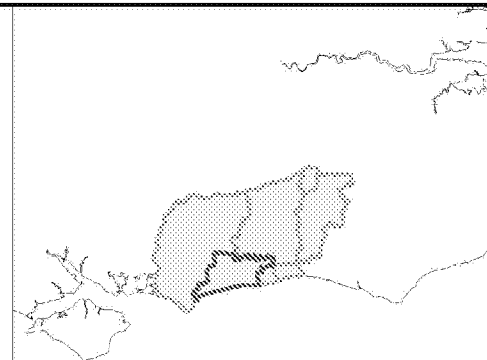
Map A1-F - Actual and Residual Risk of Flooding from Rivers



CAPITA SYMONDS

Legend

- Arun District Boundary
- Actual Defended Fluvial Flood Risk (1% AEP, 2006)
- Residual Defended Fluvial Flood Risk (0.1% AEP, 2006)



0 2 4
Kilometres

Scale at A3: 1:80,000

Date: 31/01/2008

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Map_A1-F wor

