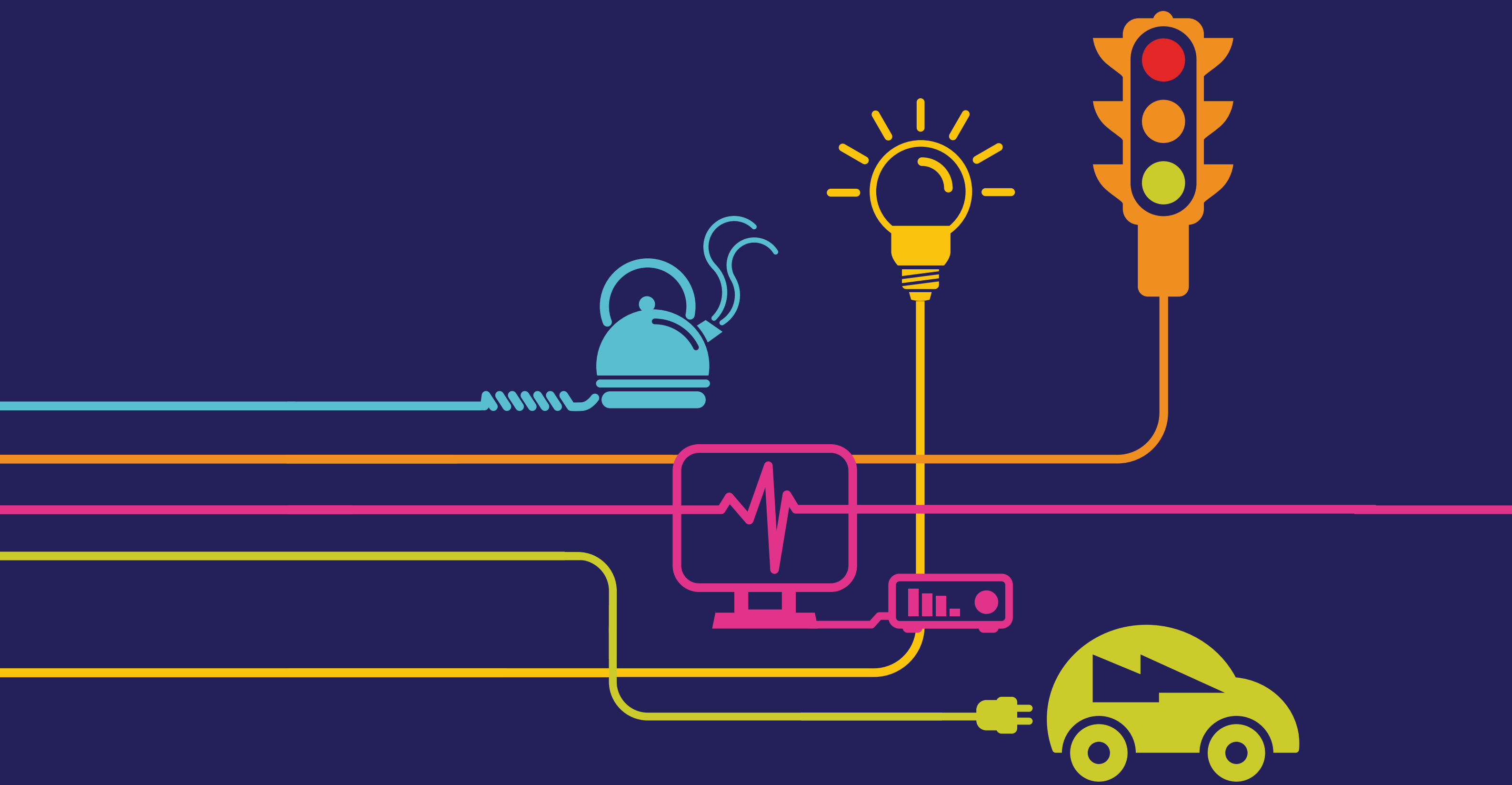
Document 5.23.3

nationalgrid

Environmental Statement Flood Risk Assessment Sandford Substation

Hinkley Point C Connection Project

Regulation 5(2)(e) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009



Application Reference EN020001

May 2014

nationalgrid

Hinkley Point C Connection Project

MAY 2014

VOLUME 5.23.3, SANDFORD SUBSTATION FLOOD RISK ASSESSMENT

<table>
<tr><th colspan="4">Document Control</th></tr>
<tr><td colspan="4">Document Properties</td></tr>
<tr><td colspan="2">Organisation</td><td colspan="2">National Grid</td></tr>
<tr><td colspan="2">Author</td><td colspan="2">Soon Hock Lee, Iain Blackwell</td></tr>
<tr><td colspan="2">Approved By</td><td colspan="2">Andy Debney</td></tr>
<tr><td colspan="2">Title</td><td colspan="2">Sandford Substation Flood Risk Assessment</td></tr>
<tr><td colspan="2">Document Reference</td><td colspan="2">Volume 5.23.3</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Date</td><td>Version</td><td>Status</td><td>Description/Changes</td></tr>
<tr><td>09/05/14</td><td>A</td><td>Live</td><td>Final version for DCO submission</td></tr>
</table>

Table of Contents

INSETS (VOLUME 5.23.3.1)

APPENDICES (VOLUME 5.23.3.2)

EX1. EXECUTIVE SUMMARY

EX1.1.1 This Flood Risk Assessment (FRA) accompanies National Grid Electricity Transmission Limited's (National Grid) application for development consent to construct, operate and maintain a new 400,000 volt (400kV) connection between Bridgwater, Somerset and Seabank Substation, north of Avonmouth ("the Proposed Development"). As part of the Proposed Development, a new substation is required at Sandford in Somerset, approximately 12km east of Weston-Super-Mare.

EX1.1.1 This FRA complies with the requirements set out in National Policy Statements published by the Department for Energy and Climate Change (July 2011), specifically Overarching Energy Policy (EN-1) and Electricity Networks Infrastructure Policy (EN-5). It also complies with the Planning Practice Guidance (PPG) on Flood Risk and Coastal Change which came into effect in March 2014 and the National Planning Policy Framework (March 2012) to which this PPG refers.

EX1.1.2 The proposed substation lies in an area designated by the Environment Agency as Flood Zone 1. This means that the site has an annual probability of flooding of less than 1 in 1,000 (<0.1%) in any year.

EX1.1.3 The NPPF sets out a Sequential Test, which states that preference should be given to development located within Flood Zone 1. If there is no reasonably available site in Flood Zone 1, then built development can be located in Flood Zone 2. If there is no reasonably available site in Flood Zone 1 or 2, then nationally significant energy infrastructure projects such as the Hinkley Point C Connection project - classified as "Essential Infrastructure" - can be located in Flood Zone 3 subject to passing a series of tests known as the Exception Test.

EX1.1.4 **Volume 5.2.1**, describes the alternatives considered for the Proposed Development, including options for the route and method of connection (overhead line or underground cable). This demonstrates compliance with the principle of the Sequential Approach. The proposed substation is required as a result of the removal of an existing 132kV overhead line between Bridgwater and Avonmouth, and the proposed new 400kV overhead line and underground cable between Bridgwater and Seabank. The Sequential and Exception Tests are applied within the constraints of the preferred route and connection option.

EX1.1.5 This FRA demonstrates that the requirements of the Sequential Test have been met by locating the substation in Flood Zone 1, and therefore the Exception Test is not required.

EX1.1.6 This FRA has concluded that:

- The estimated level for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events are 6.02mAOD and 6.52mAOD respectively based on the information provided in the Level 1 Strategic Flood Risk Assessment, updated to give 2014 level estimates. With allowance for climate change and a design life of 40 years to 2060, the adopted flood levels for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events are 6.35mAOD and 6.85mAOD respectively. With an allowance of 300mm for data uncertainty, the recommended minimum floor level of 7.15mAOD is required for the 1 in 1,000

(0.1%) annual probability flood event, with climate change. The minimum proposed slab level of 8.00mAOD is well above this level. This meets the National Grid Flood Mitigation Policy which aims at protecting the critical infrastructure to the 1 in 1,000 (0.1%) annual probability flood event.

- It is recognised that although the proposed operational life of the substation is 40 years, it is possible that the substation would still be required beyond this timeframe given that Hinkley Point C Power Station would generate power for an estimated 60 years. Therefore, consideration is given to operation at the site (with replacement infrastructure) for a further 20 years. This would give the requirement for a minimum floor level of 7.37mAOD for the 1 in 1,000 (0.1%) annual probability event. The minimum proposed slab level of 8.00mAOD is well above this level.

- Although the risk of surface water flooding at the site is generally low, there is a minor risk of surface water flooding at the proposed substation at the western corner of the site. This is due to the diversion of a watercourse (drain) that currently crosses the site. The re-alignment of the drain and associated ground works would enable the western corner of the site to be protected against flooding in the event of the drain flowing out of bank, through the excavation of the drainage channel and formation of a low flood bund.

- Flood risk from other sources (fluvial, tidal, groundwater, sewers, reservoirs and other artificial sources) is demonstrated to be low.

- The proposed substation could potentially impact on flood risk elsewhere as the proposed works would increase the local impermeable area by approximately 26% of the total developed area, thereby increasing the rainfall runoff rate and volume contributing to the catchment. This potential increase would be mitigated through provision of attenuation storage on the site. The storage volume required to attenuate the impact of the additional runoff generated is estimated to be 460m^3 (1 in 100 (1%) annual probability event with climate change) and would be attenuated via a proposed attenuation storage pond. There is adaptive capacity available on site in the event that in future the surface water attenuation needs to be increased as a result of increased rainfall intensity due to climate change.

- The impact of climate change has been assessed using the latest UKCP09 projections. This covers the anticipated operational life of the substation to 2060, with measures proposed to take into account the impacts of climate change. In the event that the site is still required beyond 2060, there is additional adaptive capacity to address the potential future impacts of increased rainfall intensity. The proposed site would also be at a sufficiently high elevation to avoid tidal and fluvial flooding well beyond 2080, even under the sensitivity testing to the H++ climate change scenario.

- A safe access and egress plan should be included within the management plan to ensure that alternative arrangements are allowed for in the event of an extreme flood. However, as the proposed substation is an unmanned site it would be unusual for there to be any planned maintenance activities during a flood event.

- The proposed substation lies on the fringe of an area designated to receive a Flood Warning in the event that a flood is likely to occur. It is recommended that National Grid, as the operator of the proposed substation, is signed up to the Floodline Warnings Direct Service provided by the Environment Agency so that adequate action could be taken to evacuate the site if necessary. This is linked primarily to the risk of flooding of access routes to the north and east of the site, in the unlikely event that the proposed substation is manned at the onset of a flood event. If evacuation is required to the north, the site area may be used as a safe refuge until evacuation can be provided to ensure the safety of the personnel.

- Provision of bunded areas and oil separator for the oil containing plant are provided as measures to manage water pollution risk. The specific National Grid procedure on managing pollution on site would be adopted to prevent any incident.

1. INTRODUCTION

1.1 Background and Context for the Flood Risk Assessment

1.1.1 In September 2007, National Grid received an application for the connection of a new nuclear power station at Hinkley Point, Somerset (Hinkley Point C Power Station) to the high voltage electricity transmission system. This connection, in combination with others in the South West and South Wales and Gloucestershire, triggered the need for new transmission capacity in the region.

1.1.2 A detailed explanation of the need for the Proposed Development is contained in National Grid document 'Need Case for the South West and South Wales and Gloucestershire Regions' (2014) (Ref 1.1).

1.1.3 As part of the application for development consent, a Flood Risk Assessment (FRA) is required. This should demonstrate that flood risk from all sources has been considered, and that a series of criteria are met, referred to as the Sequential Test and the Exception Test. These criteria are considered in detail within section 3 of this FRA.

1.1.4 This FRA accompanies National Grid Electricity Transmission Limited's (National Grid) application for development consent to construct, operate and maintain a new 400,000 volt (400kV) connection between Bridgwater, Somerset and Seabank Substation, north of Avonmouth ("the Proposed Development"). As part of the Proposed Development, a new substation is proposed at Sandford in Somerset, located approximately 12km east of Weston-Super-Mare.

1.1.5 This FRA has been prepared in accordance with the requirements set out in National Policy Statements published by the Department for Energy and Climate Change (July 2011), specifically Overarching Energy Policy (EN-1) (Ref 1.2) and Electricity Networks Infrastructure Policy (EN-5) (Ref 1.3). It also complies with the Planning Practice Guidance (PPG) on Flood Risk and Coastal Change (Department for Communities and Local Government, March 2014) (Ref 1.4) which supplements the National Planning Policy Framework (NPPF) (Ref 1.5) and supersedes the Technical Guidance to the National Planning Policy Framework. This reference to the PPG is relevant because the PPG is a "successor" document to the guidance referred to in NPS EN-1.

1.1.6 This FRA is one of a series of five FRAs related to the Proposed Development. This FRA covers the proposed substation at Sandford. Separate FRAs have been prepared for:

- the Bridgwater Tee CSE compounds (**Volume 5.23.1**);
- the South of Mendip Hills CSE compound (**Volume 5.23.2**);
- Seabank Substation (**Volume 5.23.4**); and
- the overall overhead line and underground cable route from Bridgwater to Seabank (**Volume 5.23.5**).

1.1.7 Within the wider context for this FRA the Sequential Test Report (part of **Volume 5.23.5**) sets out the Sequential Test for the preferred route as a whole, and the justification for the route selection on the basis of flood risk.

1.2 Flood Risk Assessment Structure

1.2.1 The main report sections within this FRA address all of the requirements identified within the NPS, as well as those requirements in the NPPF and the PPG on Flood Risk and Coastal Change, where the NPS refers to these other planning documents. **Volume 5.23.3.2, Appendix F** lists all of the requirements within EN-1 and EN-5 and how these points have been addressed within the FRA.

1.2.2 This FRA is structured as follows:

- **Section 2** provides an overview of the site description covering physical characteristics including topography, soils, hydrogeology, hydrology and land use.
- **Section 3** covers the planning policy context specifically with regard to the FRA including the relevant National Policy Statements on energy and electricity networks, local planning documents, and the Sequential and Exception Test requirements.
- **Section 4** gives a description of the proposed works related to the substation.
- **Section 5** describes the flood hazard and risks associated with all flood sources including as assessment of estimated flood levels through the operational life of the substation, anticipated to be from around 2020 to 2060.
- **Section 6** considers Climate Change Impacts, focused on sea level rise and increased rainfall intensities, covering the period to 2060. Consideration is also given to continued operation at the site beyond 2060.
- **Section 7** describes the flood risk management measures proposed for the site related to both the flood risk posed to the site and the potential impact that the site could have on flood risk elsewhere.
- **Section 8** summarises the main conclusions from this FRA.
- **Section 9** lists the references for the study.

2. PROPOSED SUBSTATION DESCRIPTION

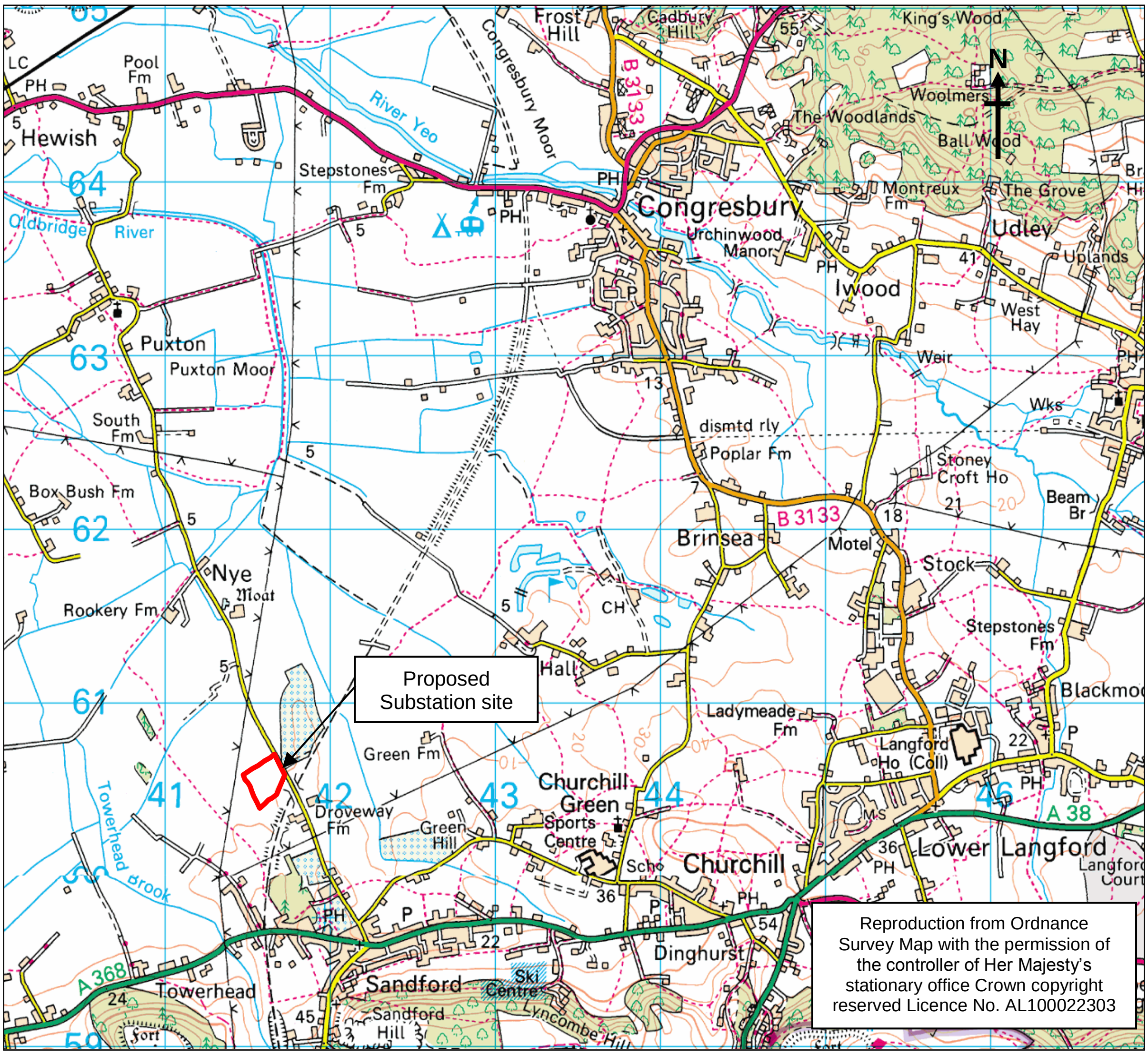
2.1 Introduction

2.1.1 This section provides an overview of the site description covering physical characteristics including topography, soils, hydrogeology, hydrology and land use (section 2.2).

2.2 Proposed Substation Description

<u>Site Location Information</u>

Inset 2.1: Location Plan



Land Use and Topographical Information

2.2.1 The site of the proposed substation is currently an undeveloped area used for agricultural purposes.

2.2.2 The topographical survey (carried out in July 2010 by Mapping Network for National Grid) indicates that the proposed development site slopes from broadly south/southeast to north/northwest with ground levels from 14.0mAOD to 7.0mAOD. Drawing nos. 12/SWA/3846055 and 18/SWA/3846240 in **Volume 5.23.3.2, Appendix B** show contours and spot levels across the site.

Soils, Geology and Hydrogeology

2.2.3 The Soil Survey of England and Wales (Ref 2.6), identifies the soil types over the proposed substation site as 813b Fladbury 1 and 711c Brockhurst 2.

2.2.4 The description for 813b Fladbury 1 is: "*Stoneless clayey soils, in places calcareous, variably affected by groundwater…"* and *"seasonally waterlogged soils affected by a shallow fluctuating groundwater-table."* The description for 711c Brockhurst 2 is *"Slowly permeable seasonally waterlogged reddish fine loamy over clayey and clayey soils. Some reddish clayey alluvial soils affected by groundwater"* and *"seasonally waterlogged slowly permeable soils"* (The Soils Guide, Cranfield University, 2014).

2.2.5 The published geological map (British Geological Survey (BGS), 1:50k Sheet No. 280 Wells) (Ref 2.7) shows that at the site, the superficial soils comprise estuarine alluvium deposits of clay, silt, sand and gravel. The underlying bedrock is Mercia Mudstone, comprising mudstone and halite-stone.

2.2.6 The Mercia Mudstone Group bedrock is designated as a "Secondary B" aquifer, implying predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. The superficial deposits have not been classified.

Hydrology and Land Drainage

2.2.7 The Towerhead Brook (an Ordinary Watercourse) runs broadly south to north approximately 800m beyond the western boundary of the proposed substation site. A tributary of the Towerhead Brook (the Hardmead Rhyne, an Ordinary Watercourse) flows broadly northeast to southwest approximately 500m west of the western site boundary. Parish Rhyne flows across the centre of the proposed substation site, broadly in a northerly direction, which joins the Hardmead Rhyne around 500m north west of the proposed substation site.

2.2.8 There is an extensive network for land drains and rhynes to the west and north of the proposed substation, draining to the Towerhead Brook and other small watercourses, ultimately flowing into either the River Banwell or the River Yeo (often referred to as the Congresbury Yeo).

3. POLICY OVERVIEW

3.1 Introduction

3.1.1 This section covers the planning policy context for the FRA requirements with regard to:

- the requirements of the National Policy Statements (NPS) on Energy (section 3.2);
- local development documents providing the normal local context for planning applications (section 3.3); and
- the requirements of the Sequential Test and the Exception Test (section 3.4).

3.2 National Policy Statements

3.2.1 The National Policy Statements on energy infrastructure (DECC, 2011) are the primary policy documents that nationally Significant Infrastructure Projects (NSIP) must comply with. For the Proposed Development the relevant National Policy Statements are:

- Overarching National Policy Statement for Energy (EN-1) (Ref 1.2)
- National Policy Statement for Electricity Networks Infrastructure (EN-5) (Ref 1.3)

3.2.2 The main requirements related to flood risk are covered in EN-1 (Section 5.7, EN-1). Flood risk also needs to be considered within the context of the PPG on Flood Risk and Coastal Change which replaced PPS25.

3.2.3 In addition to the specific flood risk requirements there are additional requirements related to applying principles of "good design" (Section 4.5, EN-1) covering sustainable drainage and flood resilience and resistance.

3.2.4 EN-1 also makes reference to the need to consider climate change adaptation (Section 4.8, EN-1) with the following aspects specifically identified:

- resilience to changes in the hydrological cycle;
- sensitivity to extreme climate change scenarios;
- adaptive capacity; and
- consequential impacts of adaptive measures on flood risk elsewhere.

3.2.5 Within EN-5, resilience to climate change in the context of flood risk posed to a particular development (and impact from the development) is also a key consideration.

3.2.6 **Volume 5.23.3.2, Appendix F** includes a summary of the main requirements of EN-1 and EN-5 related to flood risk, along with a summary commentary of how these requirements have been considered within the full suite of FRAs.

3.3 Local Development Documents

3.3.1 The local development documents provide a local context for how flood risk is generally considered within the area, although it is noted that these do not form the final basis for decision making with regard to development consent for the Proposed Development.

3.3.2 North Somerset Council's Core Strategy adopted in April 2012 (Ref 3.8) sets out policy with regard to addressing flood risk and the associated impacts of climate change. The requirements set out within the Core Strategy follow the NPPF and associated Technical Guidance.

3.4 Sequential Test

3.4.1 **Volume 5.2.1** describes the details of the need case and alternatives considered with regard to electricity transmission infrastructure development. This sets the wider context for the Sequential Test for the Proposed Development, which seeks to direct development towards areas of lowest flood risk. Details of the Sequential Test for the Proposed Development as a whole are included in the Sequential Test Report as part of the Hinkley Point C Connection Route FRA appendices (**Volume 5.23.5.2**)

Need for the Connection

3.4.2 National Grid operates the high voltage electricity transmission system in Great Britain and owns the system in England and Wales. The system operates at 400,000 and 275,000 volts, connecting the electricity generators to substations where the high voltages are transformed to lower voltages, enabling the power to be distributed to homes and businesses.

3.4.3 In September 2007, National Grid received an application for the connection of a new nuclear power station at Hinkley Point, Somerset (Hinkley Point C Power Station) to the high voltage electricity transmission system. This connection, in combination with others in the South West and South Wales and Gloucestershire, triggered the need for new transmission capacity in the region.

3.4.4 A detailed explanation of the need for the Proposed Development is contained in National Grid document 'Need Case for the South West and South Wales and Gloucestershire Regions' (2014) ('Need Case') (Ref 1.1).

Project Development Process

3.4.5 Developing a scheme to connect Hinkley Point C Power Station to the National Grid high voltage transmission system has included the following steps:

- strategic optioneering: to confirm the need and develop and assess strategic options that would meet the identified need, including assessment of alternative technologies, high level environmental constraints and costs and selection of the option to take forward;

- Route Corridor Study (RCS): to take account of environmental constraints and define potential areas of land or 'route corridors' for the new connection and identify the most appropriate option to meet the need;

- initial consultation: to obtain the views of statutory bodies, other agencies and the general public on the potential route corridors;

- back-check and review of options: to take the opportunity before corridor selection to verify whether the need case and review of strategic options remained valid in light of any changes in circumstances and consider representations received;

- route corridor selection: to consider and evaluate which of the possible route corridors would be preferred and once identified announce the preferred corridor;

- assessment of impact of infrastructure changes on the local electricity network and development of options to ensure electricity supplies are maintained (resulting from the proposed removal of existing 132kV overhead lines and where the Proposed Development interacts with the existing local electricity network);

- development of draft route: develop the connection detail within the preferred route corridor and consult on this;

- Environmental Impact Assessment (EIA) Scoping Report: outline the approach and scope of the EIA for the project;

- statutory pre-application consultation: consult statutory bodies, other non-statutory bodies and the general public on details of the proposed application, including the Preliminary Environmental Information and seeking views on specific design details;

- consultation feedback report: review of representations received during the statutory pre-application consultation;

- change control: Consideration of all suggestions to amend the Proposed Development following Stage 4 consultation; and

- preparation of application and its submission to the Planning Inspectorate (PINS).

Alternatives Considered

3.4.6 National Grid considered options to connect the new Hinkley Point C Power Station to the transmission system and evaluated options as part of the strategic optioneering process, which is detailed in a separate National Grid report 'Hinkley Point C Connection Strategic Optioneering Report' (December 2009) (Ref 3.9).

3.4.7 Options considered included the potential to upgrade the existing transmission system. However this would not adequately meet the requirements set out in the need case and established that additional capacity would still be required.

3.4.8 Options that were compliant with the requirements of the National Electricity Transmission System Security and Quality of Supply Standard (SQSS) were assessed in more detail and two main route corridors with option 1 having two variants: A and B.

3.4.9 Route Corridor 1 Option 1B considered the construction of a new 400kV overhead line parallel to the existing Western Power Distribution (WPD) 132kV overhead line, either to the east or west of the existing overhead line. The existing WPD 132kV overhead line would not be removed.

3.4.10 Route Corridor 2 involved the construction of a new 400kV overhead line between Bridgwater and Seabank Substation. This route corridor aimed to avoid the paralleling of overhead lines, although this would not be possible in certain locations due to environmental constraints and urban areas. The existing WPD 132kV overhead line would not be removed.

3.4.11 The RCS proposed that Route Corridor 1 Option 1A was the least environmentally constrained corridor as it would result in the replacement of an existing 132kV overhead line with a 400kV overhead line. The relatively wide corridor identified for much of the route would also allow an alignment to be identified to minimise the scale of change and effects on the environment.

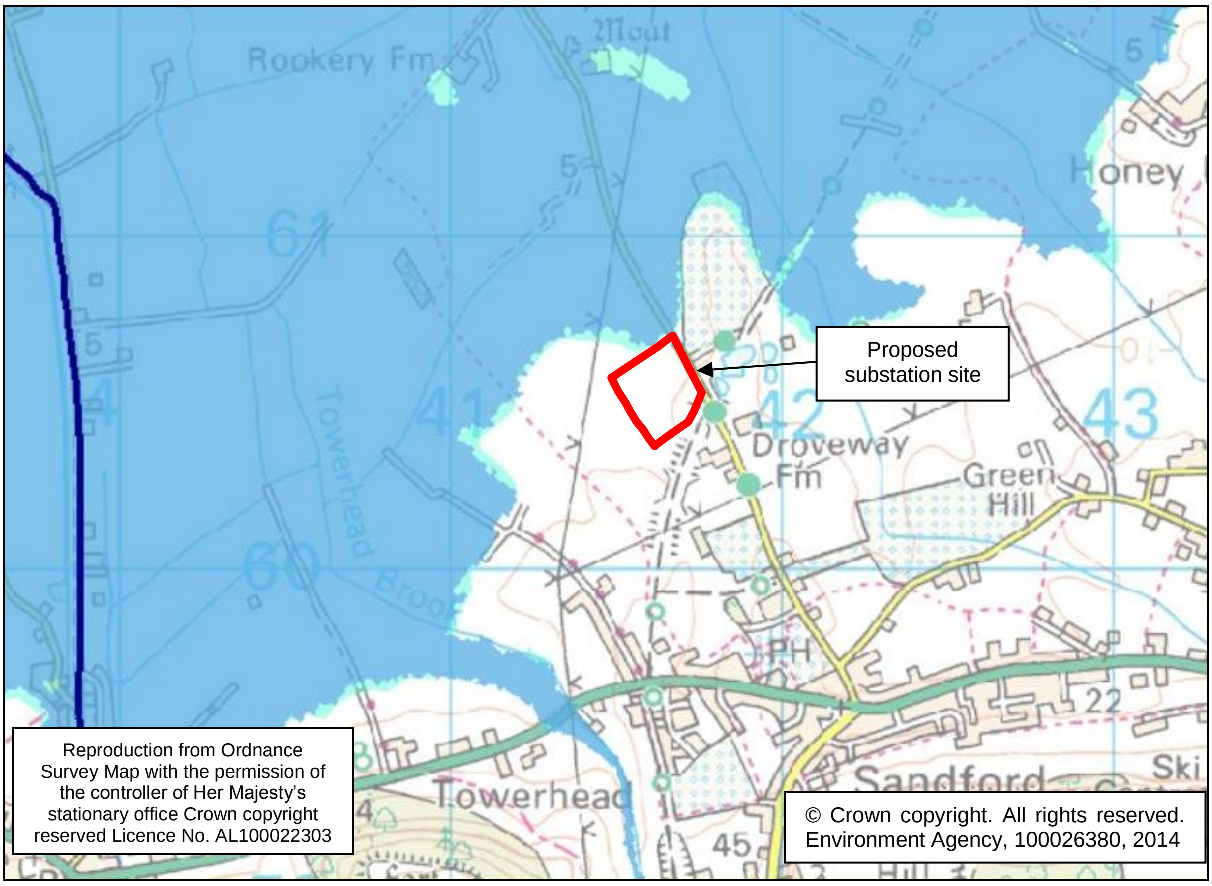
Sequential Test for the Proposed Substation

3.4.12 Specifically with regard to flood risk, the selected route (Corridor 1, Option 1A) was also noted to be the preferred route from a flood risk perspective by the Environment Agency.

3.4.13 The context for this substation is set within this wider context for the Proposed Development and route corridor, with the Sequential and Exception Tests being applied accordingly, within the constraints of the route. The proposed route is included in **Inset 3.1** (**Volume 5.23.3.2, Appendix A**) along which, the siting of a new substation is required north of the Mendip Hills Area of Outstanding Natural Beauty.

3.4.14 The proposed substation site is wholly located within Flood Zone 1 with a ‘Low Probability’ of flooding. This is defined as having less than a 1 in 1,000 (0.1%) annual probability of flooding from fluvial or tidal sources in any year. This ignores the presence of existing defences, based on the Environment Agency Indicative Floodplain Map as shown in **Inset 3.2**.

Inset 3.2: Environment Agency Indicative Flood Map



<u>Key to flood risk map:</u>

Dark blue:	Flood Zone 3 - More frequent than 1 in 200 (0.5%) annual probability event for tidal flooding, or 1 in 100 (1%) for fluvial flooding
Light blue:	Flood Zone 2 – Between 1 in 200 and 1 in 1000 (0.5% and 0.1%) annual probability events for tidal flooding, or between 1 in 100 and 1 in 1000 (1% and 0.1%) for fluvial flooding
White:	Flood Zone 1 - Less frequent than 1 in 1000 (0.1%) annual probability for tidal or fluvial flooding.
Purple dotted line:	Flood defences.
Dark blue line:	Main River.

Note: *These maps are subject to change and are only as current as the latest data held by the Environment Agency.*

3.4.15 The NPPF Planning Practice Guidance (PPG) (Ref 1.4) on Flood Risk and Coastal Change requires decision-makers to steer new development to areas at the lowest probability of flooding by applying a 'Sequential Test'.

3.4.16 Given the proposed location in Flood Zone 1, the proposed substation defined as ‘Essential Infrastructure’ from Table 3 of the PPG on Flood Risk and Coastal Change passes the Sequential Test.

3.4.17 The Exception Test is therefore not required as shown in **Table 3.1** below, which reproduces Table 3 from the PPG on Flood Risk and Coastal Change.

3.4.18 The proposed substation is therefore considered as an appropriate use of land for development in Flood Zone 1.

Table 3.1 Flood Risk Vulnerability and Flood Zone Compatibility

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

Key:

✓ Development is appropriate

× Development should not be permitted

4. DETAILED SUBSTATION DEVELOPMENT LAYOUT

4.1 Introduction

4.1.1 This section gives a description of the proposed works related to the substation.

4.2 Details of Substation Development Layout

4.2.1 To maintain supplies on the 132kV distribution network following the removal of the existing 132kV overhead line, a new 400/132kV substation is proposed adjacent to Nye Road in Sandford, North Somerset. The substation would be sited within a compound of approximately 143m by 217m and would include 400kV and 132kV electrical plant and equipment, two super grid transformers (SGTs) and two shunt reactors, electrical switchgear, steel support structures, welfare accommodation, ancillary buildings, backup diesel generator, oily water interceptor, a low voltage electricity supply connection, perimeter fencing, access roads and landscaping. The maximum height of electrical equipment would be 13m. The indicative layout of the proposed substation is shown in Drawing 12/SWA/3846055 in **Volume 5.23.3.2, Appendix B**.

4.2.2 The substation would comprise impermeable concrete surfaces, surrounded by areas of permeable stone chippings. It would be secured with a palisade fence approximately 2.4m high with an electrified fence approximately 4m high inside it. A permanent access road will be taken from Nye Road at the substation's eastern boundary.

4.2.3 The indicative layout shows that the finished ground level across the site will slope at an average gradient of around 1 in 82 from south east to the north west. The proposed site would be in areas of both cut and fill, created by a balanced earthworks operation. The southeast and northwest platforms would have operational slab levels of 10.695mAOD and 8.00mAOD respectively.

4.2.4 Reinforced conventional concrete foundations and pads (and possibly piles) are proposed for serving the buildings and its associated equipment. The access road to the substation will also be an impermeable road surface. For the rest of the site ground surface area, where the buildings and equipment will not be sited, the surface will be covered with gravel or similar. The use of gravel or similar is beneficial from a hydrological perspective to minimise runoff from the site, allowing water to drain freely through the gravel to the underlying soil. This provides both attenuation and water quality benefits with regard to the control of surface water runoff. This approach is consistent with Sustainable Drainage (SuDS) principles as required under the Flood and Water Management Act 2010.

4.2.5 To deliver the transformers, which are classed as abnormal indivisible loads (AIL), an semi-permanent access road via the south west corner of the Proposed Development site is required, and hence the need to provide a permanent bridge across Towerhead Brook.

5. FLOOD HAZARD

5.1 Introduction

5.1.1 This section considers the potential flood hazards present at the proposed substation site. There is a specific focus on each flood source at the site (sections 5.2 and 5.3) followed by an overview of existing plans and policies which provides the wider flood risk management context and other details that inform flood risk related to the proposed substation site (section 5.4).

5.2 Sources of Flooding

5.2.1 The PPG on Flood Risk and Coastal Change requires that an assessment of all potential sources of flooding is undertaken. The following potential sources have been considered:

- fluvial;
- tidal;
- pluvial (surface water);
- groundwater;
- sewer; and
- reservoirs and other artificial sources.

5.3 Description of Potential Flood Risk

Fluvial and Tidal Flooding

5.3.1 As stated in section 3.4, the proposed substation site is situated in Flood Zone 1 (low probability) based on the Environment Agency Flood Zone Map (**Inset 3.2**). The northern corner of the proposed substation is within around 100m of the edge of Flood Zone 2. The flood outline in **Inset 3.2** above relates primarily to tidal flooding, and is based on there being no flood defences in place. Critical defences in place that protect the area to the north and west of the site include large sluices on the River Banwell and the Congresbury Yeo, both of which are located around 8km to the north west of the site, and flood embankments along the Congresbury Yeo. It is noted that the Strategic Flood Risk Assessment (SFRA) Level 1 (Ref 5.10) *Existing and Future Flood Risk* map (**Volume 5.23.3.2, Appendix C**) shows a greater extent of flooding taking account of climate change.

5.3.2 The flood outline shown in **Inset 3.2** is estimated to be at a level of approximately 6.0mAOD. The ground level at the site varies between 7.0mAOD at the northern end and 14mAOD at the southern end.

5.3.3 Data provided by the Environment Agency with regard to flood risk at the site is included in **Volume 5.23.3.2, Appendix E**.

5.3.4 The risk of tidal inundation is considered to be from the Bristol Channel north of Weston-Super-Mare, primarily via the Congresbury Yeo, plus a series of other smaller watercourses including the River Banwell. The "Coastal Flood Boundary Conditions for UK Mainland and Islands" study report (Environment Agency, 2011) (Ref 5.11) gives the 1 in 200 (0.5%) annual probability tide levels at Hinkley Point and Avonmouth (the two closest coastal sites for which data is included) as 7.84mAOD and 9.11mAOD respectively. Interpolating between these coastal sites to give an estimate for Weston-Super-Mare gives an estimated tide level of around 8.2mAOD to 8.3mAOD. This is around 2.3m higher than the estimated level at the edge of the flood outline supplied by the Environment Agency of around 6.0mAOD. The lower flood level at Sandford is a consequence of the time taken for tidal waters to travel inland, the duration of the tidal cycle and the attenuation that results over this large distance, in the absence of the tidal defences.

5.3.5 The SFRA flood outline (**Volume 5.23.3.2, Appendix C**) which includes the climate change factor (100 years, up to year 2108) for a 1 in 200 (0.5%) annual probability of flooding event shows a wider flood extent to the north and west of the study area than **Inset 3.2**. From comparison of the site contours from the Digital Terrain Model data (carried out around July 2010 by Network Mapping for National Grid) with the SFRA flood outline, this level is estimated to be approximately 7.0mAOD. The minimum existing site level is approximately 7.0mAOD which is the same level as the flood outline adopted as an approximation of the 1 in 200 (0.5%) annual probability of flooding event including climate change over 100 years. The 1 in 1,000 (0.1%) annual probability of flooding event without climate change is estimated to be approximately 6.5mAOD based on the comparison of the SFRA flood outline without climate change (**Volume 5.23.3.2, Appendix C**) and the Digital Terrain Model data.

5.3.6 **Table 5.1** shows the predicted tidal still water levels at Sandford, based upon the Level 1 SFRA, October 2008 with the base year for the data of 2008. An allowance has been made for sea level rise in accordance with the UKCP09 projections (Ref 5.12) using the “upper end estimate” as defined in Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities (Environment Agency, 2011) (Ref 5.13). This approach meets the requirements for the climate change assessment identified within the EN-1 National Policy Statement for Energy (DECC, 2011). The sea level rise allowances included for the UKCP09 upper end estimates are 4mm per year up to 2025, 7mm per year from 2026 to 2050, and 11mm per year from 2051 to 2080. This gives a total rise of 353mm from 2008 (the base date for the Level 1 SFRA) to 2060 which would be the anticipated end of operational life of the substation.

Table 5.1 Predicted Tidal Still Water Levels (adjusted for sea level rise) at Sandford

Predicted Levels (mAOD)	2008	2014	2020	2040	2060	2080
1 in 200 (0.5%) annual probability	6.00	6.02	6.05	6.17	6.35	6.57
1 in 1,000 (0.1%) annual probability	6.50	6.52	6.55	6.67	6.85	7.07

5.3.7 Projecting sea level rise further to 2108 (giving an additional 28 years at 15mm per year beyond 2080) would give the 1 in 200 (0.5%) annual probability flood event level of 6.99mAOD (6.57mAOD + 0.42m) which correlates well with the projected level of 7.0mAOD (2108) from Level 1 SFRA. This degree of consistency is not necessarily a reflection of the accuracy of each assessment, but rather, a demonstration that there is consistency between these two independent methods of evaluation using current guidance.

5.3.8 Under the current National Grid Flood Mitigation Policy (October 2010) (Ref 5.14), it is targeted to provide protection for the proposed substation up to the 1 in 1,000 (0.1%) annual probability flood event. The estimated level for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events are 6.02mAOD and 6.52mAOD respectively, at present. With allowance for 40 years climate change following construction completion at around 2020, the adopted flood level for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events are 6.35mAOD and 6.85mAOD respectively at 2060. For 60 years climate change, the adopted flood levels are 6.57mAOD and 7.07mAOD respectively for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events.

5.3.9 With an allowance of 300mm for uncertainty in the data, the recommended minimum floor level of 7.15mAOD is required for the 1 in 1,000 (0.1%) annual probability flood event for an operational life of 40 years. It is recognised that although the proposed operational life of the substation is 40 years, it is possible that the substation would still be required beyond this timeframe given that Hinkley Point C Power Station would generate power for an estimated 60 years. Therefore, consideration is given to operation at the site for a further 20 years. This would give the requirement for a minimum floor level of 7.37mAOD for the 1 in 1,000 (0.1%) annual probability event. The minimum proposed finished slab of the proposed development is approximately 8.0mAOD. Therefore, the finished slab level is well above the 1 in 1,000 (0.1%) annual probability flood event level, and the site is not at risk of tidal or fluvial flooding, even in the event of a breach of the tidal defences and a failure of the tidal sluices. This meets the National Grid Flood Mitigation Policy which aims at protecting the critical infrastructure to the 1 in 1,000 (0.1%) annual probability flood event. It also allows for flexibility in the event that continued operation of the site is required beyond 40 years.

5.3.10 The new access road at the entrance to the proposed substation site at the northeast corner on Nye Road might become partially flooded during extreme flood events. The proposed minimum road level of approximately 6.2mAOD is around 0.65m below the 1 in 1,000 (0.1%) annual probability flood event with climate change to 2060, and marginally below the 1 in 200 (0.5%) annual probability flood event with climate change. The road level is kept at this level in order to tie into the existing road level at Nye Road.

5.3.11 The risk of flooding from fluvial or tidal sources is **low.**

Pluvial (Surface Water) Flooding

5.3.12 No part of the site has been identified by the Environment Agency to be within a critical drainage area. No record of surface water flooding is contained within North Somerset Council's Level 1 SFRA, or within the Preliminary Flood Risk Assessment (PFRA) (Ref 5.15).

5.3.13 The surrounding land is predominantly agricultural with no hard standing in the area, except that surrounding the small number of existing properties close to the boundary of the site. The soil type is generally clayey with low permeability.

5.3.14 The topography of the area itself should be suited to gravity drainage, due to the general slope downwards to the north and northwest across the site. The lower land to the north and north west (beyond the proposed site boundary) which would receive the discharge may well have high water levels during the winter months.

5.3.15 The need to divert the existing drainage ditch, and provide a culvert, at the south west corner of the proposed substation to provide an access road to the site would need Land Drainage Consent. The design of the culvert would be such that it would not cause any flow restriction, resulting in a change to the hydraulics of the drainage system. Additionally, under the Water Framework Directive (WFD), consideration would need to be given to whether the diversion would have an impact on a water body as defined under the WFD.

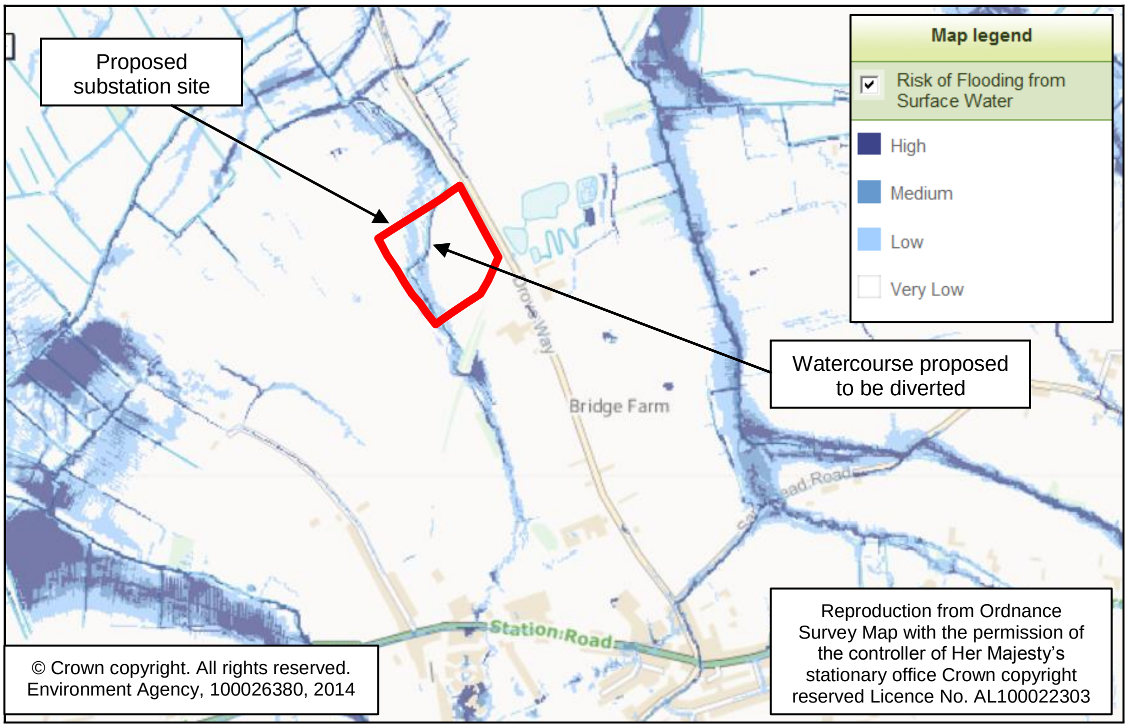
5.3.16 The Flood Map for Surface Water (FMfSW) shows surface water flood mapping undertaken at a national level to provide an indication of those areas potentially vulnerable to surface water flooding based on the 1 in 30 (3.3%) and 1 in 100 (1%) annual probability rainfall events. The area around the proposed substation is shown in **Inset 5.1**. This shows that part of the site is at risk of surface water flooding. The area close to the drain that is proposed to be diverted is shown as being at “low” risk of flooding, with the drain itself shown as being at “high” risk of flooding (due to it flowing full).

5.3.17 For the area shown as being at “low” risk of flooding, this indicates that the risk of being flooded is between the 1 in 1000 (0.1%) and 1 in 100 (1%) annual probability rainfall events.

5.3.18 The risk of surface water flooding is **low** although in extreme rainfall events there is risk of shallow ponding of water in the vicinity of the existing drain.

5.3.19 Given the potential indicative flooded area at the proposed site, mitigation measures for this surface water flood risk should be considered.

Inset 5.1: Surface Water Flood Risk Mapping



Groundwater Flooding

5.3.20 The Environment Agency has no records of groundwater flooding in the area.

5.3.21 The Level 1 SFRA indicates that there is very limited evidence of groundwater flooding across North Somerset. Within the PFRA for North Somerset, groundwater flooding is noted to occur in areas underlain by major aquifers, although at the proposed substation site, the bedrock is not classified as an aquifer.

5.3.22 With regard to specific soil and ground conditions, the area is not important in terms of groundwater resources, as indicated by the superficial deposits being unclassified, and the bedrock classified as a "Secondary B" aquifer, implying predominantly lower permeability layers. Related to this, the site is not identified by the Environment Agency as being located within a source protection zone.

5.3.23 The site topography is not assessed as being conducive to groundwater flooding.

5.3.24 The risk of groundwater flooding is **low.**

Sewer Flooding

5.3.25 There are very few properties in the area and no record of sewer flooding. Neither the Level 1 or 2 (Ref 5.16) SFRA, nor the PFRA give any indication that sewer flooding is a concern in the area.

5.3.26 Based on the rural nature of the site the area is not considered prone to such events.

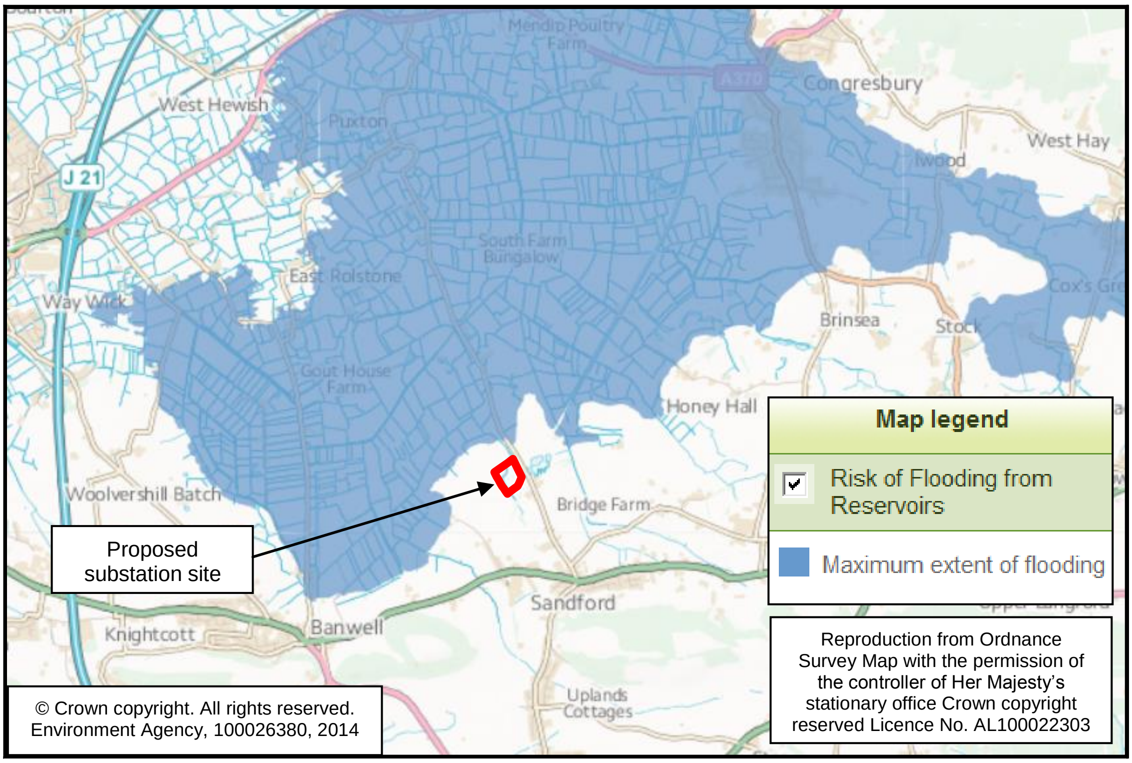
5.3.27 The risk of sewer flooding within the study area is **low.**

Flooding from Reservoirs and other Artificial Sources

5.3.28 Flooding from artificial sources includes reservoirs, canals and lakes where water is retained above the natural ground level. Blagdon Lake is located approximately 9km east of the proposed substation site. The flood inundation map, which indicates areas at risk in the unlikely event of failure of any reservoir, is shown in **Inset 5.2**. The mapping shows that the proposed substation would not be affected if the reservoir were to fail and release the water it holds.

5.3.29 The risk of flooding from reservoirs, canals or other artificial sources is **low.**

Inset 5.2: Reservoir Inundation Flood Risk Mapping



5.4 Flood Risk – Wider Context

5.4.1 This section outlines the main policies, plans and strategies specifically linked to flood risk management in the general area of the proposed substation.

Core Strategy

5.4.2 North Somerset Council's Core Strategy adopted in April 2012 (Ref 3.8) sets out policy with regard to addressing flood risk and the associated impacts of climate change.

5.4.3 Specifically Policy CS3, Environmental Impacts and Flood Risk Assessment, states that development in zones 2 and 3 of the Environment Agency Flood Map will only be permitted where it is demonstrated that it complies with the sequential test set out in the National Planning Policy Framework and associated technical guidance and, where applicable, the Exception Test.

5.4.4 It is explicitly stated that development proposals should refer to the North Somerset SFRA as the starting point for all site-specific FRAs.

Strategic Flood Risk Assessment

5.4.5 North Somerset Council has published both a Level 1 (Ref 5.10) SFRA and a Level 2 (Ref 5.16) SFRA. The Level 1 SFRA indicates that the whole of the study area for the proposed site for the substation is within Flood Zone 1. The SFRA flood mapping takes account of a wide range of sources of information and develops the Environment Agency flood risk map further. It also models climate change scenarios to 2108 to take account of increased fluvial flows (increased flows by 20%) and increased sea levels.

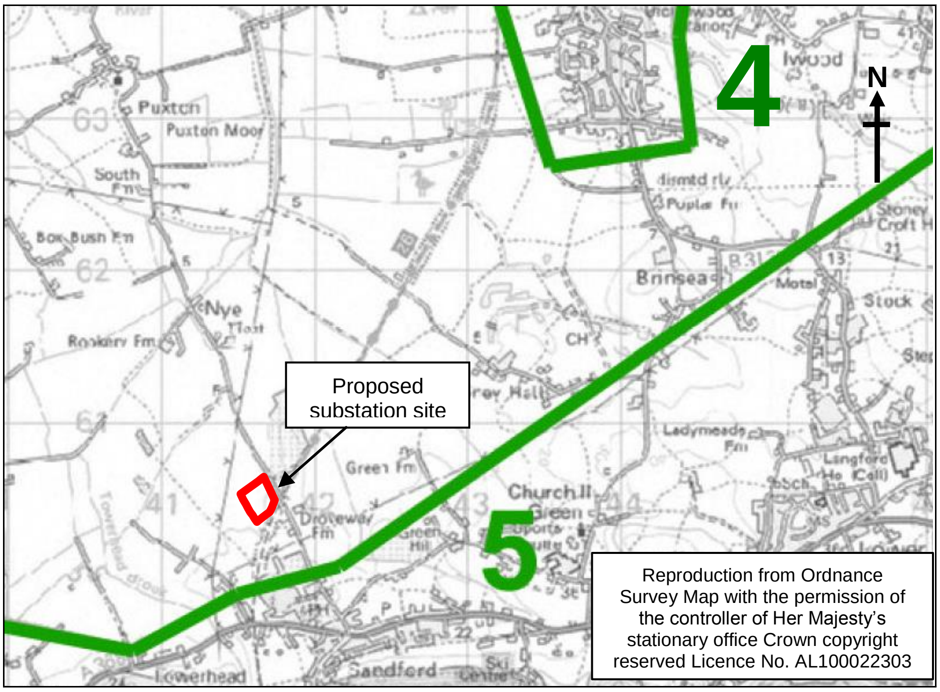
5.4.6 The Level 1 SFRA mapping output for the area is included in **Volume 5.23.3.2, Appendix C**. The mapping for *Existing and Future Flood Risk* which takes consideration of climate change shows that the flood outline developed for the SFRA as having a slightly larger area in Flood Zone 3 compared to the Environment Agency Flood Map in **Inset 3.2** (which does not account for climate change). This shows that the “with climate change” outline is in the vicinity of the site boundary, so it is recommended that the climate change flood map in **Volume 5.23.3.2, Appendix C** is used in preference to **Inset 3.2** as a conservative approach to considering flood risk.

5.4.7 The Level 2 SFRA was developed from the Level 1 SFRA findings, and covers the five areas of greatest concern (from a SFRA perspective) as identified in the Level 1 SFRA. The two areas closest to the site of interest are Areas 4 and 5 as follows:

- Area 4: Land around Yatton/Congresbury.
- Area 5: Land around Banwell/Winscombe/Churchill/Wrington.

5.4.8 **Inset 5.3** shows the closest boundaries of Areas 4 and 5 and indicates that the study area (outlined in red) is near to the Area 5 boundary. Area 5 was not modelled in the Level 2 SFRA (as it was not considered to be an area of high risk) and there is therefore no more detailed information from the Level 2 SFRA to inform this FRA.

Inset 5.3: Extract from North Somerset Level 1 SFRA



Preliminary Flood Risk Assessment

5.4.9 The preparation of a Preliminary Flood Risk Assessment is a requirement of every Lead Local Flood Authority (LLFA) as defined under the Flood and Water Management Act (FWM Act) 2010. For the area in which the proposed substation would be located, the LLFA responsible for the preparing the PFRA is North Somerset Council, who published their PFRA in June 2011 (Ref 5.15).

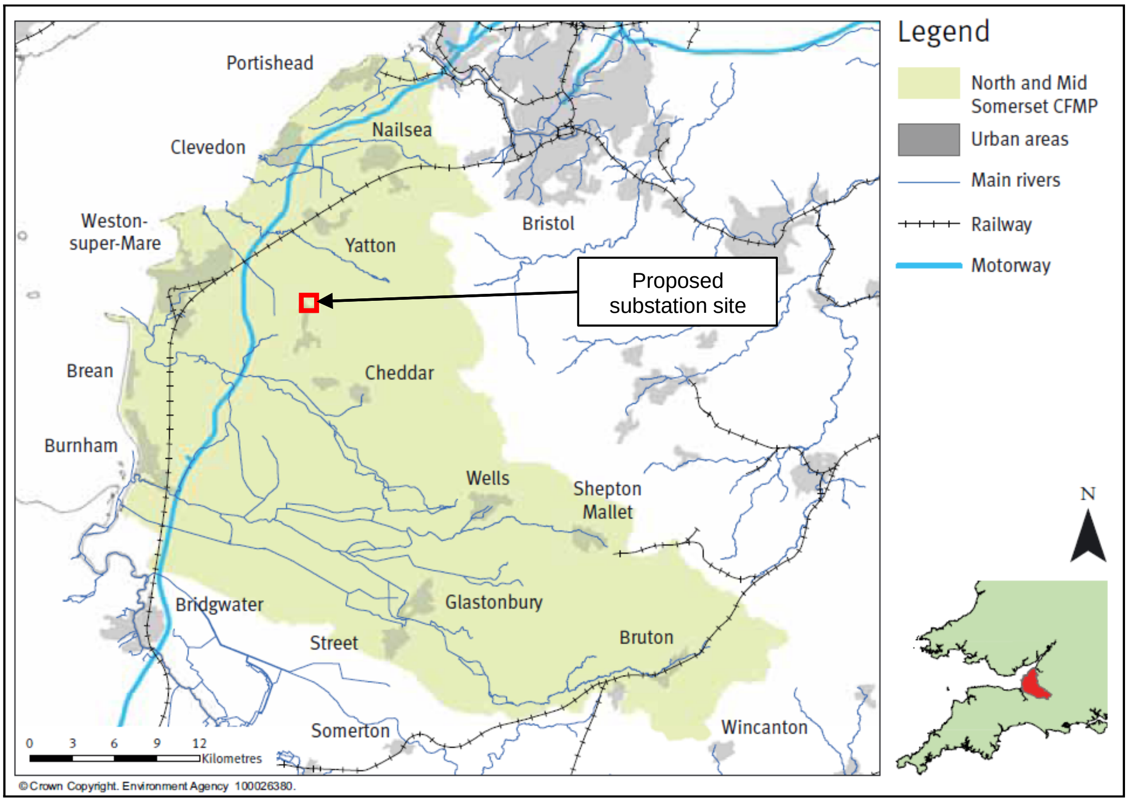
5.4.10 The PFRA is a high level overview of flood risk attributable to surface water, groundwater, ordinary watercourses, sewers, reservoirs, canals and other artificial sources. It draws together a wide range of readily available information as a means to inform the strategic overview of flood risk across the Unitary Authority area.

5.4.11 This overview of flood risk is a valuable source of data to inform flood risk at the proposed substation site. Within the context of this FRA, the PFRA is referred to with regard to various sources of flooding in section 5.2.

North and Mid Somerset Catchment Flood Management Plan

5.4.12 The Catchment Flood Management Plan (CFMP) (Ref 5.17) for North and Mid Somerset provides an overview of flood risk management in the catchment for the next 100 years. The CFMP is intended to guide investment and flood risk management in the catchment carried out by the Environment Agency and other bodies with flood risk management responsibilities and powers. **Inset 5.4** illustrates the locations and extent of the CFMP Area.

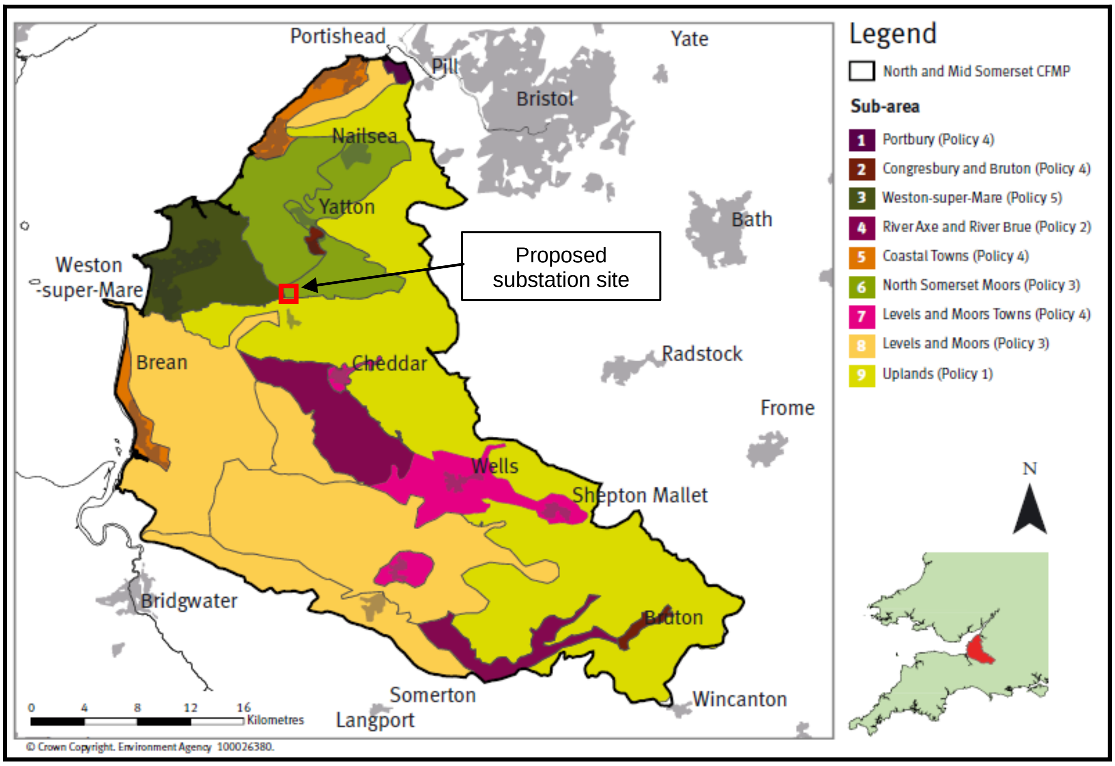
Inset 5.4: North and Mid Somerset CFMP Area



5.4.13 In the North and Mid Somerset CFMP area, it is noted that changes in land use, rural land management and climate change will all influence future flooding. Climate change is noted to have the greatest impact on flood risk, increasing the probability of large-scale flood events due to increased runoff and sea level rise. This will increase the length of time watercourses will be tide locked in the lower reaches and the length of time that the moors will have to store floodwater before evacuation. As a consequence, river flooding in the area is anticipated to result in increased flood depths and extents.

5.4.14 Within the CFMP Area there are nine sub-areas defined as shown on **Inset 5.5**. The location of the proposed substation is within sub-area 6, North Somerset Moors.

Inset 5.5: North and Mid Somerset CFMP Sub-areas



5.4.15 The Environment Agency has adopted Policy Option 3 for the North Somerset Moors, with the proposed substation located on the southern boundary of sub-area 6 with sub-area 9 (Uplands). This policy option recognises that the risks are currently appropriately managed, and the risk of flooding is not expected to increase significantly in the future. However, the Environment Agency will keep this approach under review, looking for improvements and responding to new challenges or information as they emerge. The approach to managing flood defences and other flood risk management actions may be reviewed to ensure that the best approach to managing flood risk is taken in the longer term.

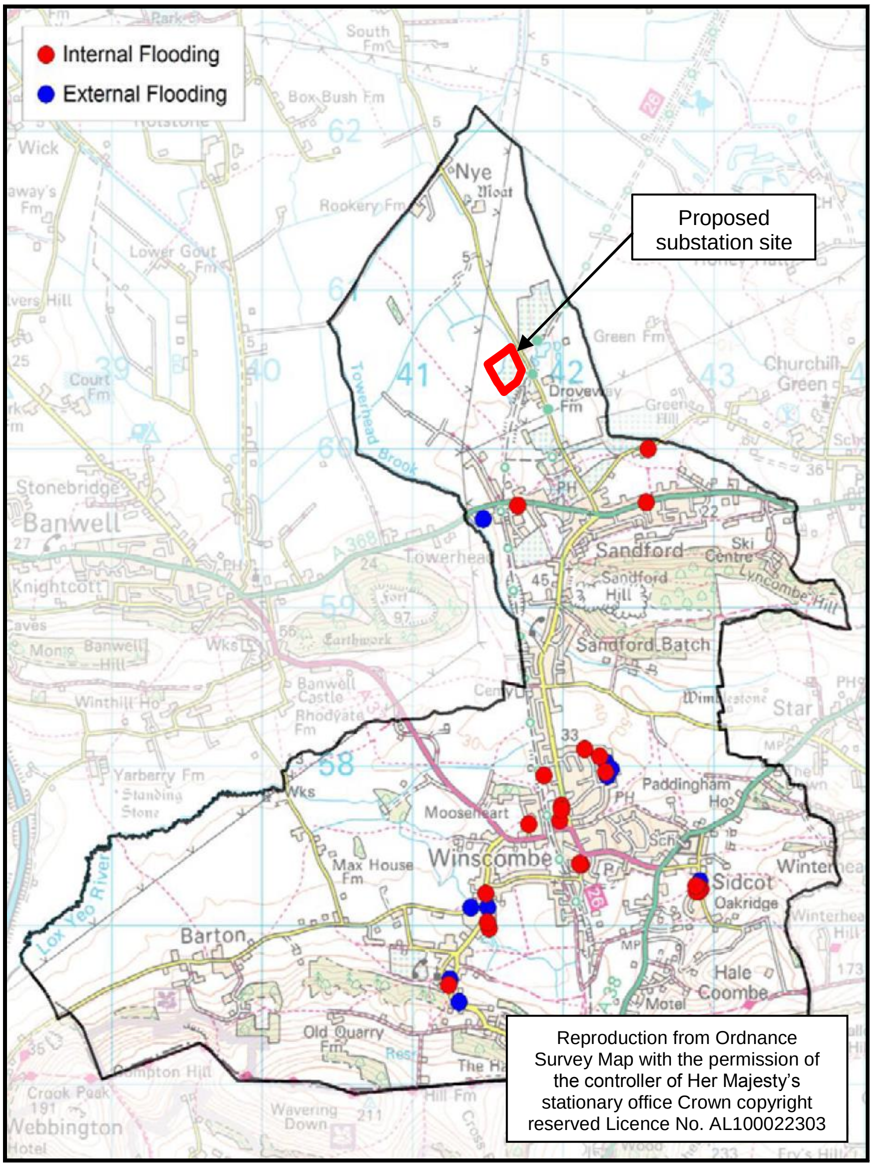
5.4.16 It is noted that from an environmental perspective, many designated sites affected are water-based and rely on frequent flood events to remain in a healthy state.

Evidence from Historic Flooding

5.4.17 The Environment Agency has no record of flooding at the site or in the surrounding area and no modelled or recorded flood levels. Similarly, the Level 1 SFRA, which draws together historic flooding events from a range of sources, does not indicate that there are any records of floods in the immediate vicinity of the site.

5.4.18 However, since the publication of the SFRA there has been significant flooding in North Somerset in August, September and November 2012. These “local” flooding events i.e. flooding not from Main Rivers or the sea, are documented in detail in ‘North Somerset 2012 Flood Investigations’ (North Somerset Council, 2013) (Ref 5.18). **Inset 5.6** is an extract from the Flood Investigation Report, which shows three internal flooding records and one external flooding record for Sandford. The proposed substation site is also marked on **Inset 5.6**.

Inset 5.6: Flood Event Records in North Somerset in 2012 (North Somerset Council, 2013)



5.4.19 The flooding experienced across North Somerset through 2012 is some of the worst flooding for many years, with many incidents recorded across North Somerset Council's administrative area. It is noted, however, that there was no fluvial flooding in Sandford during the events in 2012.

5.4.20 The 2012 Flood Investigation Report notes: *"The flooding in Sandford and Winscombe was mostly as a result of surface water being unable to get away quickly enough. This may partly have been down to blocked gullies or drainage ditches but will also have been down to capacity exceedance of both."*

5.4.21 Over the period from January to February 2014 the Somerset Levels and Moors experienced significant flooding across large areas. However with regard to the proposed substation site, no flooding has been observed.

6. CLIMATE CHANGE

6.1 Introduction

6.1.1 This section considers climate change impacts (section 6.2), focused on sea level rise and increased rainfall intensities, covering the period to 2060. Consideration is also given to continued operation at the site beyond 2060, and the sensitivity of the proposed works at the site to an extreme climate change scenario (section 6.3).

6.2 Climate Change Impacts

6.2.1 Within the context of the existing flood risk at the proposed substation, and the requirements of the National Policy Statements for Energy (specifically EN-1 and EN-5), climate change impacts from different flood sources have been considered alongside the present day scenario within section 5 using UKCP09 climate projections (Ref 5.12). By way of summary, the principal climate change impacts potentially affecting the proposed substation site are:

- sea level rise affecting tidal flood risk; and
- increase in rainfall intensity affecting pluvial/surface water flood risk.

6.2.2 With specific regard to an increase in rainfall intensity, there is also the potential for the proposed substation to impact on surface water flood risk elsewhere due to the construction of impermeable surfaces across parts of the site.

6.2.3 The consideration of climate change impacts also meets the requirements set out in the UK Climate Change Risk Assessment: Government Report (Defra, January 2012) (Ref 6.19) which are consistent with the requirements of the NPS and UKCP09 climate projections.

Sea Level Rise

6.2.4 The operational design life of the proposed substation is 40 years. However, at the end of the proposed operational life it is possible that the site may still be required as part of the inter-connected grid, at which point significant asset replacement would be required.

6.2.5 To account for sea level rise, an allowance has been made in accordance with the UKCP09 projections using the "upper end estimate" as defined in Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities (Environment Agency, 2011) (Ref 5.13). This approach meets the requirements for the climate change assessment identified within the EN-1 National Policy Statement for Energy (DECC, 2011). This upper end estimate represents the Inter-governmental Panel on Climate Change (IPCC) (Ref 6.20) high emissions scenario (referred to as the SRES A1FI scenario as defined in the IPCC Special Report on Emissions Scenarios) at the 95th percentile confidence limit.

6.2.6 The sea level rise allowances included for the UKCP09 upper end estimates are 4mm per year up to 2025, 7mm per year from 2026 to 2050, and 11mm per year from 2051 to 2080. This gives a total rise of 353mm from 2008 (the base date for the Level 1 SFRA) to 2060 which would be the anticipated end of operational life of the substation. In the event that the site continues to be used for a further 20 years to around 2080, this would give an additional rise of 220mm, giving a total rise of 525mm from 2020 to 2080. For this level of increase in extreme tidal flood water levels, with the proposed slab level of 8.0mAOD the site would still not be affected by tidal flooding.

Increased Rainfall Intensity

6.2.7 For the surface water runoff assessment, an allowance of 10% increase in the rainfall intensity values for the period 2040 to 2069 has been included to account for the impact of climate change in accordance with Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities (Environment Agency, 2011), which specifically references UKCP09 projections. This increase would apply at the end of the operational life of the substation at around 2060. The calculations showing how this has been incorporated in the attenuation storage calculations are shown in **Volume 5.23.3.2, Appendix D**.

6.2.8 As a sensitivity analysis, an increase of 20% in rainfall intensities is also considered for the period 2040 to 2069 as the upper end estimate for the UKCP09 projections under the high emissions scenario, 95th percentile value.

6.2.9 This impact of increased rainfall intensity is linked to managing the risk of flooding as a result of constructing the proposed substation, rather than the impact on the proposed substation. The impact of the substation on surface water flooding elsewhere is addressed in section 7.6.

6.3 Sensitivity to Extreme Climate Change Scenario

6.3.1 Within the UKCP09 projections, set in the context of NPS requirements in EN-1, consideration is given to the most extreme UKCP09 climate change scenario, referred to as the H++ scenario.

6.3.2 The H++ scenario provides an estimate of sea level rise and river flood flow change beyond the likely range but within physical plausibility. It is useful for contingency planning to understand what might be required if climate change were to happen much more rapidly than expected. There is no H++ scenario for changes to extreme rainfall.

6.3.3 For the proposed substation site, it is the tidal flood risk associated with sea level rise that would have the biggest overall impact. For the H++ scenario this would give an extreme tide level 325mm higher than the UKCP09 High emissions, 95th percentile value by 2060, at 7.18mAOD (6.85mAOD + 0.325m). The finished slab level at 8.0mAOD is well above this level, and hence the proposed substation would not be vulnerable to this degree of sea level rise.

7. FLOOD RISK MANAGEMENT MEASURES

7.1 Introduction

7.1.1 This section describes the flood risk management measures proposed for the site focused on the key flood risks to the site (section 7.2). Access and egress to and from the site (section 7.3) and flood warning and emergency evacuation are also considered (section 7.4). Residual risk to the site and the impact resulting from the substation is considered (sections 7.5 and 7.6). The existing flood defences benefitting the wider area are identified (section 7.7).

7.2 Overland Flow and Surface Water

7.2.1 The proposed substation is located on gently sloping ground, thereby providing natural gravity drainage of the site broadly from south to north. However, as noted in section 5 whilst there is only a low risk of surface water flooding, the surface water flood mapping does indicate potential flooding in extreme rainfall events with between a 1 in 100 and 1 in 1000 (1% to 0.1%) annual probability.

7.2.2 The current drain (Parish Rhyne) that passes across the proposed site would be diverted to the west of the substation, re-joining the existing drain to the north of the site. In determining the final re-alignment of the drain consideration would be given to the natural flow path in the surrounding area. Landscaping and ground works associated with both the drain and the substation ground levels would need to ensure that if the diverted stream flows out of bank (as may be anticipated in extreme localised rainfall events) the surface water flow path should be to the north and west, avoiding the site. The site plan as shown in Drawing no. 18/SWA/3846240 in **Volume 5.23.3.2, Appendix B** shows the ground contours, which indicate that the natural flow path would be towards the western corner of the site. Once the flow is passed the corner of the site, the natural flow path would continue away from the site. The plan also indicates that most of this part of the proposed substation is on an area of fill, elevated above the natural ground level. However, the extreme western corner of the site may remain vulnerable to surface water flows. Depending on the final details of the site layout and re-alignment of the drain, it may be necessary to provide some form of protection to the western corner of the proposed substation site, and along part of the length of the southwest facing site boundary. This could be in the form of a bund from the earthworks associated with the drain realignment, and would prevent any out of bank flows from the diverted stream flowing on to the site, as indicated on Drawing No. 18/SWA/3846240 in **Volume 5.23.3.2, Appendix B**.

7.2.3 The proposed substation will also receive surface water runoff from the undeveloped area of the field to the east and south of the site as it flows towards the proposed site. It is therefore proposed to construct a filter drain and land drainage trench along the top of the cutting on the east and south east boundary of the proposed substation. These drains will collect surface water at the top of the cutting (Drawing 18/SWA/3846240, **Volume 5.23.3.2, Appendix B**). The flow along this trench will be directed into the existing field drainage ditches at the south and north east corners of the site.

7.2.4 At detailed design stage the implications of the potential impacts on local natural drainage paths associated with these mitigation measures would be addressed in consultation with the Internal Drainage Board.

7.3 Access and Egress for Operation and Maintenance

7.3.1 Access to and egress from the proposed substation site would be from the south via Nye Road from the A368 (see **Inset 2.1**). Nye Road to the north of the site is within Flood Zone 3. The new access road at the entrance to the site at the north east corner might be partially flooded during extreme flood events. This may lead to restrictions in gaining access to the site during extreme flood events. There is an additional proposed access road from the A368. This would be located approximately 200m east of the Towerhead Brook and is not considered to be at risk of flooding.

7.3.2 A short stretch of the A368, where it crosses the Towerhead Brook, west of the Nye Road/A368 junction to the south of the site is shown to be in Flood Zone 3. The access from the east along the A368 is clear.

7.3.3 Whilst there are no significant issues regarding access and egress (as access will generally be from the south) an access or egress plan should be included within the management plan for the proposed substation to ensure that arrangements are allowed for in the event of a flood affecting access from the north or west in extreme flood events.

7.4 Flood Warning and Escape and Evacuation Routes

7.4.1 For the proposed substation site, the minimum proposed top level of the compound slab of 8.00mAOD is significantly above the predicted 1 in 1,000 (0.1%) annual probability flooding event flood level of around 6.5mAOD (excluding climate change) and 6.85mAOD with climate change over a 40 year operational life to 2060.

7.4.2 As the substation would be unmanned most of the time, scheduled maintenance is not a major consideration as the required activities could be planned around any likely major tidal or fluvial flooding incidents, as these would be forecast.

7.4.3 The current Flood Warning Area extends up to within 100m of the northern edge of the proposed substation. Whilst the proposed substation is not within the Flood Warning Area, given the criticality of the substation it is recommended that National Grid, as the operator of the proposed substation, is signed up to the Floodline Warnings Direct Service provided by the Environment Agency so that adequate action could be taken to evacuate the site if necessary. As flood warnings can be provided by phone, text or email, and the site would generally be unmanned, arrangements should be made so that the warnings are issued to a suitable National Grid operations centre in order for personnel to take action accordingly in response to the warning.

7.4.4 If evacuation is required to the north (for any reason), the site area may be used as a safe refuge until evacuation can be provided to ensure the safety of the personnel. As noted above, ordinarily, evacuation would be to the south via Nye Road and the A368.

7.5 Residual Risk

7.5.1 The measures outlined above to address flood risk at the proposed substation gives a high level of flood resilience at the site to enable the substation to continue operating during flood events. For flood events over the design event there remains a low residual risk. This is addressed primarily through the proposed finished slab level being well above the most extreme tide levels considered, including allowances for climate change. Flood warning measures and evacuation procedures provide additional measures for managing residual risk.

7.5.2 With specific regard to the possibility of increased rainfall intensity as a result of climate change, residual risk would be managed through additional adaptive measures as necessary. These measures relate to the provision of additional attenuation storage on site to limit runoff rates from the site, and protection of the western corner of the site from surface water flows.

7.6 Potential Impact from the Substation

Surface Water Runoff

7.6.1 The proposed substation would result in the introduction of some impermeable area to the catchment. This could potentially result in some increase in the rates and volume of runoff from the site which could increase flood risk elsewhere due to the additional surface water runoff, and therefore needs to be considered.

7.6.2 A summary of the proposed substation permeable and impermeable areas is presented in **Table 7.1**.

Table 7.1 Permeable and Impermeable Areas of the Substation Site

Description	**Area (m^2)**	**Percentage of Total Area (%)**
Total impermeable area	8,828	25.6
Substation building and foundation	3,185	9.2
Access Road	5,643	16.4
Total permeable area	25,608	74.4

7.6.3 To determine the peak runoff rate for the greenfield situation for various annual probabilities of flooding, the ADAS and IH124 methodologies have been used. The results are summarised in **Table 7.2** and the detailed calculations are shown in **Volume 5.23.3.2, Appendix D**.

Table 7.2 Greenfield Runoff Rates for the Proposed Substation Site

Description	**Annual Probability of Flooding each Year Event**			
	1 in 1	**1 in 2.33** **(Mean Annual Flood)** **(42.9%)**	**1 in 30** **(3.3%)**	**1 in 100** **(1%)**
(a) ADAS Method				
Runoff rate (l/s)	-	9.89	21.16	28.97
Runoff rate (l/s/ha)	-	11.20	23.97	32.82
(b) IH124 Method				
Runoff rate (l/s)	2.89	3.40	6.64	8.17
Runoff rate (l/s/ha)	3.28	3.85	7.52	9.25

7.6.4 The results show that the IH124 method gives a smaller allowable greenfield runoff rate which is more conservative compared to the ADAS method. As a conservative approach, the IH124 method is therefore used as the allowable greenfield discharge rate to derive the required attenuation storage.

7.6.5 The calculations presented in **Volume 5.23.3.2, Appendix D** and summarised in **Table 7.3** show the peak discharge rate for the post-development situation i.e. with the increased impermeable area, and the estimated required storage volume for events with a 1 in 30 (3.3%), and 1 in 100 (1%) annual probability of flooding each year (with and without climate change) to attenuate the peak runoff rate to greenfield runoff values. A 10% increase in rainfall has been presented for the climate change scenarios as prescribed in Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities (Environment Agency, 2011) for the substation with a design life of 40 years.

Table 7.3 Runoff Rate and Storage Requirements to Meet Greenfield Runoff Rates

Description	**Annual Probability of Flooding each Year Event**	
	1 in 30 (3.3%)	**1 in 100 (1%)**

Description	Annual Probability of Flooding each Year Event	
	1 in 30 (3.3%)	1 in 100 (1%)
Un-mitigated post-development Runoff rate (l/s)*1	58	66
Storage volume (m^3)	257	400
With climate change storage volume (m^3)	294	456

*1 denotes the peak runoff rate derived using Modified Runoff Method (with climate change factor)

7.6.6 The results indicate that approximately 460m^3 of storage volume would be required to attenuate the flow from the 1 in 100 (1%) annual probability event, with climate change, to below the greenfield runoff rate of 3.28l/s/ha.

7.6.7 It is currently proposed that the surface water runoff will be attenuated via an attenuation pond at the northeast corner of the proposed site, in accordance with Sustainable Drainage (SuDS) principles as required under the Flood and Water Management Act 2010.

7.6.8 As part of a sensitivity analysis to this assessment to account for climate change, in the event that the increase in rainfall intensities is up to 20%, in accordance with the UKCP09 upper end estimate (high emissions scenario, 95th percentile) the storage required is estimated to be 513m^3. Given the risk of surface water flooding is low, and the potential impact on receptors to the north of the site is also low, it is not considered appropriate to design the attenuation storage to this design standard at present. However, within the site there is the potential for future adjustments to the attenuation pond layout to provide the additional 57m^3 of storage.

Water Quality Pollution

7.6.9 The proposed substation would include oil containing plant such as transformers, which, by their presence, gives the possibility of pollution incidents due to oil leakage. However, to prevent such an occurrence, the oil containing plant would be retained in bunded areas and specific National Grid procedures for managing pollution on site would be adopted to prevent any incident. These procedures include the provision of an oil separator within the new surface water drainage system prior to discharge to the proposed attenuation pond, which ultimately discharges to the drainage ditch on the north east side of the site.

7.7 Flood Defences

7.7.1 There are no flood defences within 1km of the proposed development site. However, the site does benefit from tidal defences near Weston-Super-Mare. There are control structures and tidal defences at the mouths and along parts of the lengths of the River Banwell and the River Yeo (also referred to as the Congresbury Yeo). The proposed substation site would not be affected by flooding if these defences were to fail. The resultant flooding would be expected to be as shown in the Environment Agency flood map (**Inset 3.2**). Development of the proposed substation would not affect any flood defence maintenance activities.

8. CONCLUSIONS

8.1.1 This FRA complies with the requirements set out in National Policy Statements, specifically Overarching Energy Policy (EN-1) and Electricity Networks Infrastructure Policy (EN-5) and demonstrates that flood risk from all sources has been considered for the proposed substation site.

8.1.2 The existing substation site lies in an area designated by the Environment Agency as Flood Zone 1. This means that the site has an annual probability of flooding of less than 1 in 1,000 (<0.1%) from rivers or the sea.

8.1.3 The NPPF sets out a Sequential Test, which states that preference should be given to development located within Flood Zone 1. If there is no reasonably available site in Flood Zone 1, then built development can be located in Flood Zone 2. If there is no reasonably available site in Flood Zone 1 or 2, then nationally significant energy infrastructure projects such as the Hinkley Point C Connection project - classified as “Essential Infrastructure” - can be located in Flood Zone 3 subject to passing a series of criteria known as the Exception Test.

8.1.4 This FRA demonstrates that the requirements of the Sequential Test have been met by locating the substation in Flood Zone 1, and therefore the Exception Test is not required.

8.1.5 This FRA has concluded that:

- The estimated level for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events are 6.02mAOD and 6.52mAOD respectively based on the information provided in the Level 1 Strategic Flood Risk Assessment, updated to give 2014 level estimates. With allowance for climate change and a design life of 40 years to 2060, the adopted flood levels for the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability flood events are 6.35mAOD and 6.85mAOD respectively. With an allowance of 300mm for data uncertainty, the recommended minimum floor level of 7.15mAOD is required for the 1 in 1,000 (0.1%) annual probability flood event, with climate change. The minimum proposed slab level of 8.00mAOD is well above this level. This meets the National Grid Flood Mitigation Policy which aims at protecting the critical infrastructure to the 1 in 1,000 (0.1%) annual probability flood event.

- It is recognised that although the proposed operational life of the substation is 40 years, it is possible that the substation would still be required beyond this timeframe given that Hinkley Point C Power Station would generate power for an estimated 60 years. Therefore, consideration is given to operation at the site (with replacement infrastructure) for a further 20 years. This would give the requirement for a minimum floor level of 7.37mAOD for the 1 in 1,000 (0.1%) annual probability event. The minimum proposed slab level of 8.00mAOD is well above this level.

- Although the risk of surface water flooding at the site is generally low, there is a minor risk of surface water flooding at the proposed substation at the western corner of the site. This is due to the diversion of a watercourse (drain) that currently crosses the site. The re-alignment of the drain and associated ground works would enable the western corner of the site to be protected against flooding in the event of the drain flowing out of bank, through the excavation of the drainage channel and formation of a low flood bund.

- Flood risk from other sources (fluvial, tidal, groundwater, sewers, reservoirs and other artificial sources) is demonstrated to be low.

- The proposed substation could potentially impact on flood risk elsewhere as the proposed works would increase the local impermeable area by approximately 26% of the total developed area, thereby increasing the rainfall runoff rate and volume contributing to the catchment. This potential increase would be mitigated through provision of attenuation storage on the site. The storage volume required to attenuate the impact of the additional runoff generated is estimated to be 460m^3 (1 in 100 (1%) annual probability event with climate change) and would be attenuated via a proposed attenuation storage pond. There is adaptive capacity available on site in the event that in future the surface water attenuation needs to be increased as a result of increased rainfall intensity due to climate change.

- The impact of climate change has been assessed using the latest UKCP09 projections. This covers the anticipated operational life of the substation to 2060, with measures proposed to take into account the impacts of climate change. In the event that the site is still required beyond 2060, there is additional adaptive capacity to address the potential future impacts of increased rainfall intensity. The proposed site would also be at a sufficiently high elevation to avoid tidal and fluvial flooding well beyond 2080, even under the sensitivity testing to the H++ climate change scenario.

- A safe access and egress plan should be included within the management plan to ensure that alternative arrangements are allowed for in the event of an extreme flood. However, as the proposed substation is an unmanned site it would be unusual for there to be any planned maintenance activities during a flood event.

- The proposed substation lies on the fringe of an area designated to receive a Flood Warning in the event that a flood is likely to occur. It is recommended that National Grid, as the operator of the proposed substation, is signed up to the Floodline Warnings Direct Service provided by the Environment Agency so that adequate action could be taken to evacuate the site if necessary. This is linked primarily to the risk of flooding of access routes to the north and east of the site, in the unlikely event that the proposed substation is manned at the onset of a flood event. If evacuation is required to the north, the site area may be used as a safe refuge until evacuation can be provided to ensure the safety of the personnel.

- Provision of bunded areas and oil separator for the oil containing plant are provided as measures to manage water pollution risk. The specific National

Grid procedure on managing pollution on site would be adopted to prevent any incident.

9. REFERENCES

1.1 National Grid. Need Case for the South West and the South Wales and Gloucestershire Regions. 2014.

1.2 Department of Energy and Climate Change. Overarching Energy Policy Statement for Energy (EN-1). July 2011.

1.3 Department of Energy and Climate Change. National Policy Statement for Electricity Networks Infrastructure (EN-5). July 2011.

1.4 DCLG. NPPF Planning Practice Guidance; Flood Risk and Coastal Change. March 2014. http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

1.5 Department for Communities and Local Government (DGLG 2012a). National Planning Policy Framework (NPPF). March 2012.

2.6 Soil Survey of England and Wales. 1:250,000 Soils of England and Wales Sheet 5 South West England. 1983.

2.7 British Geological Society. Geological Map Sheet 280 (Wells). 1984.

3.8 North Somerset Council. North Somerset Council Core Strategy. Adopted April 2012.

3.9 National Grid. Hinkley Point C Connection Strategic Optioneering Report. December 2009.

5.10 North Somerset Council. North Somerset Council Strategic Flood Risk Assessment Level 1. October 2008.

5.11 Environment Agency. Coastal Flood Boundary Conditions for UK Mainland and Islands. February, 2011.

5.12 Department for Environment, Flood and Rural Affairs (Defra) and Department for Energy and Climate Change (DECC). UK Climate Projections (UKCP09) Marine and Coastal Projections. 2009.

5.13 Environment Agency. Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities. 2011.

5.14 National Grid. Flood Mitigation Policy. October 2010.

5.15 North Somerset Council. Preliminary Flood Risk Assessment Preliminary Assessment Report. June 2011.

5.16 North Somerset Council. Level 2 Strategic Flood Risk Assessment Technical Element. September 2009.

5.17 Environment Agency. North and Mid Somerset Catchment Flood Management Plan Summary Report. December 2009.

5.18 North Somerset Council. North Somerset 2012 Flood Investigations. 2013.

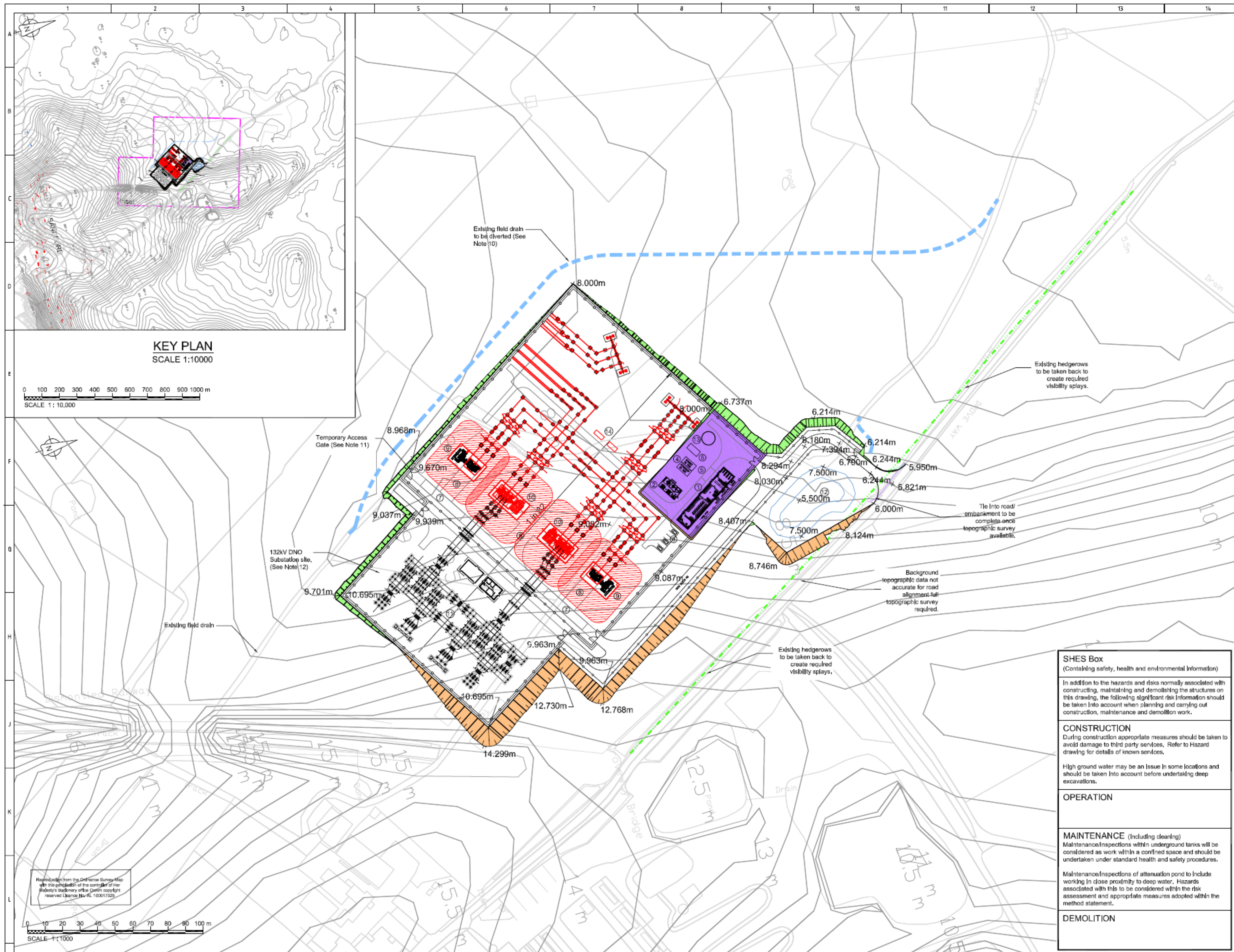
6.19 Department for Environment, Flood and Rural Affairs (Defra). UK Climate Change Risk Assessment: Government Report. January 2012.

6.20 Intergovernmental Panel on Climate Change. IPCC Special Report on Emissions Scenarios Summary for Policymakers. 2000.

Appendix A – Inset 3.1 Preferred Route Corridor

Inset 3.1. Preferred Route Corridor

Appendix B – Sandford Substation Development Drawings



SHES Box

(Containing safety, health and environmental information)

In addition to the hazards and risks normally associated with constructing, maintaining and demolishing the structures on this drawing, the following significant risk information should be taken into account when planning and carrying out construction, maintenance and demolition work.

CONSTRUCTION

During construction appropriate measures should be taken to avoid damage to third party services, Refer to Hazard drawing for details of known services.

High ground water may be an issue in some locations and should be taken into account before undertaking deep excavations.

OPERATION

MAINTENANCE (Including cleaning)

Maintenance/Inspections within underground tanks will be considered as work within a confined space and should be undertaken under standard health and safety procedures.

Maintenance/Inspections of attenuation pond to include working in close proximity to deep water. Hazards associated with this to be considered within the risk assessment and appropriate measures adopted within the method statement.

DEMOLITION

NOTES

1. This drawing is for development purposes only.
2. All coordinates are in metres and relate to Ordnance Survey Datum.
3. All levels are in metres and relate to Ordnance Survey Datum (Newlyn).
4. All foundations sizes shown indicatively. Until completion of geotechnical investigation, foundations to be assumed to consist of piles.
5. Cut and fill batters taken at 1 in 3 maximum based on a conservative figure.
6. All site levels shown indicatively at this stage, final levels to be confirmed in detailed design. For further details of proposed levels refer to drawing 12/SWA/3846135.
7. Visibility splay to be confirmed with local highway authority.
8. Surface Water Attenuation Pond location and size shown indicatively.
9. Final layout of site roads and civil infrastructure to be confirmed in detailed design.
10. Final route of field drain diversion to be agreed with local drainage board.
11. A temporary access road is to be constructed to the substation site which shall be operated during the construction stage. An allowance is to be made for the reinstatement of the access road for future construction work within the site including Shunt Reactor/SGT replacement schemes.
12. An adjacent 132kV substation, owned and operated by others, is to be constructed as part of the proposed scheme.

LEGEND

- Proposed layout
- Ordnance Survey
- Visibility Splay DRMB TD 42 / 95 215m x 4.5m Design speed 100 KMH
- Field Drain Diversion
- × 8.000m Proposed Levels
- Proposed Areas of Cut Batters
- Proposed Areas of Fill Batters
- Proposed Level area at 8.5mAOD
- Electrified Perimeter Fence
- Timber Post and Rail Fence

1. Site Control Building
2. Amenity Building
3. Site Carpark
4. Generator and Standby Generator Slab
5. 8m Long Tanker Standing Area
6. Oil Separator Bunded Cover Slab
7. 30m Long Tanker Standing Area
8. Skidway
9. Shunt Reactor Bunded Foundation
10. SGT Bunded Foundation
11. 132kV DNO Substation
12. Surface Water Attenuation Pond - See Note 8
13. Permastore Water Tank Model 2510 Capacity = 131.1m³
14. Earthstore and Workshop

REFERENCE DRAWINGS

14/SWA/3846090 – Site Hazard Plan, Sheet 1 of 2
14/SWA/3846091 – Site Hazard Plan, Sheet 2 of 2, Explanatory Notes
14/SWA/3846095 – Site CDM Plan
12/SWA/3846135 – Earthworks, Plan and Sections
14/SWA/3846240 – Site Plan, Site Drainage Layout
16/SWA/3846355 – Nye Road, Swept Path Analysis
23/SWA/3846740 – Site Lighting Plan
21/SWA/3340003 – Substation Layout, 400/132kV Substation

Rev	Rev. Date	Purpose for revision	Originator	Checker	Reviewer	Approver
P3	08.10.13	Pond information added	RIR	DC	SB	AD
P2	27.06.13	For information	BRH	DC	SB	AD
P1	24.06.13	For information	BRH	DC	SB	AD
P0	25.04.13	For information	MA	DC	SB	AD

PRELIMINARY

Electricity Alliance South West
Alliance House, Unit A, Ashville Park, Short Way, Thornbury, South Gloucestershire, BS35 3UU

nationalgrid
Warwick Technology Park, Gallows Hill, Warwick, CV34 6DA

Drawing Title
SITE PLAN
CIVIL LAYOUT

SANDFORD 400kV SUBSTATION

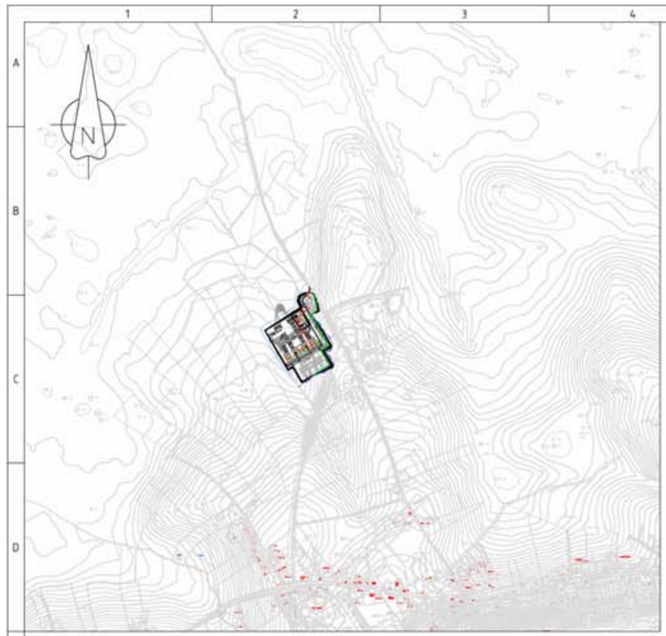
Site: SANDFORD 400kV SUBSTATION

Scale	Sheet size	Sheet No.	Total Sheets.
As Shown	A1	1	1

Originator Job No. B2904220 | Revision

Drg No. 12/SWA/3846055 | P3

N.G. Project No. 21535



KEY PLAN

SCALE 1:10000

SCALE 1 : 10,000

PLAN

SCALE 1:1000

NOTES

1. This drawing is for development purposes only.
2. All coordinates are in metres and relate to Ordnance Survey Datum.
3. All levels are in metres and relate to Ordnance Survey Datum (Newlyn).
4. Proposed drainage layout shown indicatively. Final Layout and levels confirmed at detailed design stage.
5. Surface water runoff from site roads, roofs and foundations assumed to drain to gravel areas.
6. Emergency oil drainage from SGT's and Shunt Reactor units to drain to remote underground dumptank.
7. All oil handling areas to drain to oil tight drainage system and through an oil interceptor prior to discharge in accordance with National Grid's design requirements.
8. Surface water runoff discharging from site shall be attenuated to greenfield runoff rates in accordance with SUstainable Drainage Systems (SUDS) best practice.
9. Attenuation pond shown indicatively, exact location and size to be confirmed in detailed design.
10. Foul water drainage assumed to discharge to onsite cesstank.
11. Requirement for toe drainage to battered slopes to be confirmed following geotechnical investigation.

LEGEND

- Fenceline
- Ordnance Survey
- Tanker Standing Area
- Emergency Oil Drainage Pipework
- Oil Tight Drainage Pipework
- Toe Drainage - See Note 11
- Cut-off Drain
- Drainage Ditch Diversion

REFERENCE DRAWINGS

12/SWA/3846055 - Site Plan, Civil Layout
14/SWA/3846090 - Site Hazard Plan, Sheet 1 of 2
14/SWA/3846091 - Site Hazard Plan, Sheet 2 of 2, Explanatory Notes
14/SWA/3846095 - Site CDM Plan
12/SWA/3846135 - Earthworks, Plan and Sections
16/SWA/3846355 - Nye Road, Swept Path Analysis
23/SWA/3846740 - Site Lighting Plan
21/SWA/3340003 - Substation Layout, 400/132kV Substation

HOLDS

SHES Box

(Containing safety, health and environmental information)

In addition to the hazards and risks normally associated with constructing, maintaining and demolishing the structures on this drawing, the following significant risk information should be taken into account when planning and carrying out construction, maintenance and demolition work.

CONSTRUCTION

During construction appropriate measures should be taken to avoid damage to third party services. Refer to Hazard drawing for details of known services.

High ground water may be an issue in some locations and should be taken into account before undertaking deep excavations.

OPERATION

Not Applicable

MAINTENANCE (Including cleaning)

Maintenance/inspections within underground tanks will be considered as work within a confined space and should be undertaken under standard health and safety procedures.

Maintenance/inspections of attenuation pond to include working in close proximity to deep water. Hazards associated with this to be considered within the risk assessment and appropriate measures adopted within the method statement.

DEMOLITION

Not Applicable

Rev	Rev. Date	Purpose of revision	Originator	Checker	Reviewer	Approver
P1	24.06.13	Site Layout amended. Issued for Comment	BRH	DC	SB	AD
P0	25.04.13	Site Layout amended. Issued for Comment	RIR	DC	SB	AD

PRELIMINARY

Electricity Alliance South West

Alliance House, Unit A, Ashville Park, Short Way, Thornbury, South Gloucestershire, BS35 3UU

nationalgrid

Warwick Technology Park, Gallows Hill, Warwick, CV34 6DA

Drawing Title

SITE PLAN
SITE DRAINAGE LAYOUT

SANDFORD 400kV SUBSTATION

Site: **SANDFORD 400kV SUBSTATION**

Scale	Sheet size	Sheet No.	Total Sheets.
As Shown	A1	1	1

Originator Job No. B2904220 — Revision P1

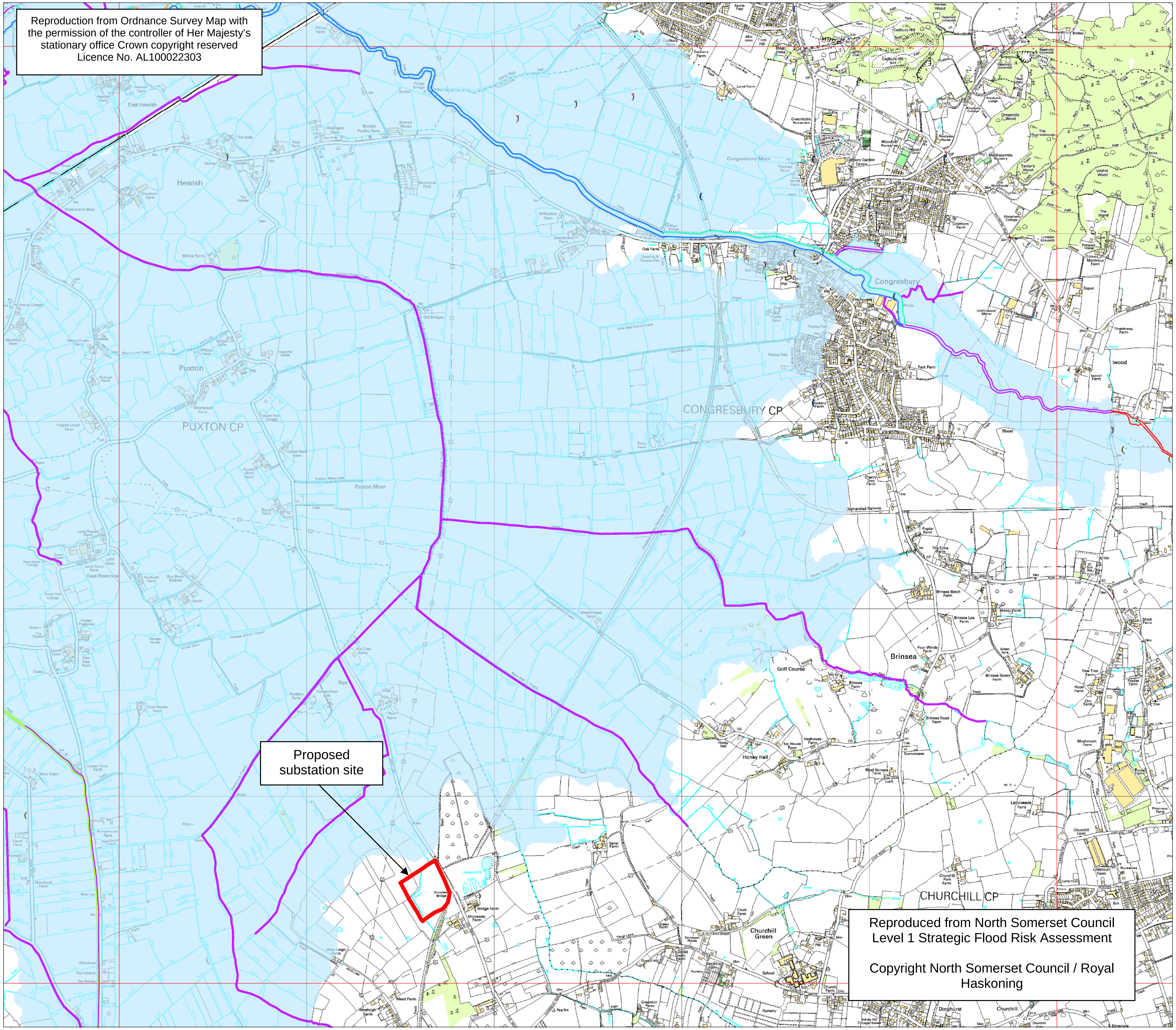
Drg No. 18/SWA/3846240

N.G. Project No. 21535

This drawing is not to be used in whole or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

Issue		NG Contract No.	Issue		NG Contract No.
Drawn		Purpose of Revision NG Issue Description to go in here when required	Drawn		Purpose of Revision
Checked			Checked		
Approved		Date	Approved		Date

Appendix C – SFRA Flood Maps



Key

- Section 24 Maps
- Flood Incidents from NSC
- EA Flooding Incidents
- Historic Flooding
- Flood Zone 3
- Historic Flood Map
- Outside Study Area

Standard Of Protection

- Unknown
- 2 Year
- 5 Year
- 10 Year
- 25 Year
- 50 Year
- 100 Year Defence or greater

NOTES:

1. The Environment Agency Flood Zones are shown for the year 2008 within the boundaries of North Somerset Council (NSC). The justification for these maps is given in the Strategic Flood Risk Assessment Report prepared by Royal Haskoning, February 2009. This map does not change the status of the Environment Agency's National Flood Zone Maps.

2. The flood risk zones mapped here are as described in the Planning Policy Statement 25 (PPS25): Development and Flood Risk, December 2006 as above.

3. Potential flooding has been considered using the best available information. Climate change predictions are uncertain and for this study and are based on the best estimates contained within the PPS25 guidelines.

4. All flood risk areas at the study (NSC) boundary need special attention when used for any purpose as the map only shows areas at risk within the NSC area.

5. The Potential Flood Risk Areas have been generated using limited site inspection and anecdotal evidence. They do not form part of the Environment Agency Flood Zones.

6. Historic Flood Map data shown on these maps relates to past flood events which may have occurred before the existence of certain flood defences. This data is supplied to Local Authorities by the Environment Agency.

7. The Environment Agency flood zones only show the predicted likelihood of flooding from rivers or the sea for defined areas, and are not detailed enough to account for precise addresses. Individual properties therefore may not always face the same chance of flooding as the areas that surround them. These maps show the flood zones as issued in 2008.

8. These maps only contain the available information up to February 2009. Additional flood incidents may have been recorded after this date and therefore NSC and the EA should be contacted for the most up-to-date information.

Title:
Historic Flood Risk & Defences: ST46SW

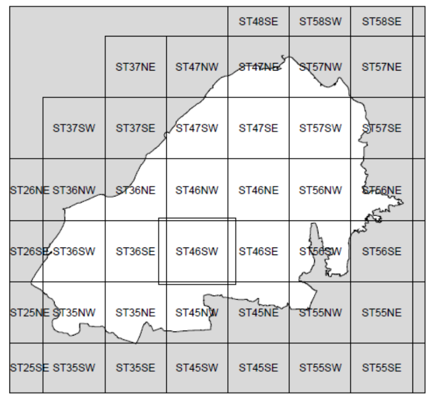
Date:
February 2009

Project:
North Somerset Council
Strategic Flood Risk Assessment

Version:1.0

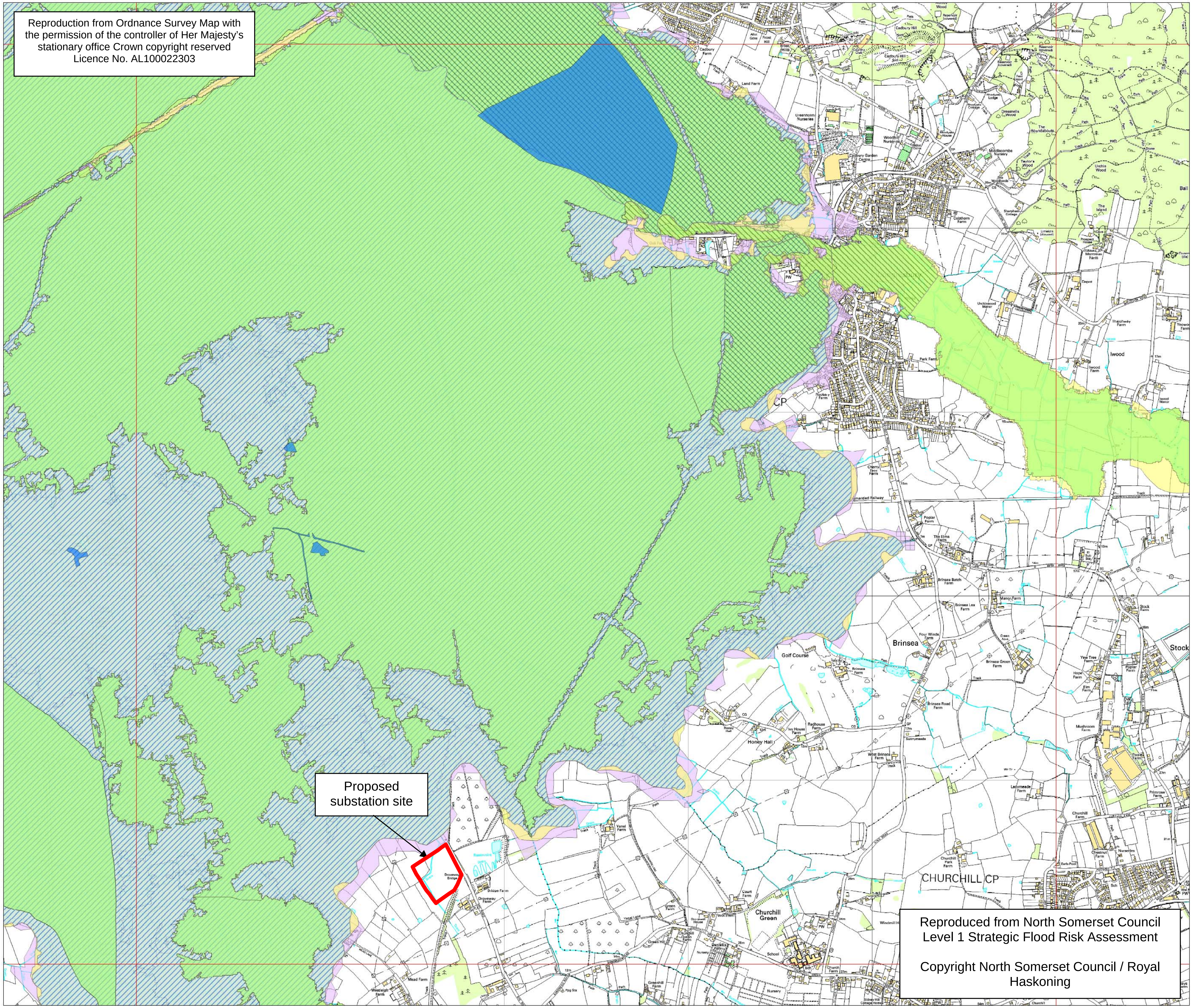
Scale:
1:10,000

Client:
North Somerset Council



ROYAL HASKONING

North Somerset Council
DEVELOPMENT & ENVIRONMENT



Key

- Outside Study Area
- Potential Flood Risk Area
- Climate change additional extents
- SFRA Flood Zone 2

SFRA Fluvial Flood Z
- SFRA Flood Zon
- SFRA Flood Zon

SFRA Tidal Flood Zon
- SFRA Flood Zon
- SFRA Flood Zon

Zone	Risk	Annual probability of flooding (equivalent return period in years)	
Zone 1	Little or no risk	>0.1%	(>1 in 1000)
Zone 2	Low to medium risk	0.1% - 1>0%	(1 in 1000 to 1 in 100 fluvial 1 in 200 tidal)
Zone 3	High Risk	<1>0%	(<1 in 100 fluvial or 200 tidal)

NOTES:

1. The SFRA Flood Zones are based on the Environment Agency Flood Zones as of April 2008 withi boundaries of North Somerset Council (NSC). The justification for these maps is given in the Strategi Flood Risk Assessment Report prepared by Royal Haskoning, February 2009. This map does not ch status of the Environment Agency's National Flood Zone Maps.

2. The flood risk zones mapped here are as described in the Planning Policy Statement 25 (PPS25): Development and Flood Risk, December 2006 as above.

3. Potential flooding has been considered using the best available information. Climate change predi are uncertain and for this study and are based on the best estimates contained within the PPS25 gui

4. All flood risk areas at the study (NSC) boundary need special attention when used for any purpose as the map only shows areas at risk within the NSC area.

5. The Potential Flood Risk Areas have been generated using limited site inspection and anecdotal evidence. They do not form part of the Environment Agency Flood Zones and are only a guide as to where flooding could occur. More details are provided in the SFRA report.

6. Historic Flood Map data shown on these maps relates to past flood events which may have occurr before the existence of certain flood defences. This data is supplied to Local Authorities by the Environment Agency.

7. The Environment Agency flood zones only show the predicted likelihood of flooding from rivers or for defined areas, and are not detailed enough to account for precise addresses. Individual propertie therefore may not always face the same chance of flooding as the areas that surround them. These show the flood zones as issued in 2008.

8. These maps only contain the available information up to February 2009. Additional flood incidents have been recorded after this date and therefore NSC and the EA should be contacted for the most up-to-date information.

Title:
Existing & Future Flood Risk:
ST46SW

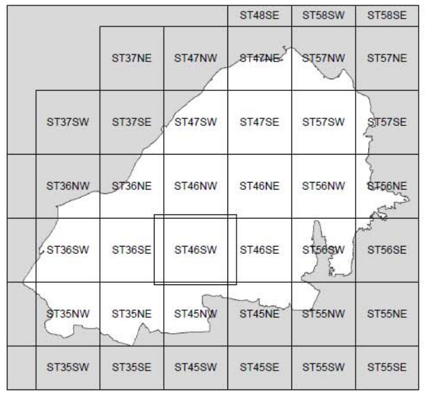
Date:
June
2009

Project:
North Somerset Council
Strategic Flood Risk Assessment

Version

Scale:
1:10,00

Client:
North Somerset Council



ROYAL HASKONING

North Somers
DEVELOPMENT & ENVIR

Appendix D – Greenfield Runoff and Attenuation Storage Calculations

JACOBS CALCULATION SHEET

OFFICE	EXETER	PAGE No	1	REVISION	A
JOB No	B2904220	ORIGINATOR	SHL	DATE	18/03/2013
TITLE	SANDFORD SUBSTATION	ARITH CHK	DC	DATE	03/05/2013
SECTION	GREENFIELD RUNOFF RATE (ADAS)	ENG CHK	DC	DATE	03/05/2013

REF	CALCULATION	OUTPUT

Aim:

To determine the peak discharge rate of the greenfield site runoff for a range of annual chance of occuring in each year events using ADAS method as recommended by Highways Agency guidance 106/04 for catchment area less than $0.4km^2$.

Reference:

Agricultural Development and Advisory Service (ADAS) Report 345

Greenfield estimation of peak flow rate of runoff

1. Area of Proposed Development **SANDFORD SUBSTAION**

   Area 1 0.88 ha

   Total Area 1 **0.88** ha

2. Maximum Length (L) of Development

   L **122** **m** (SE to NW)

3. Average Slope (S)

   Max elevation 14.00 m AOD

   Min elevation 7.50 m AOD

   S **0.053**

4. Catchment Characteristics, C = 0.0001*L/S

   C **0.229**

5. Determine Crop Type **Grass**

6. Determine Average Annual Rainfall, AAR **900** **mm** (Figure 1 of Guidance)

7. Determine Soil Type, S_t **0.8** **S_t** (Figure 2 of Guidance)

8. Determine 'F' Number, F **14** **F** (Figure 3 of Guidance)

9. Peak Flood Flow, $Q_o = S_t*F*A$ **Q_0** **9.89** l/s

Return Period (years)	2.33 MAF	10	30	50	100
South West Region Multiplier	1.00	1.58	2.14	2.45	2.93
Estimated Flow (l/s)	9.89	15.62	21.16	24.22	28.97

REF	CALCULATION	OUTPUT

Aim:
To determine the peak discharge rate of the greenfield site runoff for 1, 30, 100 annual chance of occuring in each year events using IH 124 method.

ASV1

Reference:
Defra/Environment Agency R&D Technical Report W5-074/A/TR/1
Preliminary Rainfall Runoff Management for Developments (Revision D)

Greenfield estimation of peak flow rate of runoff

Site characteristics

1 Hydrological Region (1 - 10) (R) 8 — UK is divided up into 10 hydrological regions reflecting the different flood frequency growth curves. (Appendix 1, Figure 1.1)

2 (SOIL) type (1 - 5) 3 — Refer to Wallingford Procedure WRAP map or FSR maps (Appendix 1, Figure 5)

3 Development size (A) 3.4 ha — The size of the gross development excluding large parkland areas being allocated as public open space which remain unmodified.

4 Method of Greenfield analysis
If development area is 200+ ha a full FEH analysis is recommended to obtain a more accurate estimate of greenfield runoff characteristics.

5 Area (A) 0.9 ha — Excluding public open space not modified by the proposed development

6 Annual Rainfall (SAAR) 900 mm — SAAR - use either SAAR from FSR or AAR from FEH (Appendix 1, Figure 4)

7 Soil runoff coefficient (SPR) 0.37 — SPR value for SOIL - this is not the FSR index class value for SOIL (1 - 5) but its corresponding runoff coefficient (SPR) as follows:

SOIL	1	2	3	4	5
SPR	0.10	0.30	0.37	0.47	0.53

JACOBS

CALCULATION SHEET

OFFICE	EXETER	PAGE No	3	REVISION	A
JOB No	B2904220	ORIGINATOR	SHL	DATE	18/03/2013
TITLE	SANDFORD SUBSTATION	ARITH CHK	DC	DATE	03/05/2013
SECTION	GREENFIELD RUNOFF RATE (ADAS)	ENG CHK	DC	DATE	03/05/2013

REF	CALCULATION				OUTPUT
	8 Development mean annual peak flow (1.08 $(A/100)^{0.89}$ $SAAR^{1.17}$. $SPR^{2.17}$) ($Q_{BAR} = Q_{BAR50\ hr}$ x (A/50))	(Q_{BAR})	3.40	l/s	For development sites of 50 ha or less, use 50 ha when applying the formula. Subsequently factor the resulting value by the ratio of the site area to 50 ha (i.e if the site is 10 ha divide the answer by 5)	**ASV2**
	9 Mean annual peak flow per unit area	(Q_{BAR}/A)	3.85	l/s/ha	For SOIL type 1 and occasionally type 2 Q_{BAR}/A will generally have a value less than 1. If so use 1 l/s/ha (see note 2)	
	10 Minimum limit of discharge	($Q_{throttle}$)		l/s/ha	Minimum discharge (see note 3)	Not used
	10.1 100 year flow rate per unit area	($Q_{throttle}$/A)	0.00	l/s/ha		Not used
	10.2 Equivalent mean annual peak flow per unit area	($Q_{throttle}$/3.5A)	0.00	l/s/ha	Use this value as (Q_{BAR}/A) if it is greater than item 9.	Not used
	11 1yr, 30yr and 100 yr peak discharge rate of runoff per unit area				Use the larger of the 2 values of item 9 and 10.2 for calculating 11.1 to 11.3	
	11.1 Q_{BAR}/A x 0.85	(Q_{1yr})	3.28	l/s/ha	GC_{30} and GC_{100} are the growth curve ratios Q/Q for the 30 year and 100 year events for the relevant hydrological region.	
	11.2 Q_{BAR}/A x GC_{30}	(Q_{30yr})	7.52	l/s/ha	The 30 and 100 year factors are found from Appendix 1,	
	11.3 Q_{BAR}/A x GC_{100}	(Q_{100yr})	9.25	l/s/ha	Figure 1.2 from FSSR 14. (Do NOT use the Growth Curve Factors from the embedded table in the figure).	

Note 1 *HOST classes for soil also have SPR values. Although derived a little differently, these values can also be used (IH Report 126 - Hydrology of Soil Types)*

Note 2 *Very low values of Q_{BAR} /A result in excessive storage volumes. As Long Term storage for SOIL type 1 is large, a minimum value of Q_{BAR} /A of 1 is to be used.*

Note 3 *Minimum sizes of an orifice may limit the minimum hydraulic control flow rate. This allows the derivation of an equivalent value of a Q_{BAR} /A.*

JACOBS CALCULATION SHEET

OFFICE	EXETER	PAGE No	4	REVISION	A
JOB No	B2904220	ORIGINATOR	SHL	DATE	18/03/2013
TITLE	SANDFORD SUBSTATION	ARITH CHK	DC	DATE	03/05/2013
SECTION	GREENFIELD RUNOFF RATE (ADAS)	ENG CHK	DC	DATE	03/05/2013

REF	CALCULATION	OUTPUT

Aim:
To compare the peak discharge rate of the greenfield site runoff for 1, 30, 100 annual chance of occuring in each year events from the ADAS and IH124 method.

Reference:
Defra/Environment Agency R&D Technical Report W5-074/A/TR/1
Preliminary Rainfall Runoff Management for Developments (Revision D)
Agricultural Development and Advisory Service (ADAS) Report 345

Greenfield estimation of peak flow rate of runoff

Return Period (years)	1	2.33 MAF	30.00	100.00
ADAS Method				
Greenfield runoff rate (l/s)	-	9.89	21.16	28.97
Greenfield runoff rate/area (l/s/ha)	-	11.20	23.97	32.82

Return Period (years)	1	2.33 MAF	30.00	100.00
IH124 Method				
Greenfield runoff rate/area (l/s/ha)	3.28	3.85	7.52	9.25
Greenfield runoff rate (l/s)	2.89	3.40	6.64	8.17

Discussion / Conclusion:
The results show that the IH124 method give a smaller allowable greenfield runoff rates which is more conservative compared to the ADAS method. Therefore, it is recommended to use the result of the greenfield runoff rate from the IH124 method in deriving the storage required.

JACOBS

CALCULATION SHEET

OFFICE	EXETER	PAGE No	1	REVISION	A
JOB No	B2904220	ORIGINATOR	SHL	DATE	26/03/2014
TITLE	SANDFORD SUBSTATION	ARITH CHK	IMB	DATE	26/03/2014
SECTION	ATTENUATION STORAGE CALCULATION	ENG CHK	IMB	DATE	26/03/2014

REF	CALCULATION	OUTPUT

Aim:

To determine the attenuation storage required to address the additional runoff due to the proposed Sandford Substation development.

Reference:

Greenfield runoff calculation Rev A

Preliminary Rainfall Runoff Management for Developments (Revision D)

JACOBS™ CALCULATION SHEET

OFFICE	EXETER	PAGE No	2	REVISION	A
JOB No	B2904220	ORIGINATOR	SHL	DATE	26/03/2014
TITLE	SANDFORD SUBSTATION	ARITH CHK	IMB	DATE	26/03/2014
SECTION	ATTENUATION STORAGE CALCULATION	ENG CHK	IMB	DATE	26/03/2014

REF	CALCULATION	OUTPUT

Results:

(a) Attenuation Storage

Description	**Annual chance of flooding each year**	
	1:30	**1:100**
Runoff Rate (l/s)	61.22	68.95
Storage volume (with climate change) (m^3)	294	456

FEH BASE DATA								LOCAL ATTENUATION DATA		
VERSION	FEH CD-R(Version	3 exported at	09:15:59 GMT	Thu	04-Apr-13			Qallowable/ha =	3.28	l/s/ha
Parameters								Catchment Area	3.44	ha
Calculation type=	Design rainfall							Paved Area=	0.88	ha
Calculation mode	Typical point in catchment							Unpaved PR	0%	
Calculation locat	Catchment GB	341000	160700 ST 41000 60700					Paved PR	100%	
Catchment area=	0.53	km**2						(Overall PR =	25.6%)	
Duration=	1	1 (hour)						Outflow Rate	11.28 l/s	= 0.01128 m^3/s
Fixed duration=	no									
Return period=	30	1 (years)								
Annual maximun	yes									

This sheet calculates the **attenuation storage volume** needed to attenuate the **30 year +10% storm** with the outflow rate given above.

c	d1	d2	d3	e	f
-0.02794	0.3891	0.37034	0.26947	0.29331	2.46215

Storage required 294 m^3
3.3 hours

Peak Flow 61.22 l/s (using Modified Rational Method)

An areal reduction factor of 0.969 has been applied to a point rainfall of 31.7 mm to yield a catchment design rainfall of 30.7 mm.
No warning(s) or note(s) were present for this calculation.
The data in the following table have been computed using sliding durations.

Duration	Duration	Duration	1.1 year rainfall	2.33 year rainfall	10 year rainfall	20 year rainfall	30 year rainfall	50 year rainfall	100 year rainfall	200 year rainfall	500 year rainfall	30yr+10% year rainfall	Inflow volume into storage from rain-fall onto catchment: Inflow Volume (m^3)	Outflow Volume given allowable discharge above: Outflow Volume (m^3)	Attenuation storage requirement: Storage Volume (m^3)	Duration (Hours)
minutes	hours	days	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm				
15	0.25	0.010417	4.85	7.86	13.69	17.38	19.95	23.69	29.87	37.63	51.03	21.95	193.73	10.15	184	0.25
30	0.5	0.020833	6.54	10.3	17.37	21.76	24.76	29.11	36.22	45.02	59.98	27.24	240.44	20.31	220	1
45	0.75	0.03125	7.78	12.05	19.94	24.77	28.07	32.81	40.49	49.93	65.84	30.88	272.58	30.46	242	1
60	1	0.041667	8.79	13.46	21.98	27.15	30.66	35.69	43.8	53.71	70.3	33.73	297.73	40.62	257	1
75	1.25	0.052083	9.67	14.67	23.7	29.15	32.82	38.08	46.54	56.82	73.95	36.10	318.71	50.77	268	1.25
90	1.5	0.0625	10.44	15.73	25.21	30.88	34.7	40.16	48.89	59.49	77.06	38.17	336.96	60.93	276	1.5
105	1.75	0.072917	11.15	16.69	26.55	32.42	36.37	41.99	50.98	61.84	79.79	40.01	353.18	71.08	282	1.75
120	2	0.083333	11.79	17.56	27.76	33.81	37.88	43.65	52.85	63.94	82.22	41.67	367.85	81.24	287	2
135	2.25	0.09375	12.4	18.37	28.88	35.09	39.25	45.16	54.55	65.85	84.42	43.18	381.15	91.39	290	2.25
150	2.5	0.104167	12.96	19.12	29.92	36.28	40.53	46.55	56.12	67.61	86.44	44.58	393.58	101.55	292	2.5
165	2.75	0.114583	13.49	19.83	30.89	37.38	41.71	47.85	57.58	69.23	88.3	45.88	405.04	111.70	293	2.75
180	3	0.125	14	20.5	31.8	38.41	42.83	49.06	58.94	70.75	90.03	47.11	415.91	121.86	294	3
195	3.25	0.135417	14.48	21.13	32.66	39.39	43.88	50.21	60.22	72.17	91.66	48.27	426.11	132.01	294	3.25
210	3.5	0.145833	14.93	21.74	33.48	40.32	44.87	51.29	61.42	73.52	93.18	49.36	435.72	142.17	294	3.5
225	3.75	0.15625	15.37	22.31	34.26	41.2	45.81	52.32	62.57	74.79	94.63	50.39	444.85	152.32	293	3.75
240	4	0.166667	15.8	22.87	35	42.04	46.71	53.29	63.66	76	96	51.38	453.59	162.48	291	4
255	4.25	0.177083	16.21	23.4	35.72	42.85	47.58	54.23	64.7	77.15	97.3	52.34	462.04	172.63	289	4.25
270	4.5	0.1875	16.6	23.92	36.4	43.62	48.4	55.13	65.7	78.25	98.55	53.24	470.00	182.79	287	4.5
285	4.75	0.197917	16.98	24.41	37.06	44.36	49.2	55.99	66.65	79.3	99.74	54.12	477.77	192.94	285	4.75
300	5	0.208333	17.35	24.89	37.7	45.08	49.96	56.82	67.57	80.32	100.88	54.96	485.15	203.10	282	5
315	5.25	0.21875	17.71	25.36	38.32	45.77	50.7	57.62	68.46	81.29	101.98	55.77	492.34	213.25	279	5.25
330	5.5	0.229167	18.06	25.81	38.91	46.44	51.42	58.39	69.32	82.23	103.03	56.56	499.33	223.41	276	5.5
345	5.75	0.239583	18.4	26.25	39.49	47.09	52.11	59.14	70.14	83.14	104.05	57.32	506.03	233.56	272	5.75
360	6	0.25	18.73	26.67	40.06	47.72	52.78	59.86	70.94	84.02	105.04	58.06	512.54	243.72	269	6
375	6.25	0.260417	19.05	27.09	40.6	48.33	53.43	60.56	71.72	84.88	105.99	58.77	518.85	253.87	265	6.25
390	6.5	0.270833	19.37	27.49	41.14	48.93	54.06	61.25	72.47	85.7	106.92	59.47	524.97	264.03	261	6.5
405	6.75	0.28125	19.68	27.89	41.65	49.51	54.68	61.91	73.2	86.5	107.82	60.15	530.99	274.18	257	6.75
420	7	0.291667	19.98	28.28	42.16	50.07	55.28	62.56	73.92	87.28	108.69	60.81	536.81	284.34	252	7
435	7.25	0.302083	20.28	28.65	42.65	50.62	55.87	63.19	74.61	88.04	109.53	61.46	542.54	294.49	248	7.25
450	7.5	0.3125	20.57	29.02	43.14	51.16	56.44	63.8	75.29	88.78	110.36	62.08	548.08	304.64	243	7.5
465	7.75	0.322917	20.85	29.39	43.61	51.69	57	64.41	75.95	89.5	111.16	62.70	553.52	314.80	239	7.75
480	8	0.333333	21.13	29.74	44.07	52.2	57.54	64.99	76.59	90.21	111.94	63.29	558.76	324.95	234	8
495	8.25	0.34375	21.41	30.09	44.52	52.7	58.08	65.57	77.22	90.89	112.71	63.89	564.00	335.11	229	8.25
510	8.5	0.354167	21.68	30.43	44.97	53.2	58.6	66.13	77.84	91.57	113.45	64.46	569.05	345.26	224	8.5
525	8.75	0.364583	21.94	30.77	45.4	53.68	59.11	66.68	78.44	92.22	114.18	65.02	574.01	355.42	219	8.75
540	9	0.375	22.2	31.1	45.83	54.15	59.61	67.21	79.03	92.86	114.89	65.57	578.86	365.57	213	9
555	9.25	0.385417	22.46	31.42	46.24	54.62	60.1	67.74	79.61	93.49	115.59	66.11	583.62	375.73	208	9.25
570	9.5	0.395833	22.71	31.74	46.65	55.07	60.58	68.26	80.17	94.11	116.27	66.64	588.28	385.88	202	9.5
585	9.75	0.40625	22.96	32.05	47.06	55.52	61.06	68.77	80.73	94.71	116.94	67.17	592.94	396.04	197	9.75
600	10	0.416667	23.2	32.36	47.45	55.96	61.52	69.26	81.27	95.31	117.59	67.67	597.41	406.19	191	10
615	10.25	0.427083	23.44	32.66	47.84	56.39	61.98	69.75	81.81	95.89	118.24	68.18	601.88	416.35	186	10.25
630	10.5	0.4375	23.68	32.96	48.23	56.81	62.43	70.23	82.33	96.46	118.87	68.67	606.25	426.50	180	10.5
645	10.75	0.447917	23.91	33.26	48.6	57.23	62.87	70.71	82.85	97.02	119.48	69.16	610.52	436.66	174	10.75
660	11	0.458333	24.15	33.55	48.98	57.64	63.3	71.17	83.35	97.57	120.09	69.63	614.69	446.81	168	11
675	11.25	0.46875	24.37	33.83	49.34	58.04	63.73	71.63	83.85	98.11	120.69	70.10	618.87	456.97	162	11.25

FEH BASE DATA							
VERSION	FEH CD-R(Version	3 exported at	09:15:59 GMT	Thu	04-Apr-13		
Parameters							
Calculation type=	Design rainfall						
Calculation mod(	Typical point in catchment						
Calculation locat	Catchment GB	341000	160700 ST 41000 60700				
Catchment area=	0.53	km**2					
Duration=	1	1 (hour)					
Fixed duration=	no						
Return period=	30	1 (years)					
Annual maximun	yes						
c	d1	d2	d3	e	f		
-0.02794	0.3891	0.37034	0.26947	0.29331	2.46215		

An areal reduction factor of 0.969 has been applied to a point rainfall of 31.7 mm to yield a catchment design rainfall of 30.7 mm.
No warning(s) or note(s) were present for this calculation.
The data in the following table have been computed using sliding durations.

LOCAL ATTENUATION DATA				
Qallowable/ha =	3.28	l/s/ha		
Catchment Area	3.44	ha		
Paved Area=	0.88	ha		
Unpaved PR	0%	%		
Paved PR	100%	%		
(Overall PR =	25.6%	)		
Outflow Rate	11.28	l/s	=	0.01128 m^3/s

This sheet calculates the **attenuation storage volume** needed to attenuate the **100 year +10% storm** with the outflow rate given above.

Storage required	456 m^3
	4.0 hours
Peak Flow	68.95 l/s (using Modified Rational Method)

Duration	Duration	Duration	1.1 year rainfall	2.33 year rainfall	10 year rainfall	20 year rainfall	30 year rainfall	50 year rainfall	100 year rainfall	200 year rainfall	500 year rainfall	100yr+10% year rainfall	Inflow volume into storage from rain-fall onto catchment: Inflow Volume (m^3)	Outflow Volume given allowable discharge above: Outflow Volume (m^3)	Attenuation storage requirement: Storage Volume (m^3)	Duration (Hours)
minutes	hours	days	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm				
15	0.25	0.010417	4.85	7.86	13.69	17.38	19.95	23.69	29.87	37.63	51.03	32.86	290.06	10.15	280	0.25
30	0.5	0.020833	6.54	10.3	17.37	21.76	24.76	29.11	36.22	45.02	59.98	39.84	351.73	20.31	331	0.5
45	0.75	0.03125	7.78	12.05	19.94	24.77	28.07	32.81	40.49	49.93	65.84	44.54	393.19	30.46	363	0.75
60	1	0.041667	8.79	13.46	21.98	27.15	30.66	35.69	43.8	53.71	70.3	48.18	425.33	40.62	385	1
75	1.25	0.052083	9.67	14.67	23.7	29.15	32.82	38.08	46.54	56.82	73.95	51.19	451.94	50.77	401	1.25
90	1.5	0.0625	10.44	15.73	25.21	30.88	34.7	40.16	48.89	59.49	77.06	53.78	474.76	60.93	414	1.5
105	1.75	0.072917	11.15	16.69	26.55	32.42	36.37	41.99	50.98	61.84	79.79	56.08	495.06	71.08	424	1.75
120	2	0.083333	11.79	17.56	27.76	33.81	37.88	43.65	52.85	63.94	82.22	58.14	513.22	81.24	432	2
135	2.25	0.09375	12.4	18.37	28.88	35.09	39.25	45.16	54.55	65.85	84.42	60.01	529.72	91.39	438	2.25
150	2.5	0.104167	12.96	19.12	29.92	36.28	40.53	46.55	56.12	67.61	86.44	61.73	544.97	101.55	443	2.5
165	2.75	0.114583	13.49	19.83	30.89	37.38	41.71	47.85	57.58	69.23	88.3	63.34	559.15	111.70	447	2.75
180	3	0.125	14	20.5	31.8	38.41	42.83	49.06	58.94	70.75	90.03	64.83	572.35	121.86	450	3
195	3.25	0.135417	14.48	21.13	32.66	39.39	43.88	50.21	60.22	72.17	91.66	66.24	584.78	132.01	453	3.25
210	3.5	0.145833	14.93	21.74	33.48	40.32	44.87	51.29	61.42	73.52	93.18	67.56	596.44	142.17	454	3.5
225	3.75	0.15625	15.37	22.31	34.26	41.2	45.81	52.32	62.57	74.79	94.63	68.83	607.60	152.32	455	3.75
240	4	0.166667	15.8	22.87	35	42.04	46.71	53.29	63.66	76	96	70.03	618.19	162.48	456	4
255	4.25	0.177083	16.21	23.4	35.72	42.85	47.58	54.23	64.7	77.15	97.3	71.17	628.29	172.63	456	4.25
270	4.5	0.1875	16.6	23.92	36.4	43.62	48.4	55.13	65.7	78.25	98.55	72.27	638.00	182.79	455	4.5
285	4.75	0.197917	16.98	24.41	37.06	44.36	49.2	55.99	66.65	79.3	99.74	73.32	647.22	192.94	454	4.75
300	5	0.208333	17.35	24.89	37.7	45.08	49.96	56.82	67.57	80.32	100.88	74.33	656.16	203.10	453	5
315	5.25	0.21875	17.71	25.36	38.32	45.77	50.7	57.62	68.46	81.29	101.98	75.31	664.80	213.25	452	5.25
330	5.5	0.229167	18.06	25.81	38.91	46.44	51.42	58.39	69.32	82.23	103.03	76.25	673.15	223.41	450	5.5
345	5.75	0.239583	18.4	26.25	39.49	47.09	52.11	59.14	70.14	83.14	104.05	77.15	681.12	233.56	448	5.75
360	6	0.25	18.73	26.67	40.06	47.72	52.78	59.86	70.94	84.02	105.04	78.03	688.88	243.72	445	6
375	6.25	0.260417	19.05	27.09	40.6	48.33	53.43	60.56	71.72	84.88	105.99	78.89	696.46	253.87	443	6.25
390	6.5	0.270833	19.37	27.49	41.14	48.93	54.06	61.25	72.47	85.7	106.92	79.72	703.74	264.03	440	6.5
405	6.75	0.28125	19.68	27.89	41.65	49.51	54.68	61.91	73.2	86.5	107.82	80.52	710.83	274.18	437	6.75
420	7	0.291667	19.98	28.28	42.16	50.07	55.28	62.56	73.92	87.28	108.69	81.31	717.82	284.34	433	7
435	7.25	0.302083	20.28	28.65	42.65	50.62	55.87	63.19	74.61	88.04	109.53	82.07	724.52	294.49	430	7.25
450	7.5	0.3125	20.57	29.02	43.14	51.16	56.44	63.8	75.29	88.78	110.36	82.82	731.13	304.64	426	7.5
465	7.75	0.322917	20.85	29.39	43.61	51.69	57	64.41	75.95	89.5	111.16	83.55	737.54	314.80	423	7.75
480	8	0.333333	21.13	29.74	44.07	52.2	57.54	64.99	76.59	90.21	111.94	84.25	743.75	324.95	419	8
495	8.25	0.34375	21.41	30.09	44.52	52.7	58.08	65.57	77.22	90.89	112.71	84.94	749.87	335.11	415	8.25
510	8.5	0.354167	21.68	30.43	44.97	53.2	58.6	66.13	77.84	91.57	113.45	85.62	755.89	345.26	411	8.5
525	8.75	0.364583	21.94	30.77	45.4	53.68	59.11	66.68	78.44	92.22	114.18	86.28	761.72	355.42	406	8.75
540	9	0.375	22.2	31.1	45.83	54.15	59.61	67.21	79.03	92.86	114.89	86.93	767.44	365.57	402	9
555	9.25	0.385417	22.46	31.42	46.24	54.62	60.1	67.74	79.61	93.49	115.59	87.57	773.08	375.73	397	9.25
570	9.5	0.395833	22.71	31.74	46.65	55.07	60.58	68.26	80.17	94.11	116.27	88.19	778.51	385.88	393	9.5
585	9.75	0.40625	22.96	32.05	47.06	55.52	61.06	68.77	80.73	94.71	116.94	88.80	783.95	396.04	388	9.75
600	10	0.416667	23.2	32.36	47.45	55.96	61.52	69.26	81.27	95.31	117.59	89.40	789.20	406.19	383	10
615	10.25	0.427083	23.44	32.66	47.84	56.39	61.98	69.75	81.81	95.89	118.24	89.99	794.44	416.35	378	10.25
630	10.5	0.4375	23.68	32.96	48.23	56.81	62.43	70.23	82.33	96.46	118.87	90.56	799.49	426.50	373	10.5
645	10.75	0.447917	23.91	33.26	48.6	57.23	62.87	70.71	82.85	97.02	119.48	91.14	804.54	436.66	368	10.75
660	11	0.458333	24.15	33.55	48.98	57.64	63.3	71.17	83.35	97.57	120.09	91.69	809.40	446.81	363	11
675	11.25	0.46875	24.37	33.83	49.34	58.04	63.73	71.63	83.85	98.11	120.69	92.24	814.25	456.97	357	11.25

JACOBS		CALCULATION SHEET			
OFFICE	EXETER	PAGE No	1	REVISION	B
JOB No	B2904220	ORIGINATOR	SHL	DATE	26/03/2014
TITLE	SANDFORD SUBSTATION	ARITH CHK	IMB	DATE	26/03/2014
SECTION	ATTENUATION STORAGE CALCULATION	ENG CHK	IMB	DATE	26/03/2014

REF	CALCULATION	OUTPUT

Aim:

To determine the attenuation storage required to address the additional runoff due to the proposed Sandford Substation development (with no climate change allowance).

Reference:

Greenfield runoff calculation Rev A

Preliminary Rainfall Runoff Management for Developments (Revision D)

JACOBS

CALCULATION SHEET

OFFICE	EXETER	PAGE No	2	REVISION	B
JOB No	B2904220	ORIGINATOR	SHL	DATE	26/03/2014
TITLE	SANDFORD SUBSTATION	ARITH CHK	IMB	DATE	26/03/2014
SECTION	ATTENUATION STORAGE CALCULATION	ENG CHK	IMB	DATE	26/03/2014

REF	CALCULATION	OUTPUT

Results:

(a) Attenuation Storage

Description	**Annual chance of flooding each year**	
	1:30	**1:100**
Runoff Rate (l/s)	60.43	66.80
Storage volume (without climate change) (m^3)	257	400

FEH BASE DATA

VERSION FEH CD-R(Version 3 exported at 09:15:59 GMT Thu 04-Apr-13
Parameters
Calculation type= Design rainfall
Calculation mode Typical point in catchment
Calculation locat Catchment GB 341000 160700 ST 41000 60700
Catchment area= 0.53 km**2
Duration= 1 1 (hour)
Fixed duration= no
Return period= 30 1 (years)
Annual maximun yes

c	d1	d2	d3	e	f
-0.02794	0.3891	0.37034	0.26947	0.29331	2.46215

An areal reduction factor of 0.969 has been applied to a point rainfall of 31.7 mm to yield a catchment design rainfall of 30.7 mm.
No warning(s) or note(s) were present for this calculation.
The data in the following table have been computed using sliding durations.

LOCAL ATTENUATION DATA

Qallowable/ha =	3.28	l/s/ha
Catchment Area	3.44	ha
Paved Area=	0.88	ha
Unpaved PR	0%	
Paved PR	100%	
(Overall PR =	25.6%	)
Outflow Rate	11.28	l/s = 0.01128 m^3/s

This sheet calculates the **attenuation storage volume** needed to attenuate the **30 year storm** with the outflow rate given above.

Storage required	257	m^3
	2.8	hours
Peak Flow	60.43	l/s (using Modified Rational Method)

Duration	Duration	Duration	1.1 year rainfal	2.33 year rainfal	10 year rainfall	20 year rainfal	30 year rainfall	50 year rainfal	100 year rainfal	200 year rainfall	500 year rainfall	30yr year rainfall	Inflow volume into storage from rain-fall onto catchment	Outflow Volume given allowable discharge above	Attenuation storage requirement	
minutes	hours	days	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	Inflow Volume (m^3)	Outflow Volume (m^3)	Storage Volume (m^3)	Duration (Hours)
15	0.25	0.010417	4.85	7.86	13.69	17.38	19.95	23.69	29.87	37.63	51.03	19.95	176.12	10.15	166	0.25
30	0.5	0.020833	6.54	10.3	17.37	21.76	24.76	29.11	36.22	45.02	59.98	24.76	218.58	20.31	198	1
45	0.75	0.03125	7.78	12.05	19.94	24.77	28.07	32.81	40.49	49.93	65.84	28.07	247.80	30.46	217	1
60	1	0.041667	8.79	13.46	21.98	27.15	30.66	35.69	43.8	53.71	70.3	30.66	270.67	40.62	230	1
75	1.25	0.052083	9.67	14.67	23.7	29.15	32.82	38.08	46.54	56.82	73.95	32.82	289.73	50.77	239	1.25
90	1.5	0.0625	10.44	15.73	25.21	30.88	34.7	40.16	48.89	59.49	77.06	34.70	306.33	60.93	245	1.5
105	1.75	0.072917	11.15	16.69	26.55	32.42	36.37	41.99	50.98	61.84	79.79	36.37	321.07	71.08	250	1.75
120	2	0.083333	11.79	17.56	27.76	33.81	37.88	43.65	52.85	63.94	82.22	37.88	334.40	81.24	253	2
135	2.25	0.09375	12.4	18.37	28.88	35.09	39.25	45.16	54.55	65.85	84.42	39.25	346.50	91.39	255	2.25
150	2.5	0.104167	12.96	19.12	29.92	36.28	40.53	46.55	56.12	67.61	86.44	40.53	357.80	101.55	256	2.5
165	2.75	0.114583	13.49	19.83	30.89	37.38	41.71	47.85	57.58	69.23	88.3	41.71	368.22	111.70	257	2.75
180	3	0.125	14	20.5	31.8	38.41	42.83	49.06	58.94	70.75	90.03	42.83	378.10	121.86	256	3
195	3.25	0.135417	14.48	21.13	32.66	39.39	43.88	50.21	60.22	72.17	91.66	43.88	387.37	132.01	255	3.25
210	3.5	0.145833	14.93	21.74	33.48	40.32	44.87	51.29	61.42	73.52	93.18	44.87	396.11	142.17	254	3.5
225	3.75	0.15625	15.37	22.31	34.26	41.2	45.81	52.32	62.57	74.79	94.63	45.81	404.41	152.32	252	3.75
240	4	0.166667	15.8	22.87	35	42.04	46.71	53.29	63.66	76	96	46.71	412.36	162.48	250	4
255	4.25	0.177083	16.21	23.4	35.72	42.85	47.58	54.23	64.7	77.15	97.3	47.58	420.04	172.63	247	4.25
270	4.5	0.1875	16.6	23.92	36.4	43.62	48.4	55.13	65.7	78.25	98.55	48.40	427.28	182.79	244	4.5
285	4.75	0.197917	16.98	24.41	37.06	44.36	49.2	55.99	66.65	79.3	99.74	49.20	434.34	192.94	241	4.75
300	5	0.208333	17.35	24.89	37.7	45.08	49.96	56.82	67.57	80.32	100.88	49.96	441.05	203.10	238	5
315	5.25	0.21875	17.71	25.36	38.32	45.77	50.7	57.62	68.46	81.29	101.98	50.70	447.58	213.25	234	5.25
330	5.5	0.229167	18.06	25.81	38.91	46.44	51.42	58.39	69.32	82.23	103.03	51.42	453.94	223.41	231	5.5
345	5.75	0.239583	18.4	26.25	39.49	47.09	52.11	59.14	70.14	83.14	104.05	52.11	460.03	233.56	226	5.75
360	6	0.25	18.73	26.67	40.06	47.72	52.78	59.86	70.94	84.02	105.04	52.78	465.94	243.72	222	6
375	6.25	0.260417	19.05	27.09	40.6	48.33	53.43	60.56	71.72	84.88	105.99	53.43	471.68	253.87	218	6.25
390	6.5	0.270833	19.37	27.49	41.14	48.93	54.06	61.25	72.47	85.7	106.92	54.06	477.24	264.03	213	6.5
405	6.75	0.28125	19.68	27.89	41.65	49.51	54.68	61.91	73.2	86.5	107.82	54.68	482.72	274.18	209	6.75
420	7	0.291667	19.98	28.28	42.16	50.07	55.28	62.56	73.92	87.28	108.69	55.28	488.01	284.34	204	7
435	7.25	0.302083	20.28	28.65	42.65	50.62	55.87	63.19	74.61	88.04	109.53	55.87	493.22	294.49	199	7.25
450	7.5	0.3125	20.57	29.02	43.14	51.16	56.44	63.8	75.29	88.78	110.36	56.44	498.25	304.64	194	7.5
465	7.75	0.322917	20.85	29.39	43.61	51.69	57	64.41	75.95	89.5	111.16	57.00	503.20	314.80	188	7.75
480	8	0.333333	21.13	29.74	44.07	52.2	57.54	64.99	76.59	90.21	111.94	57.54	507.96	324.95	183	8
495	8.25	0.34375	21.41	30.09	44.52	52.7	58.08	65.57	77.22	90.89	112.71	58.08	512.73	335.11	178	8.25
510	8.5	0.354167	21.68	30.43	44.97	53.2	58.6	66.13	77.84	91.57	113.45	58.60	517.32	345.26	172	8.5
525	8.75	0.364583	21.94	30.77	45.4	53.68	59.11	66.68	78.44	92.22	114.18	59.11	521.82	355.42	166	8.75
540	9	0.375	22.2	31.1	45.83	54.15	59.61	67.21	79.03	92.86	114.89	59.61	526.24	365.57	161	9
555	9.25	0.385417	22.46	31.42	46.24	54.62	60.1	67.74	79.61	93.49	115.59	60.10	530.56	375.73	155	9.25
570	9.5	0.395833	22.71	31.74	46.65	55.07	60.58	68.26	80.17	94.11	116.27	60.58	534.80	385.88	149	9.5
585	9.75	0.40625	22.96	32.05	47.06	55.52	61.06	68.77	80.73	94.71	116.94	61.06	539.04	396.04	143	9.75
600	10	0.416667	23.2	32.36	47.45	55.96	61.52	69.26	81.27	95.31	117.59	61.52	543.10	406.19	137	10
615	10.25	0.427083	23.44	32.66	47.84	56.39	61.98	69.75	81.81	95.89	118.24	61.98	547.16	416.35	131	10.25
630	10.5	0.4375	23.68	32.96	48.23	56.81	62.43	70.23	82.33	96.46	118.87	62.43	551.13	426.50	125	10.5
645	10.75	0.447917	23.91	33.26	48.6	57.23	62.87	70.71	82.85	97.02	119.48	62.87	555.02	436.66	118	10.75
660	11	0.458333	24.15	33.55	48.98	57.64	63.3	71.17	83.35	97.57	120.09	63.30	558.81	446.81	112	11
675	11.25	0.46875	24.37	33.83	49.34	58.04	63.73	71.63	83.85	98.11	120.69	63.73	562.61	456.97	106	11.25

FEH BASE DATA

VERSION FEH CD-R(Version 3 exported at 09:15:59 GMT Thu 04-Apr-13
Parameters
Calculation type= Design rainfall
Calculation mod(Typical point in catchment
Calculation locat Catchment GB 341000 160700 ST 41000 60700
Catchment area= 0.53 km**2
Duration= 1 1 (hour)
Fixed duration= no
Return period= 30 1 (years)
Annual maximun yes

c	d1	d2	d3	e	f
-0.02794	0.3891	0.37034	0.26947	0.29331	2.46215

An areal reduction factor of 0.969 has been applied to a point rainfall of 31.7 mm to yield a catchment design rainfall of 30.7 mm.
No warning(s) or note(s) were present for this calculation.
The data in the following table have been computed using sliding durations.

LOCAL ATTENUATION DATA

Qallowable/ha =	3.28	l/s/ha
Catchment Area	3.44	ha
Paved Area=	0.88	ha
Unpaved PR	0%	%
Paved PR	100%	%
(Overall PR =	25.6%	)
Outflow Rate	11.28	l/s = 0.01128 m^3/s

This sheet calculates the **attenuation storage volume** needed to attenuate the **100 year storm** with the outflow rate given above.

Storage required	400	m^3
	3.5	hours
Peak Flow	66.80	l/s (using Modified Rational Method)

Duration minutes	Duration hours	Duration days	1.1 year rainfal mm	2.33 year rainfal mm	10 year rainfall mm	20 year rainfal mm	30 year rainfall mm	50 year rainfal mm	100 year rainfal mm	200 year rainfall mm	500 year rainfall mm	100yr year rainfall mm	Inflow volume into storage from rain-fall onto catchment: Inflow Volume (m^3)	Outflow Volume given allowable discharge above: Outflow Volume (m^3)	Attenuation storage requirement: Storage Volume (m^3)	Duration (Hours)
15	0.25	0.010417	4.85	7.86	13.69	17.38	19.95	23.69	29.87	37.63	51.03	29.87	263.69	10.15	254	0.25
30	0.5	0.020833	6.54	10.3	17.37	21.76	24.76	29.11	36.22	45.02	59.98	36.22	319.75	20.31	299	0.5
45	0.75	0.03125	7.78	12.05	19.94	24.77	28.07	32.81	40.49	49.93	65.84	40.49	357.45	30.46	327	0.75
60	1	0.041667	8.79	13.46	21.98	27.15	30.66	35.69	43.8	53.71	70.3	43.80	386.67	40.62	346	1
75	1.25	0.052083	9.67	14.67	23.7	29.15	32.82	38.08	46.54	56.82	73.95	46.54	410.86	50.77	360	1.25
90	1.5	0.0625	10.44	15.73	25.21	30.88	34.7	40.16	48.89	59.49	77.06	48.89	431.60	60.93	371	1.5
105	1.75	0.072917	11.15	16.69	26.55	32.42	36.37	41.99	50.98	61.84	79.79	50.98	450.05	71.08	379	1.75
120	2	0.083333	11.79	17.56	27.76	33.81	37.88	43.65	52.85	63.94	82.22	52.85	466.56	81.24	385	2
135	2.25	0.09375	12.4	18.37	28.88	35.09	39.25	45.16	54.55	65.85	84.42	54.55	481.57	91.39	390	2.25
150	2.5	0.104167	12.96	19.12	29.92	36.28	40.53	46.55	56.12	67.61	86.44	56.12	495.43	101.55	394	2.5
165	2.75	0.114583	13.49	19.83	30.89	37.38	41.71	47.85	57.58	69.23	88.3	57.58	508.32	111.70	397	2.75
180	3	0.125	14	20.5	31.8	38.41	42.83	49.06	58.94	70.75	90.03	58.94	520.32	121.86	398	3
195	3.25	0.135417	14.48	21.13	32.66	39.39	43.88	50.21	60.22	72.17	91.66	60.22	531.62	132.01	400	3.25
210	3.5	0.145833	14.93	21.74	33.48	40.32	44.87	51.29	61.42	73.52	93.18	61.42	542.22	142.17	400	3.5
225	3.75	0.15625	15.37	22.31	34.26	41.2	45.81	52.32	62.57	74.79	94.63	62.57	552.37	152.32	400	3.75
240	4	0.166667	15.8	22.87	35	42.04	46.71	53.29	63.66	76	96	63.66	561.99	162.48	400	4
255	4.25	0.177083	16.21	23.4	35.72	42.85	47.58	54.23	64.7	77.15	97.3	64.70	571.17	172.63	399	4.25
270	4.5	0.1875	16.6	23.92	36.4	43.62	48.4	55.13	65.7	78.25	98.55	65.70	580.00	182.79	397	4.5
285	4.75	0.197917	16.98	24.41	37.06	44.36	49.2	55.99	66.65	79.3	99.74	66.65	588.39	192.94	395	4.75
300	5	0.208333	17.35	24.89	37.7	45.08	49.96	56.82	67.57	80.32	100.88	67.57	596.51	203.10	393	5
315	5.25	0.21875	17.71	25.36	38.32	45.77	50.7	57.62	68.46	81.29	101.98	68.46	604.36	213.25	391	5.25
330	5.5	0.229167	18.06	25.81	38.91	46.44	51.42	58.39	69.32	82.23	103.03	69.32	611.96	223.41	389	5.5
345	5.75	0.239583	18.4	26.25	39.49	47.09	52.11	59.14	70.14	83.14	104.05	70.14	619.20	233.56	386	5.75
360	6	0.25	18.73	26.67	40.06	47.72	52.78	59.86	70.94	84.02	105.04	70.94	626.26	243.72	383	6
375	6.25	0.260417	19.05	27.09	40.6	48.33	53.43	60.56	71.72	84.88	105.99	71.72	633.14	253.87	379	6.25
390	6.5	0.270833	19.37	27.49	41.14	48.93	54.06	61.25	72.47	85.7	106.92	72.47	639.77	264.03	376	6.5
405	6.75	0.28125	19.68	27.89	41.65	49.51	54.68	61.91	73.2	86.5	107.82	73.20	646.21	274.18	372	6.75
420	7	0.291667	19.98	28.28	42.16	50.07	55.28	62.56	73.92	87.28	108.69	73.92	652.57	284.34	368	7
435	7.25	0.302083	20.28	28.65	42.65	50.62	55.87	63.19	74.61	88.04	109.53	74.61	658.66	294.49	364	7.25
450	7.5	0.3125	20.57	29.02	43.14	51.16	56.44	63.8	75.29	88.78	110.36	75.29	664.66	304.64	360	7.5
465	7.75	0.322917	20.85	29.39	43.61	51.69	57	64.41	75.95	89.5	111.16	75.95	670.49	314.80	356	7.75
480	8	0.333333	21.13	29.74	44.07	52.2	57.54	64.99	76.59	90.21	111.94	76.59	676.14	324.95	351	8
495	8.25	0.34375	21.41	30.09	44.52	52.7	58.08	65.57	77.22	90.89	112.71	77.22	681.70	335.11	347	8.25
510	8.5	0.354167	21.68	30.43	44.97	53.2	58.6	66.13	77.84	91.57	113.45	77.84	687.17	345.26	342	8.5
525	8.75	0.364583	21.94	30.77	45.4	53.68	59.11	66.68	78.44	92.22	114.18	78.44	692.47	355.42	337	8.75
540	9	0.375	22.2	31.1	45.83	54.15	59.61	67.21	79.03	92.86	114.89	79.03	697.68	365.57	332	9
555	9.25	0.385417	22.46	31.42	46.24	54.62	60.1	67.74	79.61	93.49	115.59	79.61	702.80	375.73	327	9.25
570	9.5	0.395833	22.71	31.74	46.65	55.07	60.58	68.26	80.17	94.11	116.27	80.17	707.74	385.88	322	9.5
585	9.75	0.40625	22.96	32.05	47.06	55.52	61.06	68.77	80.73	94.71	116.94	80.73	712.68	396.04	317	9.75
600	10	0.416667	23.2	32.36	47.45	55.96	61.52	69.26	81.27	95.31	117.59	81.27	717.45	406.19	311	10
615	10.25	0.427083	23.44	32.66	47.84	56.39	61.98	69.75	81.81	95.89	118.24	81.81	722.22	416.35	306	10.25
630	10.5	0.4375	23.68	32.96	48.23	56.81	62.43	70.23	82.33	96.46	118.87	82.33	726.81	426.50	300	10.5
645	10.75	0.447917	23.91	33.26	48.6	57.23	62.87	70.71	82.85	97.02	119.48	82.85	731.40	436.66	295	10.75
660	11	0.458333	24.15	33.55	48.98	57.64	63.3	71.17	83.35	97.57	120.09	83.35	735.81	446.81	289	11
675	11.25	0.46875	24.37	33.83	49.34	58.04	63.73	71.63	83.85	98.11	120.69	83.85	740.23	456.97	283	11.25

Appendix E – Environment Agency Correspondence

[redacted]
Jacobs
By email: [redacted]@jacobs.com
By email: [redacted]@jacobs.com

Our ref: NWX/CSC/28238
Your ref:

Date: 18th June 2009

Dear [redacted]

Information request – FRA for Sandford, Churchill 1

Thank you for your enquiry of 04 June 2009. We are happy to provide the following information:

The flood map currently indicates that the site is outside the Extreme Flood Outline.

For planning purposes it is classed as Flood Zone 1.

For your information enclosed is a flood map which indicates the estimated extent of flooding from the river which may occur from an extreme rainfall event.

Zone 1 - is shaded white and shows areas with the lowest probability of flooding from rivers and the sea, where the chance of flooding in any one year is less than 0.1% (i.e. a 1000 to 1 chance).

Zone 2 - is shaded turquoise and shows the area between zone 1 and zone 3. This represents an area with the chance of flooding in any one year between 0.1% and 1% fluvial or 0.5% tidal (i.e. between a 1000 to 1 and a 100 to 1 fluvial or 200 to 1 tidal chance). The outer edge of this zone is referred to as the 'Extreme Flood Outline' (EFO).

Zone 3 - is shaded blue and shows areas with the highest probability of flooding. The chance of flooding in any one year is greater than or equal to 1% (i.e. a 100 to 1 chance) for river flooding and greater or equal to 0.5% (i.e. a 200 to 1 chance) for coastal and tidal flooding.

The flood map does not take into account existing defences, nor the effects of climate change, but is used as a planning reference tool when considering new development in areas of flood risk.

Unfortunately on this occasion we do not have any modelled or historic flood levels to assist with your flood risk assessment. However we would refer you to the web link below for standing advice on Flood Risk Assessments (FRA).

http://www.environment-agency.gov.uk/research/planning/82587.aspx.

If that does not resolve your query then we advise that you contact our Development Control Team on 01278 484683 to discuss how you should progress your FRA.

Cont'd…

The Environment Agency
Rivers House, East Quay, Bridgwater, Somerset TA6 4YS
Tel: 08708 506506 Fax: 01278 452985 DX 135476 Bridgwater 3
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Although our records do not show any specific flood incidents at this property, we advise that you also contact the Drainage Engineer Mr John Inman of North Somerset Council, Development and Environment, Streets and Open Spaces, Weston Court, Oldmixon Crescent, Weston-Super-Mare, BS24 9AU, (01934 427307) as he may be able to provide further advice with respect to localised flooding and drainage issues.

There are no flood defences within 1 km of NGR ST 414 605 however flood zone 3 (100 yr flood outline) shows tidal flooding 120m to the Northwest & fluvial flooding 480m to the Southwest.

Flood zone 2 (1000 yr flood outline) also shows tidal flooding 120m to the Northwest & fluvial flooding 340m to the North.

We have no information regarding groundwater flood risk at this site.

We hope you find this information helpful and it is provided subject to the notice overleaf, which we strongly recommend you read.

Yours sincerely

[redacted]

External Relations Officer

Enc: Standard Notice, Commercial
Flood Map

The Environment Agency
Rivers House, East Quay, Bridgwater, Somerset TA6 4YS
Tel: 08708 506506 Fax: 01278 452985 DX 135476 Bridgwater 3
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Standard Notice – Commercial

Information warning

We, the Environment Agency, do not promise that the information supplied to you will always be accurate, complete or up to date or that the information will provide any particular facilities or functions or be suitable for any particular purpose. You, the recipient of the information must ensure that the information meet your needs and are entirely responsible for the consequences of using the Information.

If an electronic format has been used, we do not promise that the media on which the information is provided will always be free from defects, computer viruses, worms, Trojan horses, software locks or other similar code of a destructive or unwelcome nature. You should carry out all necessary checks prior to loading the information on to your computer system. Please also note any specific information warning supplied to you.

Permitted use

The information is protected by intellectual property rights and whilst you have certain statutory rights which include the right to read the information, you are granted no additional use rights whatsoever except that you may optionally agree to the limited use Licence set out below (but not for Third Party Information). To activate this Licence you do not need to contact us but if you make any use (such as copying) in excess of your statutory rights you are deemed to accept the terms below. If you need even more rights than simple copying (such as supplying to others or making adaptations) please contact us.

Licence for taking as-is internal copies of the Information

1. Definitions

"Contractor Use" means passing of Information to a person (Contractor) who is contracted on commercial terms to provide services, and:

- use is limited to the purposes of that contract, and
- all terms of this licence are applied, and
- the Contractor does not pass the Information to any person other than the person contracting with them or a subcontractor who complies with these conditions

"Fixed Format" means Information that is formatted in such a way as to be static and unalterable (or not easily alterable without the loading of special software). It will typically include hard copy, pdf format, image format (such as jpeg, gif, tiff and bmp) and video format (such as mpeg, avi and wmv)

"Information" means the information supplied to you excluding anything that we have identified as Third Party Information

"Professional Use" means supply, by you if you are a professional adviser/consultant directly licensed by us under these terms, of full and un-amended copies of the Information to a client and any other person who reasonably needs the Information in relation to that client matter in respect of which you obtained the Information provided that a copy of this Standard Notice - Commercial is sent with the Information so supplied and you tell the recipient they must comply with its terms

"Regulatory Use" means inclusion of a Fixed Format unaltered extract of Information in any documentation that you are required to supply to a court, tribunal or regulatory body (but not including a trade association) where the inclusion of such extract is reasonably necessary in connection with a hearing, application or other judicial or regulatory process

2. Licence and Use of Information

In consideration of the payment of our standard supply charges including the optional internal as-is use licence fee (currently £10) we hereby grant to you a non-transferable, non-exclusive, perpetual licence subject to the terms of this agreement to make internal as-is use of the Information, including Contractor Use, Professional Use and Regulatory Use which are deemed to be internal. This licence is given to you personally and not to anyone else

3. Your Obligations

3.1 You must not make any use of Information that is not permitted

3.2 All copies you make must be attributed to us

3.3 Any intended use of Information must not represent a risk of:

- being misleading to anyone you are allowed to pass the Information to,
- detriment to the Agency's ability to achieve its objectives, or
- detriment to the environment, including the risk of reduced future enhancement, or
- being prejudicial to the effective management of information held by the Agency, or
- damage to the Agency's reputation

4. Limitation of Liability

We will under no circumstance be liable for indirect, special, or consequential damages including any loss of business, revenue, profits, goodwill, reputation, anticipated savings or data in relation to your use of the information supplied to you. Nothing within this Agreement will operate to exclude any liability for death or personal injury arising as result of the negligence of the Environment Agency, or any of their employees or agents. Any implied promise or warranty is excluded as far as the law allows. Our maximum aggregate liability in connection with this agreement shall not exceed the total sum of one thousand pounds

5. Intellectual Property Rights

No Intellectual Property Rights are transferred or licensed to you save those which are expressly provided in this agreement

6. Assignment

You may not transfer or in any other way make over to any third party the benefit of this agreement either in whole or in part

7. Waiver

Failure by either of us to exercise or enforce any rights available to it, or any forbearance, delay or grant of indulgence, will not be construed as a waiver of rights under this agreement or otherwise

8. Entire agreement

This agreement constitutes the entire agreement between us and supersedes all oral or written agreements, representations, understandings or arrangements (whether previous, contemporaneous or future) relating to its subject matter. You agree to waive any right to rescind this agreement by virtue of any misrepresentation and not to claim damages for any misrepresentation that is not fraudulent

9. Severance

If any part of the agreement is found by a court of competent jurisdiction or other competent authority to be unenforceable, then that part will be severed from the remainder of the agreement which will continue to be valid and enforceable to the fullest extent permitted by law

10. Variation and Termination

This agreement may not be amended, modified, varied or supplemented but it may if both of us agree be terminated or replaced by a new agreement

11. Relationship of Parties

We are not in a partnership or joint venture, nor is either of us the agent of the other or authorised to act on behalf of the other

12. Rights Of Third Parties

No third parties shall have rights to enforce any part of this agreement under the Contracts (Rights of Third Parties) Act 1999

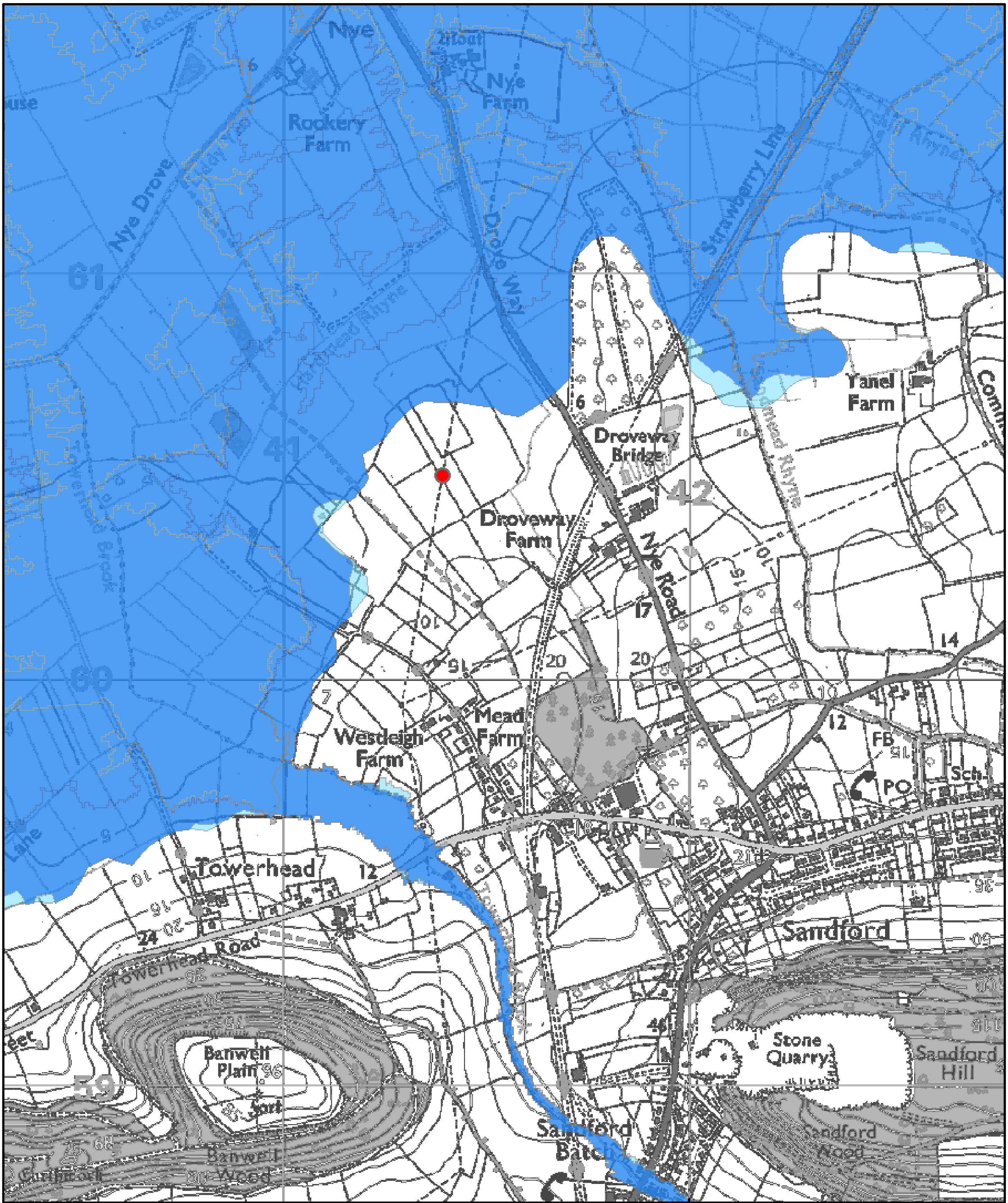
13. Governing Law

This agreement shall be governed and construed in accordance with English law

The Environment Agency
Rivers House, East Quay, Bridgwater, Somerset TA6 4YS
Tel: 08708 506506 Fax: 01278 452985 DX 135476 Bridgwater 3
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

CSC\28238 Sandford, Chuchill 1

ENVIRONMENT AGENCY



Legend

Main River

Flood Zone 3

Flood Zone 2

Approx NGR ST4154360186

0 90 180 360 Meters

Date: 17 June 2009 RR

[redacted]

To: [redacted]
Subject: RE: Churchill Flood Data Request [CSC/4841/BW]

From: SW Wessex North, External Relations [mailto:custswnw@environment-agency.gov.uk]
Sent: 02 July 2012 16:02
To: [redacted]
Subject: RE: Churchill Flood Data Request [CSC/4841/BW]

Dear [redacted]

Thank you for your email dated 27 June.

We don't have any levels for the Sandford site. We do for the Brinsea site, but the data has not changed since your last request in 2009.

If you have any further queries please do not hesitate to contact me.

Kind regards

[redacted]
Communications Officer

Environment Agency
Rivers House
Bridgwater
TA6 4YS

[redacted]@environment-agency.gov.uk
Direct Dial: [redacted]

From: [redacted] [mailto:[redacted]@jacobs.com]
Sent: 27 June 2012 15:09
To: SW Wessex North, External Relations
Cc: [redacted]
Subject: Churchill Flood Data Request [CSC/4841/BW]

B2904220/T3P

Hello,

We are updating a Flood Risk Assessment (FRA) for two sites around the village of Churchill in Somerset.

The grid references for the two sites are:

ST 41490 60281 (Sandford)
ST 45083 62225 (Brinsea)

Can you please provide the following information for these locations, if available:

- Flood history with known flood levels;
- Known flood risks e.g. fluvial, tidal, surface water or groundwater - flood maps etc;
- Any information on existing hydraulic models (Environment Agency or other);
- Any predicted flood levels or still water levels;
- Whether the area is in a critical drainage area or groundwater emergency zone and;
- If any defences exist,
- Type and standard of existing flood defences (e.g. 1% annual probability);
- Breach level of existing flood defences where applicable;
- Condition of existing flood defences (e.g. fair condition).

Please note that we had requested data for this area when creating the orginal reports in June 2009 and received a number of flood information. Our reference for this request was CSC/28239 and CSC/28238 if this is of use.

Thanks in advance,

[redacted] | JACOBS | Graduate Engineer | Energy | [redacted] | [redacted]@jacobs.com

Appendix F – NPS Requirements and Compliance

EN-1 - Overarching Energy

EN-1 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
Criteria for 'good design' for energy infrastructure	4.5.3	The IPC needs to be satisfied that energy infrastructure developments are sustainable and, having regard to regulatory and other constraints, are as attractive, durable and adaptable (including taking account of natural hazards such as flooding) as they can be.	All flooding hazards are considered, with specific comment included on being adaptable (related to building in adaptive capacity) in the event of (1) climate change being different from what may currently be anticipated; (2) current flood risk management plans and strategies changing over the lifetime of the development; (3) the need for continued operation at various sites beyond the currently planned 40 year operational life.
Climate Change Adaptation	4.8.5	New energy infrastructure will typically be a long-term investment and will need to remain operational over many decades, in the face of a changing climate. Consequently, applicants must consider the impacts of climate change when planning the location, design, build, operation and, where appropriate, decommissioning of new energy infrastructure. The ES should set out how the proposal will take account of the projected impacts of climate change. While not required by the EIA Directive, this information will be needed by the IPC.	The FRAs take account of projected climate change with regard to rising sea levels, increases in river flows, and increased rainfall intensity. The impacts are addressed through designing for the future at present, as well as building in adaptive capacity for any futher future adaptations in line with the precautionary principle so as to NOT affect the ability to make future adaptations.
	4.8.6	The IPC should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections available at the time the ES was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure.	UKCP09 projections have been used for sea level rise and rainfall intensity. For fluvial flows, climate change scenarios from various exisiting models (including SFRA level 2 assessments) have been used.
	4.8.7	Applicants should apply as a minimum, the emissions scenario that the Independent Committee on Climate Change suggests the world is currently most closely following – and the 10%, 50% and 90% estimate ranges. These results should be considered alongside relevant research which is based on the climate change projections.	The High emissions scenario at 95th percentile has been used for sea level rise. For rainfall intensity the 50th percentile has been used, plus the 95th percentile as sensitivity.
	4.8.8	The IPC should be satisfied that there are not features of the design of new energy infrastructure critical to its operation which may be seriously affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections, taking account of the latest credible scientific evidence on, for example, sea level rise (for example by referring to additional maximum credible scenarios – i.e. from the Intergovernmental Panel on Climate Change or EA) and that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime.	At the end of the operational life of 40 years (around 2060) each site would be reviewed to see whether continued operation (and associated asset replacement) is required. In the event that the sites are still required, resilience and adaptive measures would be built in accordingly. Adaptive measures in the future will be driven by a combination of actual climate change and future flood and coastal risk management strategies and policies for the area. However, taking the H++ scenario gives levels 325mm higher than the UKCP09 High emissions, 95th percentile value by 2060. Three sites (Sandford, Bridgwater Tee and South of Mendips) are either resilient to this level or could be adpated in future through planned asset replacement. The fourth site (Seabank) has estimated levels conservatively up to 2073, with an additional 400mm freeboard for uncertainties. This covers the H++ scenario at present. For the Route FRA, the works are resilient to flooding even under the H++ scenario. Due consideration has therefore been given to the H++ scenario, and it is demonstrated that the Proposed Development is resilient to this scenario.
	4.8.9	Where energy infrastructure has safety critical elements (for example parts of new fossil fuel power stations or some electricity sub-stations), the applicant should apply the high emissions scenario (high impact, low likelihood) to those elements.	High emissions scenario has been applied. For sensitivity, H++ scenario has also been tested.

EN-1 - Overarching Energy

EN-1 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
	4.8.10	If any adaptation measures give rise to consequential impacts (for example on flooding, water resources or coastal change) the IPC should consider the impact of the latter in relation to the application as a whole and the impacts guidance set out in Part 5 of this NPS.	For all of the FRAs, none of the adaptation measures proposed give rise to consequential impacts elsewhere.
	4.8.11	Any adaptation measures should be based on the latest set of UK Climate Projections, the Government's latest UK Climate Change Risk Assessment, when available and in consultation with the EA.	The latest set of UK Climate projections have been used, as agreed in discussion with the EA. Adaptation measures and the adaptive management approach proposed are consistent with approaches outlined in the UK CCRA.
	4.8.12	Adaptation measures can be required to be implemented at the time of construction where necessary and appropriate to do so. However, where they are necessary to deal with the impact of climate change, and that measure would have an adverse effect on other aspects of the project and/or surrounding environment (for example coastal processes), the IPC may consider requiring the applicant to ensure that the adaptation measure could be implemented should the need arise, rather than at the outset of the development (for example increasing height of existing, or requiring new, sea walls).	All adaptation measures proposed are to be implemented at the time of construction to take account of climate change over the proposed lifetime of the development (40 years). In the event that the sites continue to be used beyond 40 years, further adaptive measures could be implemented. There are no adverse impacts of these measures on other apects of the project.
Flood Risk	5.7.4	Applications for energy projects of 1 hectare or greater in Flood Zone 1 in England or Zone A in Wales113 and all proposals for energy projects located in Flood Zones 2 and 3 in England or Zones B and C in Wales should be accompanied by a flood risk assessment (FRA).	FRAs have been completed for the following: (1) Bridgwater Tee CSE compound; (2) South of Mendip Hills CSE Compounds; (3) Sandford Substation; (4) Seabank Substation; (5) Hinkley C Connection Route FRA.
	5.7.5	The minimum requirements for FRAs are that they should:	See below:
	5.7.5	be proportionate to the risk and appropriate to the scale, nature and location of the project.	Each FRA is proportional to the risk with all sources of flooding addressed. The Route FRA has a specific detailed focus on flood risk during construction as this is different from flood risk during operation due to the presence of haul raods and other temporary works.
	5.7.5	consider the risk of flooding arising from the project in addition to the risk of flooding to the project	Each FRA consideres the risk <u>to</u> the development and the risk elsewhere resulting <u>from</u> the development.
	5.7.5	take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made	Climate change impacts have been considered for sea level rise, increase in fluvial flows, and increase in rainfall intensity. The baseline assessment is for 40 years (the proposed operational life of the works) but with consideration to operation at the sites for an additional 20 years.
	5.7.5	be undertaken by competent people, as early as possible in the process of preparing the proposal	The FRAs have been undertaken by a competent framework supplier, with flood risk issues integrated into the process.
	5.7.5	consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure	These factors are considered within the context of each FRA.
	5.7.5	consider the vulnerability of those using the site, including arrangements for safe access	Users have been considered, and safe access to and agress from the sites is considered as part of each FRA.
	5.7.5	consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made	All sources of flooding have been considered - fluvial, tidal, pluvial (surface water), groundwater, sewers and water mains, reservoirs, canals and other artificial sources. Flood risk reduction (management) measures are considered for all FRAs to address all flood risks.
	5.7.5	consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes	Events considered range in severity from the 1 in 10 (10%) to 1 in 1000 (0.1%) annual probability event.

EN-1 - Overarching Energy

EN-1 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
	5.7.5	include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project	Residual risk is addressed within the context of the flood risk management measures proposed.
	5.7.5	consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems	Infiltration has been considered, and linked to design with permeable surfaces, and use of SuDS as part of the overall design. SuDS to be developed where applicable to maintain "greenfield" runoff rates as required.
	5.7.5	consider if there is a need to be safe and remain operational during a worst case flood event over the development's lifetime	All sites can remain operational during a major flood event. There is not a need for people to be located at the sites, and therefore, no need for access during a flood. This is demonstrated within each FRA for the specific conditions / requirements for each site.
	5.7.5	be supported by appropriate data and information, including historical information on previous events	A wide range of data sources is referred to, and data from the EA and Local Authority flood model outputs are used as part of the basis for design, in line with best practice. Flood history is researched for all sites and referenced where relevant. Specific reference is made to the January / February 2014 flood event on the Somerset Levels for those FRAs where this is relevant.
	5.7.6	Further guidance can be found in the Practice Guide which accompanies Planning Policy Statement 25 (PPS25), TAN15 for Wales or successor documents.	PPS 25 is no longer applicable. The current guidance for flood risk assessments is given in the Planning Practice Guidance (PPG) published on 6th March 2014 on Flood Risk and Coastal Change. Elements of the National Planning Policy Framework (NPPF) are also relevant, but the Technical Guidance which originally accompanied the NPPF is no longer valid. The suite of FRAs for the Proposed Development follow the guidance in the NPPF and PPG, as required within the NPS.
	5.7.7	Applicants for projects which may be affected by, or may add to, flood risk should arrange pre-application discussions with the EA, and, where relevant, other bodies such as Internal Drainage Boards, sewerage undertakers, navigation authorities, highways authorities and reservoir owners and operators. Such discussions should identify the likelihood and possible extent and nature of the flood risk, help scope the FRA, and identify the information that will be required by the IPC to reach a decision on the application when it is submitted.	Pre-application flood risk discussions have been held, and correspondence exchanged with EA, IDBs, and Local Authorities with specific regard to flood risk. Information from stakeholders has been used, and specific queries raised by stakeholders as part of the pre-application process have been addressed.
	5.7.8	If the EA has concerns about the proposal on flood risk grounds, the applicant should discuss these concerns with the EA and take all reasonable steps to agree ways in which the proposal might be amended, or additional information provided, which would satisfy the Environment Agency's concerns.	Various discussions and meetings have been held with the EA, plus an exchange of correspondence to identify specific concerns that the EA has, followed up with further discussions. The issues identified from these communications have been addressed.
	5.7.9	The IPC should be satisfied that where relevant:	See below:
	5.7.9	the application is supported by an appropriate FRA;	A series of five FRAs have been prepared in support of the DCO application.
	5.7.9	the Sequential Test has been applied as part of site selection	The Sequential Test has been applied to the route as a whole, and then to each site specific FRA within the context of the preferred route. The Sequential test Report is included as an Appendix to the Hinkley C Connection Route FRA.
	5.7.9	a sequential approach has been applied at the site level to minimise risk by directing the most vulnerable uses to areas of lowest flood risk	The sequential approach has been applied at a site level for each of the four site specific FRAs.
	5.7.9	the proposal is in line with any relevant national and local flood risk management strategy	All FRAs take account of national and local flood risk management strategies and plans. However, the continued operation of these plans and strategies has NOT been assumed, as it is recognised that these policies and plans could change over the lifetime of the Proposed Development.

EN-1 - Overarching Energy

EN-1 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
	5.7.9	priority has been given to the use of sustainable drainage systems (SuDs)	SuDS are proposed for those locations where the post-development runoff rate would otherwsie be increased above the greenfield runoff rate due to the Proposed Development.
	5.7.9	in flood risk areas the project is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed over the lifetime of the development.	Flood resilience and resistance measures are proposed as necessary at each site, including safe access and egress to and from the sites for maintenance, and escape from the sites in case of emergency. For the Route FRA this includes consideration of evacuation during the construction phase.
	5.7.10	For construction work which has drainage implications, approval for the project's drainage system will form part of the development consent issued by the IPC. The IPC will therefore need to be satisfied that the proposed drainage system complies with any National Standards published by Ministers under Paragraph 5(1) of Schedule 3 to the Flood and Water Management Act 2010. In addition, the development consent order, or any associated planning obligations, will need to make provision for the adoption and maintenance of any SuDS, including any necessary access rights to property. The IPC should be satisfied that the most appropriate body is being given the responsibility for maintaining any SuDS, taking into account the nature and security of the infrastructure on the proposed site. The responsible body could include, for example, the applicant, the landowner, the relevant local authority, or another body, such as an Internal Drainage Board.	There are no "final" National Standards yet published under this section of the Flood and Water Management Act. However, the proposed surface water drainage arrangements comply with the draft final guidance, published in January 2014. Any SuDS proposed would be maintained by National Grid. Active (intermittent) maintenance of SuDS would only be required at Sandford (attenuation pond) and at Seabank (on site drainage system).
	5.7.12	The IPC should not consent development in Flood Zone 2 in England or Zone B in Wales unless it is satisfied that the sequential test requirements have been met. It should not consent development in Flood Zone 3 or Zone C unless it is satisfied that the Sequential and Exception Test requirements have been met.	The requirements of the Sequential Test and the Exception Test are set out in each FRA. For each FRA, it is also demonstrated that the requirements of both tests (where appropriate) are met. All of the FRAs with the exception of Sandford require development in Flood Zone 3.
	5.7.13	Preference should be given to locating projects in Flood Zone 1 in England or Zone A in Wales. If there is no reasonably available site in Flood Zone 1 or Zone A, then projects can be located in Flood Zone 2 or Zone B. If there is no reasonably available site in Flood Zones 1 or 2 or Zones A & B, then nationally significant energy infrastructure projects can be located in Flood Zone 3 or Zone C subject to the Exception Test.	For all sites except Sandford, part of the works for the Proposed Development are required in Flood Zone 3. The Exception Test is required for these developments and this is set out within each FRA (except Sandford for which it is not needed).
	5.7.16	All three elements of the test will have to be passed for development to be consented. For the Exception Test to be passed:	See below:
	5.7.16	(1) it must be demonstrated that the project provides wider sustainability benefits to the community that outweigh flood risk	Confirmed for all FRAs on the basis of the need for the Proposed Developnment addressed elsewhere within the Environmental Statement.
	5.7.16	(2) the project should be on developable, previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs	This requirement set out in the NPS refers to Planning Policy Statement 25 on Development and Flood Risk. PPS25 is now superseded, and the requirement is not identified in subsequent national planning policy, including both the NPPF (2012), and the recently published (March 6th 2014) Planning Practice Guidance. However, it is confirmed that there are no other previously developed sites that could be used, that have not been used. At Seabank, the proposal is to make use of the existing site for the substation amendments and extension i.e. making use of a previously developed site.
	5.7.16	(3) A FRA must demonstrate that the project will be safe, without increasing flood risk elsewhere subject to the exception below and, where possible, will reduce flood risk overall	All of the FRAs demonstrate that there is no quantifiable increase in flood risk elsewhere during operation. The Route FRA indicates that during construction there is a very minor increase in flood risk, although this is temporary (5 years). Mitigation measures are proposed to minimise this impact during the construction phase.

EN-1 - Overarching Energy

EN-1 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
	5.7.18 / 5.7.19	To satisfactorily manage flood risk, arrangements are required to manage surface water and the impact of the natural water cycle on people and property. In this NPS, the term Sustainable Drainage Systems (SuDS) refers to the whole range of sustainable approaches to surface water drainage management including, where appropriate: ● source control measures including rainwater recycling and drainage; ● infiltration devices to allow water to soak into the ground, that can include individual soakaways and communal facilities; ● filter strips and swales, which are vegetated features that hold and drain water downhill mimicking natural drainage patterns; ● filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground and provide storage if needed; ● basins ponds and tanks to hold excess water after rain and allow controlled discharge that avoids flooding; and ● flood routes to carry and direct excess water through developments to minimise the impact of severe rainfall flooding.	Surface water management is included within all FRAs, covering both the impact on the development and the impact resulting from the development. This follows SuDS principles and meets the requirements of the draft national Standards on drainage arrangements as prespared under the Flood and Water Management Act 2010. Within different FRAs, various of the measures outlined within the NPS are included as part of the SuDS approach.
	5.7.20	Site layout and surface water drainage systems should cope with events that exceed the design capacity of the system, so that excess water can be safely stored on or conveyed from the site without adverse impacts.	All sites can appropriately deal with over design flood events without additional adverse impact.
	5.7.21	The surface water drainage arrangements for any project should be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect.	For all sites, greenfield runoff rates would be maintained from the pre-development condition.
	5.7.22	It may be necessary to provide surface water storage and infiltration to limit and reduce both the peak rate of discharge from the site and the total volume discharged from the site. There may be circumstances where it is appropriate for infiltration facilities or attenuation storage to be provided outside the project site, if necessary through the use of a planning obligation.	Within various FRAs, surface water storage and/or infiltration is proposed. All of these measures proposed are within the project site boundaries.
	5.7.23	The sequential approach should be applied to the layout and design of the project. More vulnerable uses should be located on parts of the site at lower probability and residual risk of flooding. Applicants should seek opportunities to use open space for multiple purposes such as amenity, wildlife habitat and flood storage uses. Opportunities should be taken to lower flood risk by reducing the built footprint of previously developed sites and using SuDS.	The sequential approach has been considered at a site level, although it should be noted that because all of the sites within Flood Zone 3 are very flat, there is no quanitifiable difference in flood risk across the sites. Opportunities have been taken for flood storage and habitat enhancement at Sandford. At those sites (including parts of the Route FRA, e.g. site compounds) where flood risk could potentially be adversely affected, SuDS are proposed. At previously developed sites (only applies to Seabank) the built "impermeable" footprint is reduced to balance the new impermeable areas to be added.

EN-1 - Overarching Energy

EN-1 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
	5.7.24	Essential energy infrastructure which has to be located in flood risk areas should be designed to remain operational when floods occur. In addition, any energy projects proposed in Flood Zone 3b the Functional Floodplain (where water has to flow or be stored in times of flood), or Zone C2 in Wales, should only be permitted if the development will not result in a net loss of floodplain storage, and will not impede water flows.	All of the infrastructure for which the FRAs have been developed is classified as "Essential Infrastructure". It has all been designed to remain operational during a flood. This includes allowing flooding across the CSE compound sites without affecting operation as the water sensitive equipment would all be elevated above the appropriate extreme design flood level. For those aspects of the Proposed Development located in Flood Zone 3b (primarily linked to aspects of the route FRA such as pylons and underground cables) there is no net loss of flood plain storage, nor any impedance to flood flows following completion of construction. During construction for the route FRA, there is a very small loss of storage, but this is temporary, and negligible compared to the total flood plain storage volume. Mitigation measures are proposed that signficantly limit any potential impacts.
	5.7.25	The receipt of and response to warnings of floods is an essential element in the management of the residual risk of flooding. Flood Warning and evacuation plans should be in place for those areas at an identified risk of flooding. The applicant should take advice from the emergency services when producing an evacuation plan for a manned energy project as part of the FRA. Any emergency planning documents, flood warning and evacuation procedures that are required should be identified in the FRA.	For all sites that are located within flood warning areas, the FRAs recommend that the sites would be signed up to the Environment Agency Flood Warnings Direct service. There are no (generally) manned sites for the Proposed Development. Evacuation plans are recommended within the FRAs, to be developed prior to the start of operations at the various sites. For the route FRA, where construction is required across extensive lengths of flood plain, an evacuation plan is recommended, linked to the provision of flood warnings for the areas located within the flood plain. All FRAs outline evacuation routes, flood warning requirements, and the need for evacuation plans to be developed.

NPS Requirements and Compliance

EN-5 - Electricity Networks Infrastructure

EN-5 Section	Para no.	Requirement as stated in the NPS	Compliance and Comment Related to the FRAs
Climate Change Adaptation	2.4.1	Applicants should set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it would be resilient to: flooding, particularly for substations that are vital for the electricity transmission and distribution network; effects of wind and storms on overhead lines; higher average temperatures leading to increased transmission losses; and earth movement or subsidence caused by flooding or drought (for underground cables).	Resilience of the Proposed Development to flooding is discussed in the following FRAs: (1) Bridgwater Tee CSE Compounds; (2) South of Mendips CSE compound; (3) Sandford Substation; (4) Seabank Substation amendments and extension; (5) Hinkley C Connection Route FRA. Resilience of the Proposed Development to other potential effects of Climate Change are discussed in the Planning Statement.
	2.4.2	Section 4.8 of EN-1 advises that the resilience of the project to climate change should be assessed in the Environmental Statement (ES) accompanying an application. For example, future increased risk of flooding would be covered in any flood risk assessment (see Section 5.7 in EN-1).	The ES takes Climate Change into account in each of the topic assessments.