AMBER PLANNING
Flood Risk & Hydrology

Flood Risk Assessment
March 2023

Energy Reserve Facility
Land at Severn Road
Avonmouth
BS10 7SE
Version 5

FORSA ENERGY

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Site Area	1.76ha (wider site); 0.60ha current application area.
Existing / Historic Use	Greenfield
Proposed Use	Installation of a 50MW Gas Powered Energy Reserve Facility to provide back-up power for the National Grid.
Flood Zone	**Indicative:** Defended Flood Zone 3a (High Risk) **Assessed Fluvial Flood Risk:** Defended Flood Zone 3a (High Risk) Mitigation and management measures are outlined to reduce residual flood hazards to an acceptable level throughout the development lifetime.
Groundwater Flooding	Low. GW indicated to be absent.
Reservoir Failure	Low
Overland Flow - Flooding	Low
Sewer Flooding	Low
Change to Site Surface Finishings (Y/N)	Yes. An uplift in the runoff coefficient is anticipated to arise from proposals. Full surface water management is proposed in line with best practice for new development.
Infiltration Potential?	Potentially. Site is underlain by a mixture of clay and permeable underlying soils.
Attenuation Storage Proposed	555m^3 (Attenuation pond)
Potential Receptor for Surface Water Discharges	▪ Infiltration ▪ Local watercourses (rhines)
Climate Change Allowance	25% based a 50-year lifetime (*non-residential*).

1.0 INTRODUCTION

1.1 Background

1.1.1 Amber Planning Ltd was originally commissioned in September 2017 and again in October 2019 to prepare a Flood Risk Assessment (FRA) in support of two separate planning applications for the installation of a 40MW Energy Reserve Facility and Battery Plant, respectively, to provide back-up generation for the National Grid. The Flood Risk Assessment produced in support of the above application has been revised to account for differing layouts as follows:

- Version 1 – Sept. 2017: Application for 40MW Energy Reserve Facility.
- Version 2 – Oct. 2017: Application for 40MW Energy Reserve Facility (amended layout) + Battery Plant.
- Version 3 – Sept. 2018: Application for 40MW Energy Reserve Facility + Battery Plant (amended layout).
- Version 4 – October 2019: Application for 40MW Energy Reserve Facility and Battery Plant (Revised Battery Plant Layout).

1.1.2 This document represents Version 5 and considers a fresh application for a 50MW Gas Powered Energy Reserve Facility, prepared on behalf of Forsa Energy Gas Holdings Ltd. with this subject to a revised layout.

1.1.3 The subject site comprises a 0.6ha plot of land within a 1.75ha wider site, situated on land to the north east of Severn Road, Hallen Industrial Estate, Avonmouth, Bristol, BS10 7SE. The Hallen Industrial Estate area falls within the administrative remit of South Gloucestershire Council, although is located on the border of Bristol City Council's administrative area.

1.1.4 Reference to Environment Agency (EA) online Flood Maps indicates the study area to be located entirely within defended Flood Zone 3a (High Risk), Figure 001. The property is indicated to be unaffected by surface water or reservoir flooding and to be external to Groundwater Source Protection Zones.

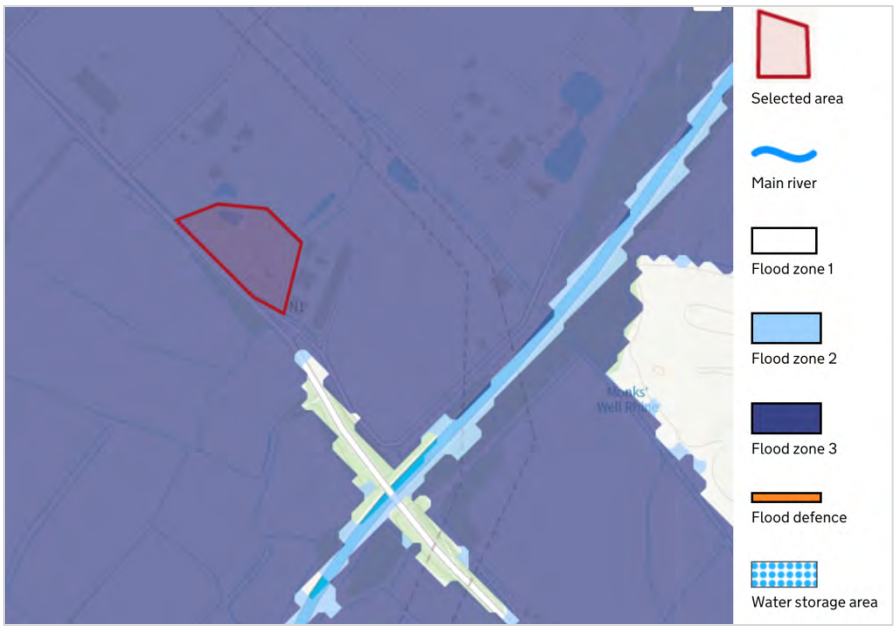

Figure 001: Environment Agency Flood Map

1.1.5 This Flood Risk Assessment has been prepared in accordance with the National Planning Policy Framework (NPPF) and its Planning Practice Guidance (PPG). The requirements of the Environment Agency, Lower Severn IDB (LSIDB), South Gloucestershire Council and Bristol City Council have also been accounted for within this study.

1.2 Objectives

1.2.1 The objectives of the Flood Risk Assessment are to:

- Review national and local planning policy documents and identify any issues they raise, and which need to be addressed in relation to flooding and hydrology;
- Review readily available information on flooding using data provided by the EA and, where available, the Strategic Flood Risk Assessment (SFRA);
- Evaluate the background hydrology;
- Assess the risks from all sources of flooding, including tidal and fluvial;
- Consider the impacts of the development on predeveloped rates and volumes of surface water runoff;
- Recommend the mitigation and / or management measures required to prevent detrimental impacts to surface water flooding or hydrology at the site or within downstream receptors;
- Identify opportunities for the incorporation of Sustainable Drainage Systems (SuDS); and
- Provide recommendations for the design and delivery of surface water management. This includes the design of a drainage scheme which accounts for the requirements of the Environment Agency and the Lead Local Flood Authority.

1.2.2 Local development framework documents, including strategic policy and technical studies, have been reviewed as part of this study.

1.3 Confidentiality

1.3.1 Amber Planning has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from Amber Planning; a charge may be levied against such approval.

2.0 SOURCES OF INFORMATION

2.1 General

2.1.1 In preparing this assessment background information has been obtained from the following sources:

- Communities and Local Government (July 2021). National Planning Policy Framework[1];
- Communities and Local Government (*Living Document*). Planning Practice Guidance[2];
- UK Government Guidance (May 2022). Flood Risk Assessments: Climate Change Allowances[3];
- CIRIA (2015). C753: The SUDS Manual V6;
- South Gloucestershire Council Website, Planning Policy Page[4];
- Bristol City Council website, Planning Policy page[5];
- Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project, web page[6];
- South Gloucestershire Council (2013). Core Strategy 2006-2027;
- South Gloucestershire Council (2021). Level 1 Strategic Flood Risk Assessment;
- South Gloucestershire (2011). Level 2 Strategic Flood Risk Assessment;
- Bristol City Council (2020). Citywide Level 1 Strategic Flood Risk Assessment;
- Bristol City Council, South Gloucestershire Council, Lower Severn Drainage Board (2011). Level 2 Strategic Flood Risk Assessment Avonmouth/ Severnside: Summary Report;
- Bristol City Council, South Gloucestershire Council, Lower Severn Drainage Board (2011). Level 2 Strategic Flood Risk Assessment Avonmouth/ Severnside: Technical Report;
- Bristol City Council. Strategic Flood Risk Assessment – Level 2: Avonmouth / Severnside. Flood depth mapping function (online)[7];
- Bristol City Council (2012). Avonmouth and Severnside Integrated Development, Infrastructure and Flood Risk Management Strategy;
- Bristol City Council (2013). Flood Risk Sequential Test: *Practice Note*;
- Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project, web page[8];
- Environment Agency / Gov.uk website[9];
- British Geological Survey online mapping and borehole data[10];
- Centre for Ecology and Hydrology Flood Estimation Handbook (FEH) Web Service, hydrometric data[11];
- Site Specific Topographical survey (June 2017); and
- Ordnance Survey mapping data[12].

[1] https://www.gov.uk/government/publications/national-planning-policy-framework--2
[2] https://www.gov.uk/government/collections/planning-practice-guidance
[3] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-2
[4] http://www.southglos.gov.uk/environment-and-planning/planning/planning-policy/
[5] https://www.bristol.gov.uk/planning-and-building-regulations/planning-policy
[6] https://www.insouthglos.co.uk/enterprise/avonmouth/flood-ecology/
[7] http://bcc.maps.arcgis.com/apps/webappviewer/index.html?id=9e2bd00706144606a12c1c6fab6d1f02
[8] https://www.insouthglos.co.uk/enterprise/avonmouth/flood-ecology/
[9] http://www.environment-agency.gov.uk / www.gov.uk
[10] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[11] https://fehweb.ceh.ac.uk/GB/map
[12] www.promap.co.uk

2.2 National Planning Policy

2.2.1 The National Planning Policy Framework (NPPF) Section 14: Meeting the Challenge of Climate Change, Flooding and Coastal Change, considers the implications of flooding within the planning process. According to the NPPF:

'A site-specific flood risk assessment is required for:

- *All development within Flood Zones 2 (Medium Risk) and 3 (High Risk);*

In flood zone 1 an assessment should accompany all proposals involving:

- *Sites of 1ha or more;*
- *Land identified by the Environment Agency as having critical drainage problems;*
- *Land identified in a Strategic Flood Risk Assessment as being at increased flood risk in future; or*
- *Land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.'*

2.2.2 Paragraph 167 of the NPPF states the following regarding the consideration of flood risk within the planning application process:

'When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood risk assessment. Development should only be allowed in areas at risk of flooding where, in light of this assessment (and the sequential and exceptions tests, as applicable), it can be demonstrated that:

a) *Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
b) *The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
c) *It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
d) *Any residual risk can be safely managed; and*
e) *Safe access and escape routes are included, where appropriate, as part of an agreed emergency plan.'*

2.3 Local Planning Policy

2.3.1 The site lies within the administrative area of South Gloucestershire Council, but is situated in close proximity to Bristol City Council administrative area, with a number of the evidence base documents applying to both councils.

Core Strategy

2.3.2 The Core Strategy was adopted in December 2013 and is the key planning policy document for South Gloucestershire, setting out the general location of development, its type and scale, as well as protecting what is valued about the area.

2.3.3 The site is allocated within policies CS12 (Areas Safeguarded for Economic Development), PSP26 (Enterprise Areas), PSP27 (B8 Storage and Distribution Uses), and CS35 (Severnside) of this document.

2.3.4 Key policies relevant to the consideration of flood risk and drainage are:

- CS1 High Quality Design
- CS2 Green Infrastructure
- CS6 Infrastructure and Developer Contributions
- CS9 Managing the Environment and Heritage

2.3.5 South Gloucestershire Council is in the process of developing a new Local Plan for South Gloucestershire, to include a new strategy and policies to guide and manage growth and change in the area over at least the next 15 years. The new plan is in a period of consultation with adoption scheduled for July 2025.

Strategic Flood Risk Assessment

2.3.6 The Strategic Flood Risk Assessment (SFRA) report evaluates the extent and nature of flooding in the district, it also considers the implications for land use planning and sets out the criteria for submitting future planning applications and guiding development control decisions.

2.3.7 The SFRA for South Gloucestershire comprises the following documents:

- Level 1 Strategic Flood Risk Assessment (Nov. 2021);
- Strategic Flood Risk Assessment: Level 2 (Dec.2011);
- Strategic Flood Risk Assessment Level 2: Avonmouth / Severnside Summary Report (Mar. 2011); and
- Strategic Flood Risk Assessment Level 2: Avonmouth / Severnside Technical Report (Feb. 2011).
- Bristol City Council. Strategic Flood Risk Assessment – Level 2: Avonmouth / Severnside. Flood depth mapping function (online)[13]; and
- Bristol City Council (2020). Level 1 Strategic Flood Risk Assessment.

2.3.8 These reports were used to inform land allocations within the South Gloucestershire Core Strategy and have been reviewed as input to this study.

Emergent Studies

2.3.9 The Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project is a partnership between South Gloucestershire Council, Bristol City Council and the Environment Agency. It focuses on helping to support the growth of the Avonmouth Severnside Enterprise Area and protecting the existing communities from flooding. The project will help towards unlocking the economic potential of the Enterprise Area and benefit the local community by:

- Managing the risk of flooding to keep pace with climate change and rising sea levels; and
- Ensuring that sufficient wetland habitat for birds is created to protect the internationally important habitats and species of the Severn Estuary site.

2.3.10 Bristol City Council and South Gloucestershire Council have both granted planning permission for 17km of improved sea defences between Aust and Avonmouth and around 85ha of wetland areas for ecological mitigation. BCC, SGC and the EA have appointed engineers to undertake the detailed design and construction of these elements.

2.3.11 Site investigation, survey and ecological mitigation works are ongoing, with the main construction works currently ongoing and scheduled for completion in 2026/27. Progress reports for this project are available on the following website[14].

[13] http://bcc.maps.arcgis.com/apps/webappviewer/index.html?id=9e2bd00706144606a12c1c6fab6d1f02
[14] https://www.asea-flood-ecology.co.uk/

3.0 BACKGROUND AND DATA REVIEW

3.1 Site Setting

Property Address	Land off Severn Road, Hallen Industrial Estate, Avonmouth, Bristol, BS10 7SE
National Grid Reference	354341, 181245
Area	0.60ha

Table 001: Site Setting

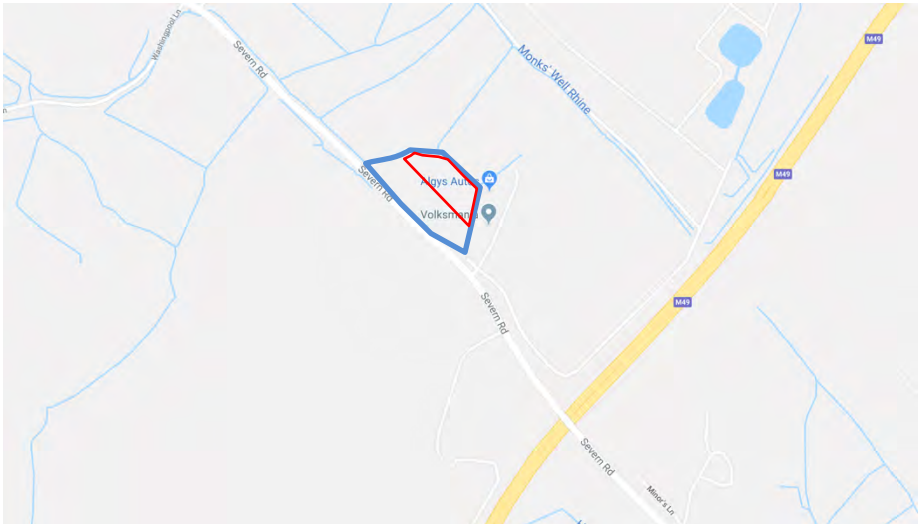

Figure 002: Site Location Plan

3.2 Current Layout

Figure 003: Existing Site Layout – Aerial Photograph

3.2.1 The property currently comprises a greenfield plot located north east of Severn Road, within Hallen Industrial Estate. Access is via Severn Road on the south western boundary. Surface finishings are currently entirely soft landscaped, refer to Figure 003.

3.3 Proposed Development

3.3.1 A planning application is to be submitted for the installation of a 50MW Gas Powered Energy Reserve Facility to provide back-up generation for the National Grid, refer to figure 004, below and Drawing CP0113-GA-001: *Site Layout – Plan View*, located to the rear of this report.

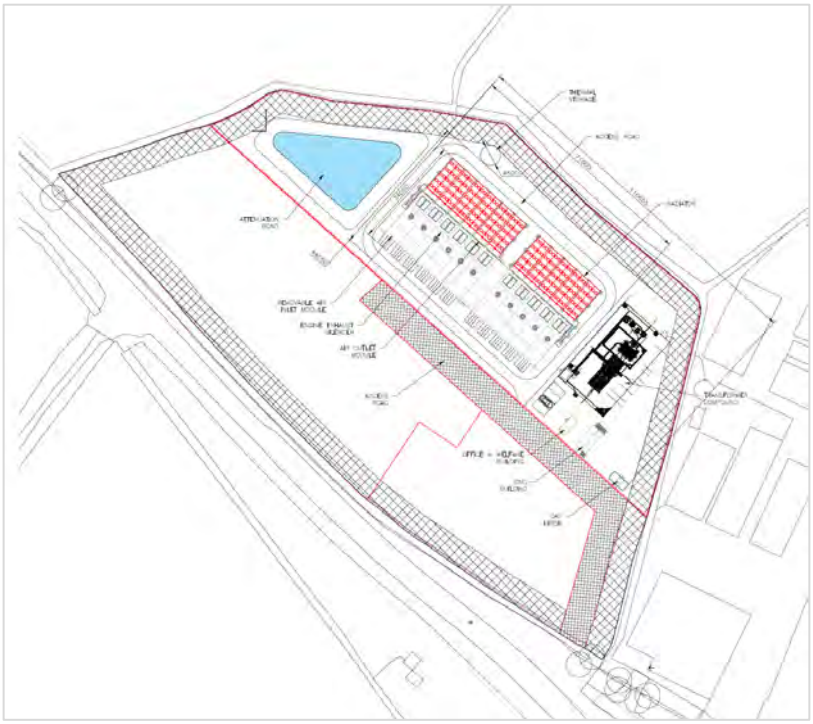

Figure 004: Proposed Layout

3.3.2 The total area subject to development measures approximately 0.60hawithin a 1.76ha wider site, although eventually the entire site will be subject to development, with the drainage provisions prepared on the premise of servicing all 4 plots. This will result in an uplift in impervious surface which, without mitigation, would affect the rates and volumes of surface water runoff generated.

3.4 Topographical Survey

3.4.1 Topographical survey data obtained for the site in June 2017 (Drawing H8163-001) indicates ground levels to be relatively uniform ranging between 6.0m AOD and 6.4m AOD across the wider site and between 6.14m AOD and 6.40m AOD within the application area, with no discernible gradient in any particular direction. Invert levels in the surrounding drainage channels are noted between 4.28m AOD and 5.95m AOD, with greatest elevations on the north eastern boundary and lowest on the south western boundary, reducing in a north and westerly direction.

3.5 Surrounding Area

Direction	Description
North east	Industrial sites / warehouses – Wren Kitchens
South east	Hallen Industrial Estate
South west	Severn Road, agricultural land beyond
North west	Industrial sites / warehouses – Wren Kitchens

Table 002: Site Surrounds

3.6 Hydrogeology

3.6.1 Regional geological mapping[15] shows the underlying bedrock to comprise Mudstone and Halite of the Mercia Mudstone Series. This is indicated to be c. 1,350m thick and in this vicinity to be overlain by Tidal Flat Deposits (Clay and Silt).

3.6.2 BGS borehole log data is available for 5 locations in the immediate vicinity, (Figure 005), which date from 1945-1990. These suggest a general absence of groundwater, although some slight seepage is noted from fissures at 2.1m bgl (4.55m AOD) in borehole ST585SW/67, likely associated with perched water tables. The soils beneath the site are recorded as a 2.3m thick brown clay underlain by a 1.2m thick layer of gravel, beneath which a 23.8m thick layer of sandstone is present. This indicates potential for the use of infiltration to dispose of surface water runoff.

Figure 005: British Geological Survey Borehole Location Map

3.6.3 Mapping data downloaded from the EA website indicates the site to be located external to Groundwater Source Protection Zones.

3.6.4 Based on consideration of the above data the proposed development is indicated to be at **Low** risk from groundwater flooding, with the clay layer locally preventing the upward migration of groundwater, and with the rhines likely to intercept extruded water and convey it away from the site. No further assessment is therefore proposed.

3.7 Tidal Watercourses

3.7.1 The property is located approximately 1.75km south east of the Tidal River Severn and is indicated by EA flood mapping to be at **High Risk** of flooding from this watercourse.

3.7.2 The tidal River Avon discharges into the River Severn some 4.5km south of the application area, although the flood outlines associated with the River Severn are likely to predominate at this location.

3.7.3 The Avonmouth Level 2 SFRA notes the wider area to be currently largely protected from significant tidal flooding by the presence of flood defences (Figure 006), with flood depths generally <0.2m indicated by the BCC online flood depth mapping function and with a low associated flood hazard. This flood outline dates from 2010 and accounts for the maximum flood depths arising from 2 different flood scenarios, as follows:

- 200 year Tidal + 2 year Fluvial
- 100 year Fluvial + 2 year Tidal

3.7.4 However, the SFRA notes the standard of protection offered by these tidal flood defences to reduce over time in line with predictions of climate change and sea level rise, with the flood zones estimated to increase accordingly. BCC online SFRA interactive flood maps indicate future flood depths of up to 0.9m (to 2073), with a **High** associated risk and with further assessment required.

[15] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

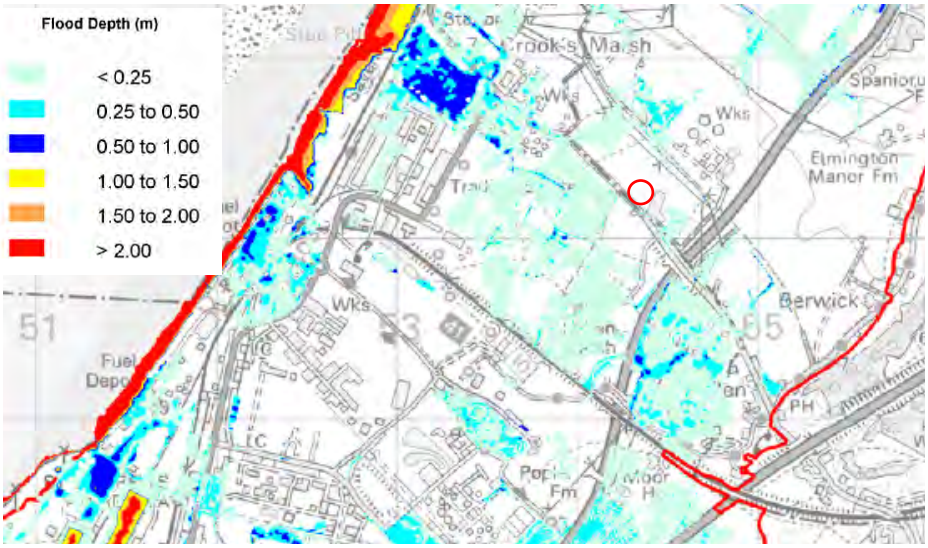

Figure 006: Excerpt from Avonmouth SFRA Figure 7.19 Detailed Flood Map: Existing Flood Risk (2010)

Flood Data

3.7.5 No EA site specific flood level data is available for the future 200 year defended tidal flood outline with which to assess the flood risk to the facility. It is therefore proposed to use the flood depths obtained from the BCC online mapping function as input to this assessment.

3.8 Fluvial Flooding and Hydrology

3.8.1 The site is located within an area which benefits from an extensive network of land drains, referred to locally as rhines. These fall under the remit of the Lower Severn Internal Drainage Board (LSIDB). Minor drainage channels are present on the site perimeters which drain to a larger channel (rhine) on the south western boundary. This eventually discharges to the tidal River Severn downstream.

3.8.2 The minor drainage channels on the northern and eastern boundaries were noted as dry at the time of the topographical survey (2017), although were holding water during a recent site visit (Dec. 2022). Water was present in the rhine on the south western boundary both during the topographical survey and recent site visit. Water levels in this rhine were surveyed at between 4.97m AOD and 4.99m AOD (0.4m and 0.7m deep), reducing in a north westerly direction. Invert levels on the rhine of between 4.28m AOD and 4.47m AOD were recorded, reducing in a north westerly direction.

3.8.3 The SFRA notes the current Flood Zone 3a (2010) to be driven largely by fluvial flooding generated by the rhine system in low lying land, with flooding from these watercourses noted to be extensive.

3.8.4 However, whilst Figure 006 indicates the site to experience minor flooding, this flood outline is produced in combination with tidal flooding. Review of SFRA Figure 7.13 (Figure 013 of this report), which considers the impacts of a 100 year fluvial flood (2110) in conjunction with a blockage of the M49 culvert immediately north, indicates the facility to be unaffected by fluvial flooding. It is therefore concluded that the application area is unaffected by fluvial flooding now and in the future, with no further assessment required.

Catchment Details

3.8.5 Catchment data for the area has been downloaded from the CEH Flood Estimation Handbook Web Service and is summarised in Table 003. This indicates a small entirely rural catchment, with moderately permeable geology.

3.8.6 Flows within local watercourses are likely to be predominated by baseflow (BFIHOST) with more minor contributions via overland flow (SPRHOST) and with a low catchment response to incident rainfall anticipated. The limited upstream catchment may locally increase the catchment response to incident rainfall, particularly where impervious overlaying soils or urban surfaces are present, with a limited lag time between incident rainfall and peak river flows in some areas.

Catchment Descriptor	Value
Area	0.71km^2
River Baseflow Index (BFIHOST-19)	0.680
Standard Percentage Runoff (SPRHOST)	25.46%
Drainage Path Length (DPLBAR)	0.86km
Drainage Path Slope (DPSBAR)	4.90m/km
Flood Attenuation by Rivers and Lakes (FARL)	1.00
Proportion of time soils are wet (PROPWET)	0.35
Standard Annual Average Rainfall (SAAR)	800mm
Urban Extent (URBEXT: 2000)	0.000

Table 003: FEH Catchment Descriptor Information

3.9 Historic Flooding

3.9.1 The SFRA Figure 2.4 indicates historic flooding to have occurred to the south west on Severn Road, with this arising from surcharge of a ditch to the south of Willow Farm. No date is recorded.

3.9.2 Desk based investigation, including review of the Defra Historic Flood Maps[16], reveals no further records of historic flooding in this locale, although this may arise from a lack of recorded incidents based on the current and historic land uses, i.e. agricultural / industrial.

3.9.3 Caution should be exercised when reviewing historic flood records. This information is largely anecdotal and does not always include record of either the antecedent conditions giving rise to flooding (e.g. flood source), or reference to a flood return period. Furthermore, a lack of recorded incidents is no guarantee that an area has never flooded.

3.10 Flood Zone Classification

3.10.1 The entire site is indicated to be located within defended Flood Zone 3a (**High Risk**).

[16] https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/HistoricFloodMap&Mode=spatial

3.11 Flood Risk Vulnerability

	Flood Risk Vulnerability Class'n (PPG Table 2)	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (Functional Floodplain)	Exception Test Required	x	x	x	✓

Key:

✓ Development is appropriate x Development should not be permitted

Table 004: PPG Table 3 – Flood Risk Vulnerability and Flood Zone Compatibility

3.11.1 Development proposals include the installation of a 50MW Gas Powered Energy Reserve Facility to provide back-up generation for the National Grid within a 0.60ha plot of land within the Hallen Industrial Estate and to the north east of Severn Road, Avonmouth, BS10 7SE.

3.11.2 Table 2 of the PPG defines the facility as '*infrastructure for electricity supply including generation, storage and distribution systems*' and classifies this use as *'Essential Infrastructure*.' Table 3 of the PPG considers this an appropriate use within Flood Zones 1, 2 and 3a.

3.12 NPPF Sequential and Exception Tests

3.12.1 The Sequential Test steers development preferentially towards Flood Zone 1 (Low Risk), considering Flood Zone 2 (Medium Risk) and then Flood Zone 3 (High Risk) only if land cannot be identified as available for development in zones at lower risk from flooding.

3.12.2 The Sequential Test is generally carried out at a strategic level by the Local Planning Authority with input from the Environment Agency, as part of the Local Plan process and should be informed by a Strategic Flood Risk Assessment.

3.12.3 The development area is allocated by South Gloucestershire Council within its Core Strategy policy areas CS12 (Areas Safeguarded for Economic Development), PSP26 (Enterprise Areas), PSP27 (B8 Storage and Distribution) and CS35 (Committed Sites). This land allocation was informed by a Level 2 SFRA.

3.12.4 A site specific Flood Risk Assessment was prepared in support of the 2017 application for this site which was deemed to be acceptable by the Lead Local Flood Authority subject to flood mitigation and management measures. The current application represents a variation to the original permitted layout.

3.12.5 Furthermore, the proposals comprise '*Essential Infrastructure'* situated within defended Flood Zone 3a and therefore fulfil the requirements of the Flood Risk Sequential Test by default, with no requirement for application of the Exception Test. Nevertheless, element two of the Exception Test is addressed within this FRA.

3.13 Climate Change

Tidal Allowance

3.13.1 The flood data downloaded via BCC online mapping for this locale was prepared using detailed hydrodynamic modelling which includes climate change allowances for both fluvial and tidal inputs for the next 100 years, with these based on detailed joint probability modelling. Furthermore, the site specific flood depths provided account for the presence of flood defences and overtopping processes.

3.13.2 The impacts of tidal flooding have been assessed to 2073, based on a development lifetime of <50 years (*non-residential*).

Rainfall Allowance

3.13.3 Government Guidance on Climate Change Allowances to Peak Rainfall Intensity (Table 2), requires application of climate change factors of up to 25% (Central Allowance) for both the 2050s epoch (2022-2060) and the 2070s epoch, e.g. development with a lifetime between 2061 and 2100 (*non-residential* use).

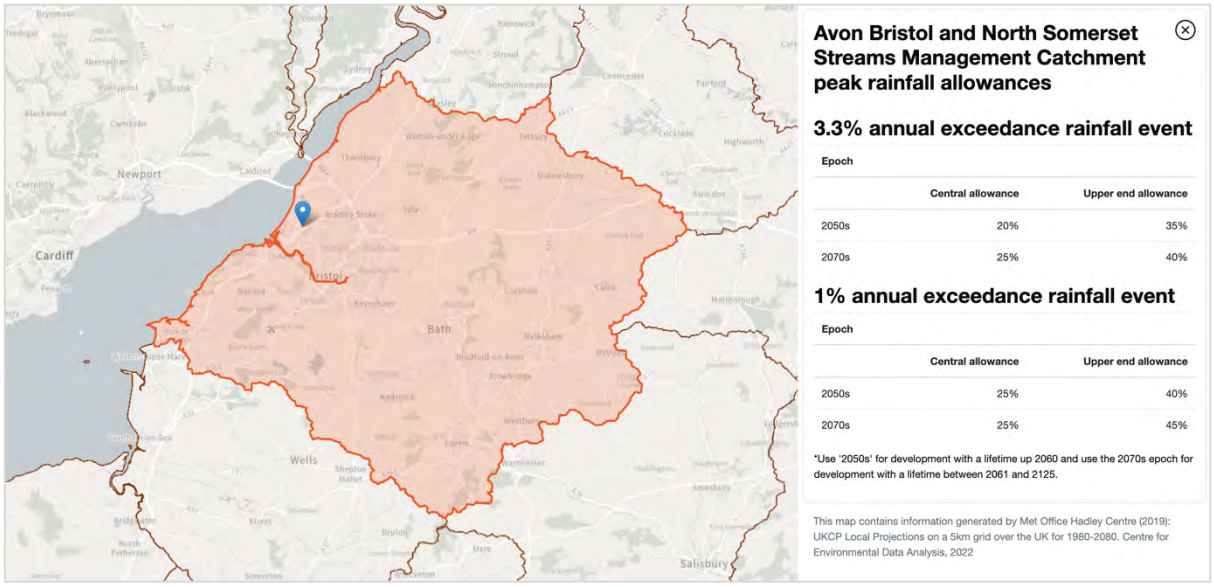

Figure 007: Climate Change Allowances – Rainfall Intensity

3.14 Infrastructure Failure

3.14.1 Flooding from artificial sources occurs when man made infrastructure e.g. flood defences, raised channels or surface water storage features, including reservoirs, becomes overwhelmed leading to breach or failure. The probability of failure is low owing to regular inspection and maintenance regimes. However, in the event of a breach occurring, the consequences can be significant.

Flood Defences

3.14.2 The site is indicated to benefit from the presence of flood defences (SFRA Figure 2.1) being located within Management Unit '*New Pill to Mitchell's Salt Rhine*'. The SFRA notes these to comprise a mixture of formal EA and privately maintained flood defences including a raised foreshore, raised railway embankment and earth embankments, which are stated to provide a good standard of protection.

3.14.3 The SFRA notes a policy of Hold the line (short term) with a policy for Hold or Retreat the Line (long term). Bristol City Council and South Gloucestershire Council have both granted planning permission for 17km of improved sea defences between Aust and Avonmouth as part of the Avonmouth Severnside Enterprise Area Ecology Mitigation and Flood Defence Project, with construction works scheduled to commence by late 2020.

3.14.4 The proposed flood defence upgrade involves:

- Raising the height of existing flood banks (earth embankments);
- Building new, higher concrete flood walls; and
- Building new, higher flood defences from steel sheet piles.

3.14.5 Figure 008 provides an overview of the proposed works, with the Hallen Marsh area indicated to benefit from these proposals. The new flood defences will allow for sea level rise caused by anticipated climate change to ensure flood risk is reduced for at least 60 years. This document post-dates the SFRA and is assumed to be representative of current policy, with this considered to demonstrate a commitment to maintaining the current Standard of Protection.

3.14.6 The above desk based research confirms the property to be situated within an area benefitting from the presence of flood defence infrastructure, the failure of which could lead to flooding. Further investigation is therefore required to quantify the associated residual risks.

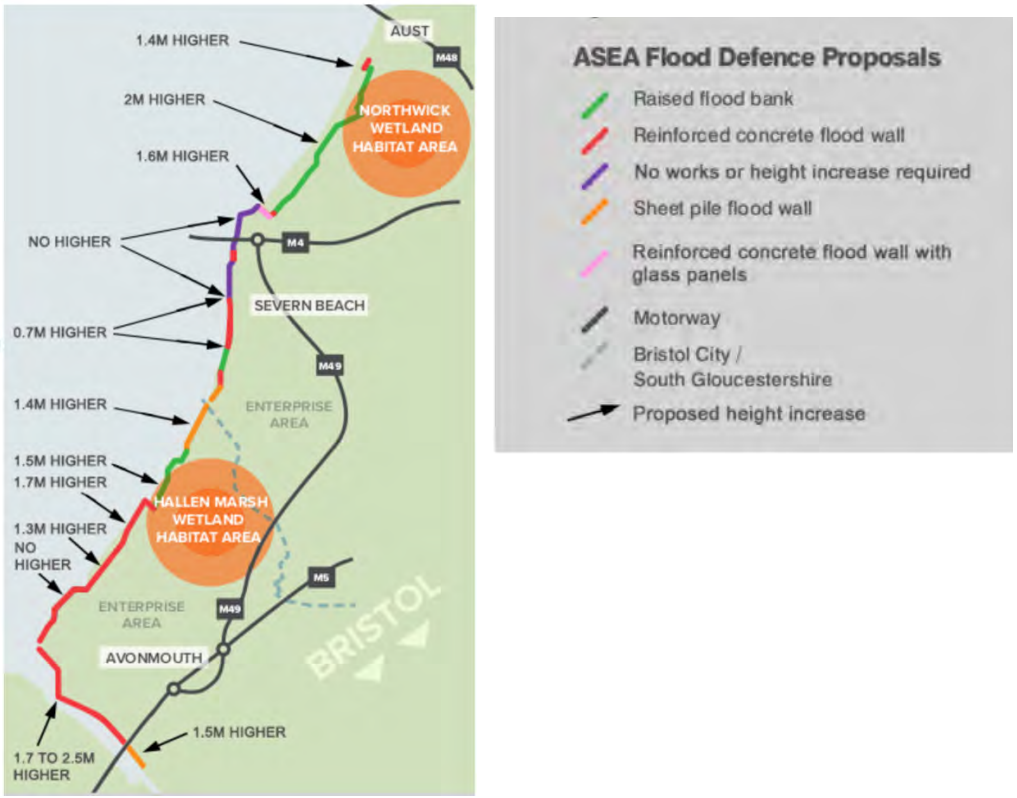

Figure 008: ASEA Flood Defence Proposals

Reservoirs and Raised Waterways

3.14.7 Review of the EA National Reservoir Flood Maps indicates the application area to be unaffected by reservoir flooding, and to be remote to raised canals or waterways, the failure of which could lead to flooding, with a **Low** associated risk of flooding from these sources and with no further assessment required.

3.15 Surface Water Flooding

3.15.1 Detailed EA pluvial mapping downloaded from the EA website, assesses three main scenarios, Low Risk (0.1%-1% probability of flooding annually), Medium Risk (3.3% - 1%) and High Risk (>3.3%). The findings of this assessment are summarised in Figure 009.

3.15.2 This data indicates the plot to be at **Very Low** risk from pluvial flooding with no requirement for further assessment.

Figure 009: Environment Agency Surface Water Flood Map

3.16 Sewers

3.16.1 The site is assumed to be remote from surface water sewers, with the nearest likely to be present within the adjacent Severn Road, to the south west. Whilst this road is elevated relative to the application area, a rhine (drainage channel) is present on the south western boundary, which would intercept flood water and convey it to the north west and away from the development, with the flood outlines likely to be similar to that outlined for surface water.

3.16.2 The potential for flooding from sewers therefore considered to be **Very Low**, with no requirement for further consideration.

4.0 FLOOD RISK ASSESSMENT

4.1 Screening Opinion

4.1.1 In accordance with the NPPF Section 14 it is necessary to consider all forms of flood risk. A flood risk scoping exercise has therefore been completed for the site, the results of which are outlined in Table 005.

Nature of Flood Risk	Flood Risk to Site?
Groundwater	No. Groundwater is located at depth. Underlying Clay geology further reduces risk.
Tidal	Yes. Development is located entirely within defended Flood Zone 3a for the tidal River Severn.
Fluvial	Yes. Whilst site is indicated to be currently unaffected by fluvial flooding, this risk may increase in the future taking account of climate change.
Infrastructure Failure (reservoirs, canals and other artificial sources)	Flood Defence breach / failure requires further assessment. EA website indicates no flood risk from reservoirs. Property is remote from raised waterways.
Overland Flow (surface water from off-site sources)	No. EA website indicates **Very Low** flood risk of pluvial flooding with no further assessment required.
Sewers	No. The flood risk from sewerage infrastructure is considered to be **Very Low** with no further assessment required.
Surface Water Drainage (on site)	Yes. An uplift in impermeable surface will arise from proposals. Consideration of surface water management is therefore required.

Table 005: Flood Risk Screening Opinion

4.1.2 Flood screening indicates the principal flood risk to arise from tidal sources, which has been duly assessed. Residual risks associated with flood defence breach and or failure and extreme storm events have also been considered. The results are summarised below.

4.2 Tidal Flooding

Existing Flood Risk 200 Year (2010)

4.2.1 According to the SFRA detailed flood mapping and the BCC online interactive SFRA Flood Maps, the development area is currently (2010) indicated to be unaffected by 200 year tidal flooding, with no requirement for flood mitigation.

Future Flood Risk (2073)

4.2.2 The SFRA detailed flood mapping indicates the site to be affected by tidal flooding for future (2073) scenarios, with flood depths of between 0.6m and 0.9m noted for future design return period events (200 year tidal), accounting for the presence of flood defences and with flood mitigation required. This flood outline assumes no upgrade of the flood defences to occur over time (conservative).

4.2.3 Planning permission has been granted for the upgrade of the flood defences serving the Avonmouth Severnside Area, with those benefitting the Hallen Marshes to be raised by up to 1.7m and with works understood to have been scheduled for commencement in late 2020. The new flood defences are stated to include allowance within their design for sea level rise caused by anticipated climate change to ensure flood risk is reduced for at least 60 years. It is therefore considered that the facility will remain protected from flooding throughout its lifetime (<50 years).

4.2.4 In the instance that no upgrade / maintenance of the flood defences occurred over time, the tidal nature of the flood risk provides a degree of predictability which, coupled with the flood mechanism, (overtopping of the River Severn flood defences)

and the presence of significant intervening flood storage between the site and the flood defences, would provide significant lead time for flood warning.

4.2.5 Low flow velocities are anticipated, with the flood hazard to the development governed by the depth of flooding, with a flood hazard rating of '***Danger for Some***' indicated by comparing the 2073 flood depth (0.9m) obtained via online mapping with the flood hazard ratings noted within the key of SFRA Figure 7.4.

4.2.6 Accounting for the factors outlined above and the nature of use proposed, it is considered that with the proposed flood mitigation and management measures in place, the risks posed to personnel and the plant by flooding, can be reduced to an acceptable level. The above assumes no upgrade of flood defences in the Avonmouth / Severnside area (conservative).

4.3 Flood Mitigation and Management

4.3.1 The site is indicated to be unaffected by fluvial flooding for return period events up to and including 1000 years, and from tidal flooding for return period events up to and including 200 years, with that standard of protection indicated to be maintained over time.

4.3.2 Based on the above factors and coupled with the potential maximum 200 year flood depth of 0.9m (future tidal) and >2.5m (flood defence breach), assuming no flood defence upgrade / maintenance occurs over time (unlikely), it is considered prohibitive to fully protect the facility from the risks posed by tidal flooding, particularly as these flood depths are unlikely to be entirely realised.

4.3.3 The following flood mitigation and management measures are therefore proposed minimise the disruption caused in the event of flooding:

- Raising of all on-site controls and critical infrastructure by 600mm above the surrounding ground level to ensure that any disruption caused by flooding is kept to a minimum;
- Incorporation of flood resistant and resilient construction techniques within the design of the facility (particularly any elements which have not been raised), to minimise water ingress in the event of flooding. This should be suited to salt water environments;
- Preparation of a Flood Management Plan outlining the procedures to be followed in the event of flooding;
- Signing up to the EA flood warning system to alert personnel to the potential for flooding and allow safe evacuation and execution of the Flood Management Plan;
- The plant will be subject to remote operation with no staff present would could be placed at risk; and
- In the event of flooding the plant will be subject to remote shut down / isolation.

Safe Access

4.3.4 In the instance that maximum flood depths were realised at the site, safe access exists via Severn Road onto the bridge across the M49 (immediately south east), which is elevated (13.50m AOD) and where safe refuge could be sought. This road is indicated by the BCC online mapping function to be unaffected by flooding throughout all return period flood events now and in the future.

4.3.5 Safe access also exists via Severn Road to the south east which is indicated to be largely unaffected by future flooding (to 2073), although minor discrete sections may experience maximum depths of 0.3m. This would allow safe passage for emergency vehicles, including fire engines.

4.3.6 The risks posed to site users will be minimised through remote operation, with staff highly unlikely to be present during day to day operations.

4.4 Residual Flood Risk

Flood Zone 2 - 1000 Year Flood Outline

4.4.1 In accordance with the requirements of the NPPF it is necessary to consider the risks associated with more extreme flooding, to inform the flood management measures required. The NPPF regards the 1000 year storm to be representative of an extreme event and this has been duly assessed.

4.4.2 According to the detailed SFRA mapping for the current (2010) 1000 year tidal flood event (Figure 010), the site is indicated to be subject to flood depths <0.25m, with a **Low** associated flood hazard (SFRA Figure 7.22) and with safe access available onto Severn Road to the south west which is indicated to remain free from flooding. These flood outlines are unlikely to be fully realised as they disregard the scheduled upgrade of flood defences.

4.4.3 Under future (2110) scenarios of extreme flooding, the site is indicated to be subject to significant flooding, with depths of 1.5m to 2.0m predicted and with a flood hazard rating of '***Danger for All***'. It is noted that the wider Avonmouth / Severnside area would be subject to similar flooding.

4.4.4 No EA detailed site specific defended flood levels are available with which to assess the 1000 year tidal flood. Whilst undefended flood levels of up to 8.46m AOD (2.46m deep) are indicated, these are unlikely to be representative of the actual flood depths experienced at the site, since they ignore the presence of flood defences and the recent / ongoing flood defence upgrades. Furthermore, the climate change applied to this mapping is for a development lifetime of 100 years, with this unlikely to be fully realised within the anticipated development lifetime (<50 years).

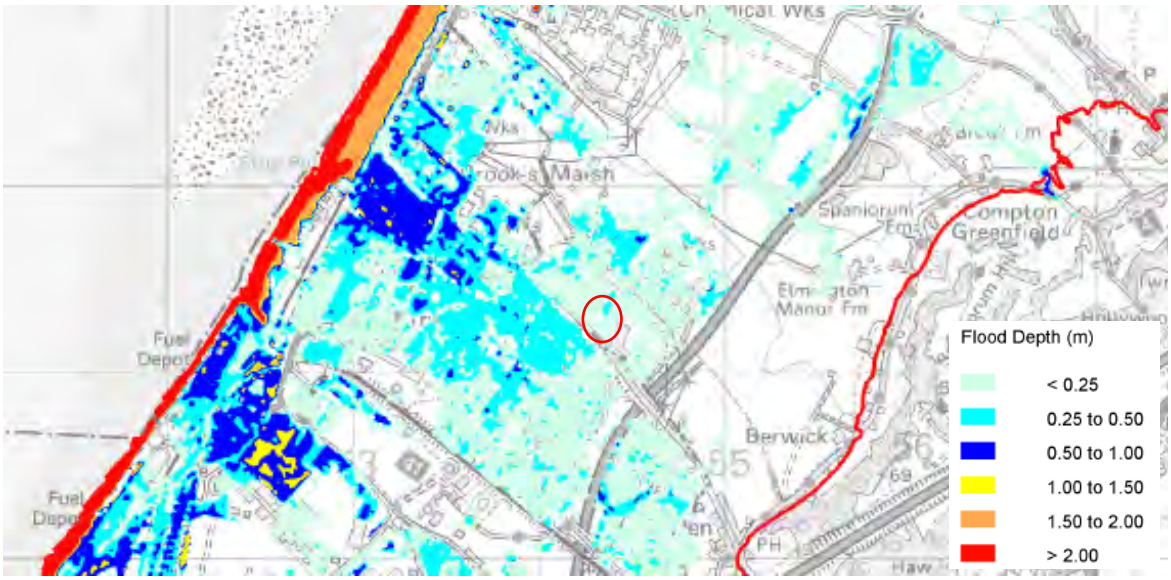

Figure 010: Excerpt from Avonmouth SFRA Figure 7.21 Detailed Tidal Flood Map: Residual Risk 1000 Year (2010)

4.4.5 The probability of extreme flooding occurring is considered to be low, which reduces the flood hazard. The same operational measures outlined above will apply during the 1000 year flood event (existing and future), with the plant subject to remote operation, shut down and isolation procedures, and with no personnel present within the site who could be placed at risk. Safe refuge remains on the Severn Road bridge across the M49, which is indicated to be unaffected by flooding.

4.4.6 It is therefore considered that with the outlined mitigation and management measures in place, the residual risks posed to the installation from tidal flooding can be reduced to an acceptable level.

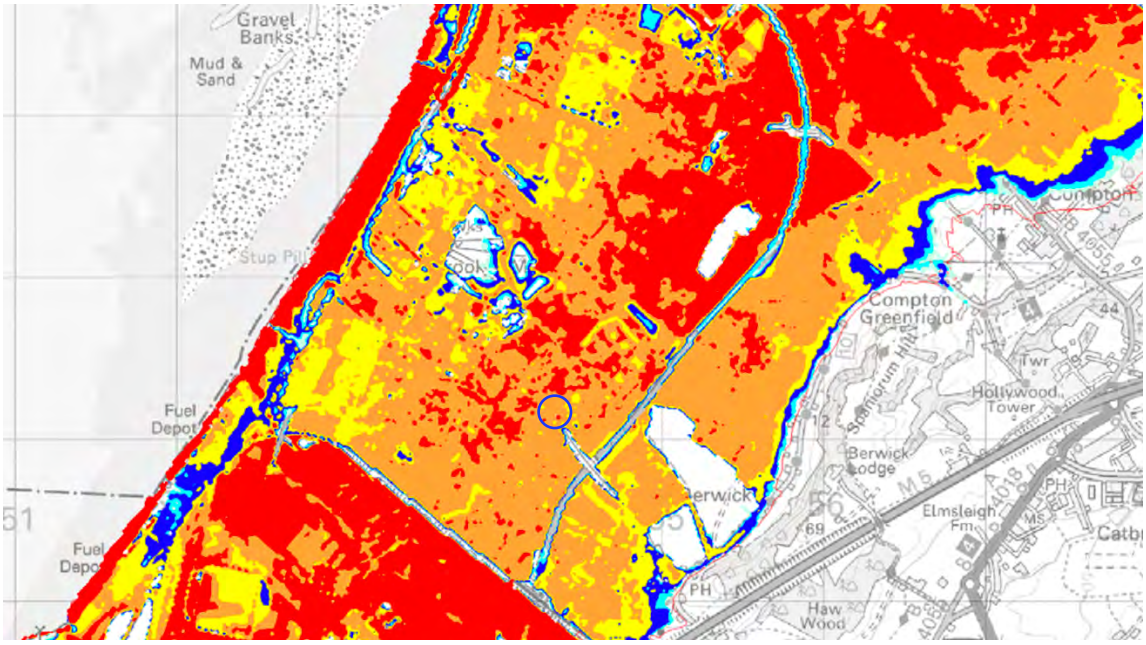

Figure 011: Excerpt from Avonmouth SFRA Figure 7.15 Detailed Tidal Flood Map Future Risk 1000 Year (2110)

Infrastructure Failure – Breach of Flood Defences

4.4.7 The development is located within an area which benefits from the presence of flood defences, the breach / failure of which could lead to flooding of Avonmouth / Severnside and potentially the site.

4.4.8 In this event there would be little or no flood warning, with a significant associated flood hazard. Flow velocities would be greatest close to the defences, reducing with distance as waters spread out across the floodplain (spreading loss). The site is located some 1.75km from the defences and is therefore likely to experience lower flow velocities.

4.4.9 The impact of defence breach or failure has been assessed within the SFRA for six locations along the Severn Estuary, where the probability or consequence of failure was deemed significant.

4.4.10 This indicates the flood hazard at the site during a future (2110) 200 year breach event to be '*Danger for Most'* with water depths of 1.5m-2.5m anticipated, (Figure 012).

4.4.11 During a future (2110) 1000 year breach event this hazard increases to '*Danger for All'* with flood depths >2.5m indicated.

4.4.12 The SFRA notes the following in relation to the New Pill to Mitchell's Salt Rhine flood defence management unit:

'Given the robust economic case for this management unit, it is recommended that further study be undertaken of the flood cell from New Passage to Avonmouth (15A East to 15C East). There should be a consistent standard of protection provided for the whole flood cell to avoid breach.'

4.4.13 The probability of a breach occurring is therefore considered to be extremely low. Further, recent flood defence works would likely reduce the probability of a breach occurring. This, coupled with the operational measures outlined above, will ensure that the plant is subject to remote operation, shut down and isolation procedures, and with no personnel present within the site who could be placed at flood hazard. Safe refuge is available on the Severn Road bridge across the M49.

4.4.14 It is therefore considered that with the outlined flood mitigation and management measures in place, the residual risks posed to site users or the installation by flooding arising from a breach of the coastal defences can be reduced to an acceptable level.

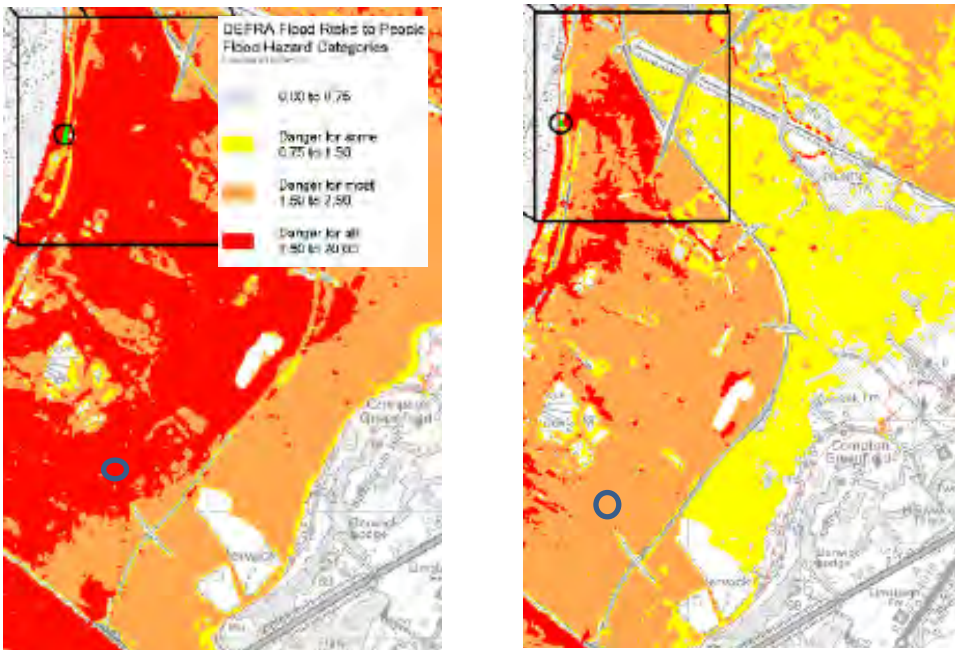

Figure 012: Excerpt from Avonmouth SFRA Figures 7.6 and 7.7 Detailed Tidal Flood Maps: Residual Risk (Breach) 1000 Year (on left) and 200 Year (on Right) Future (2110)

Infrastructure Failure – Blockage of M49 Culverts

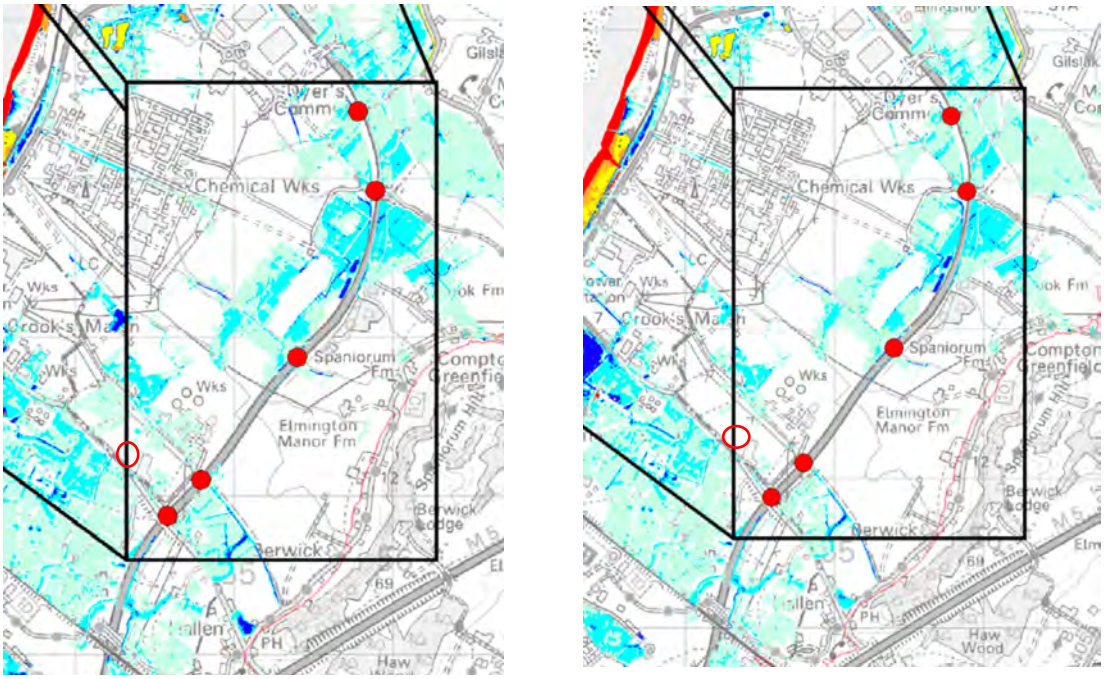

Figure 013: Excerpt from Avonmouth SFRA Figures 7.13 and 7.14 Detailed Fluvial Flood Maps: Residual Risk M49 Culvert Blockage 100 Year (on left) and 1000 Year (on Right) Future (2110)

4.4.15 The SFRA considers the impact of a blockage of the M49 culverts on fluvial flooding from the Rhine network at a total of five locations (Figure 013), with the site indicated to be unaffected by flooding during both 100 year and 1000 year fluvial flood events up to 2110.

4.5 Summary of Flood Risk

4.5.1 In accordance with the requirements of the NPPF, all potential flood risks posed to / by the development have been assessed. The site is concluded to be defended from fluvial and tidal flooding for design return period events, with this standard of protection likely to be maintained over time and with flooding only likely to arise from those risks which cannot be borne out through design, e.g. defence breach / failure. The proposed operational measures, which include remote operation and shut down / isolation, further reduce the flood hazard to site users.

4.5.2 It is concluded that with the outlined flood mitigation and management measures in place, the identified residual flood risks to the site and its users can be reduced to an acceptable level through the development lifetime. It is also demonstrated that the proposals will not detrimentally impact flood risk elsewhere.

4.5.3 The proposals are therefore considered appropriate within the context of Local Planning Policy Documents and paragraph 167 of the NPPF:

- *Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- *The development is appropriately flood resistant and resilient such that, in the event of a flood it could be quickly brought back into use without significant refurbishment;*
- *It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- *Any residual risk can be safely managed; and*
- *Safe access and escape routes are included, where appropriate, as part of an agreed emergency plan.*

4.5.4 Potential impacts to flood risk arising from surface water generated within the development are addressed in Section 5.0.

5.0 SURFACE WATER

5.1 Introduction

5.1.1 An application is to be submitted for the installation of a 50MW Gas Powered Energy Reserve Facility to provide back-up generation for the National Grid, with associated hardstanding areas and access within a 0.60ha plot located within a 1.76ha wider site to the north east of Severn Road, Hallen Industrial Estate, Avonmouth, BS10 7SE.

5.1.2 The wider site is served by a formal surface water management system which includes on site attenuation and discharge control and into which a gravitational connection can be established for the discharge of surface water from the current application area. This attenuation facility discharges into the surrounding rhine network.

5.1.3 An uplift in the runoff coefficient will arise from development proposals which, without mitigation, would have a consequent detrimental impact on the rate and volume of surface water runoff generated. This would be further compounded by climate change impacts over time.

5.1.4 In accordance with the NPPF new development must incorporate flood attenuation measures sized to accommodate runoff generated by formalised surfaces for return period pluvial flood events up to and including 100 years, taking account of climate change and with discharges restricted to greenfield rates. This to ensure that existing runoff rates are maintained and that, wherever possible, a degree of betterment is provided. Sustainable Drainage Systems (SuDS) must be incorporated within the design, wherever practicable.

5.2 Land Use

Surface Finishing	Pre-Developed (ha)	Runoff Coefficient	Developed (ha) Entire Site	Developed (ha) Current Site	Runoff Coefficient
Impervious Areas	0	0.95	0.65	0.22	0.90
Grade 2 Stone Chippings	0	0.70	0.62	0.21	0.70
Soft Landscaping	0.40	0.40	0.49	0.17	0.40
TOTAL	**0.60**		**1.76**	**0.60**	
Average Runoff Coefficient		**0.40**			**0.65**

Table 006: Land Use

5.2.1 The above land use data assumes the entire site will be developed over time, with the current application comprising a 0.60ha area. This to allow for a degree of future proofing of the surface water management system.

5.3 SuDS Options for Surface Water Disposal

5.3.1 Desk based investigation indicates the presence of underlying clay bedrock geology, overlain by soils with infiltration potential.

5.3.2 The wider site is served by a formal surface water management system which includes on site attenuation and into which a gravitational connection is proposed for the discharge of surface water from the current application area. This facility discharges at controlled (greenfield) rates into the surrounding rhine network via an existing connection.

5.3.3 This is in accordance with the SuDS hierarchy as outlined within Section 3.2.3 of the SuDS Manual, and summarised below:

SuDS Discharge Hierarchy:

- Infiltration
- Discharge to surface waters
- Discharge to surface water sewer
- Discharge to combined sewer (Last Resort).

Greenfield Runoff

5.3.4 Greenfield runoff rates have been estimated using the WinDes Micro drainage ICPSUDS function, with input data from the Flood Estimation Handbook web service and based on a linear interpolation from a 50ha catchment, in accordance with SUDS manual guidance. Table 007 summarises the results of this analysis. Full copies of these calculations are located at Appendix II: *Workings*.

5.3.5 The calculations assume the entire wider site (1.76ha) will be developed over time, with the current application comprising a 0.60ha area within this. This allows an audit of the existing surface water management networks, including the attenuation facility, to ensure they remain fit for purpose over the development lifetime.

Return Period (yrs.)	Runoff Rate (l/s/ha)	Runoff Rate (l/s) Wider Site
Q_{BAR}	5.136	6.523
30	9.790	12.433
100	12.430	15.786

Table 007: Greenfield Runoff Rates

* Based on a 1.27ha u/s impervious area.

5.4 Attenuation and Controlled Discharge

5.4.1 The WinDes Micro Drainage software suite has been used to estimate the surface water storage. Storm scenarios were run for both winter and summer profiles, for a range of durations between 15-10,080 minutes, taking account of land use data, allowable discharge rates and climate change, respectively. Copies of these calculations are located at Appendix II and are summarised in Table 008.

5.4.2 The WinDes Micro Drainage package assumes all land surface to be impermeable. Therefore, where the runoff coefficient differs (e.g. gravel / stone chipping) the total contributing area has been multiplied by the runoff coefficient to establish an '*Effective Impermeable Area*' for assessment. Impermeable surfaces are accounted for at 100%.

5.4.3 Although a range of surface finishes is currently proposed across the site, the original drainage calculations prepared for the site (2017) assumed that all development platform areas would be impervious, to allow for a '*worst-case'* impact on surface runoff and to offer flexibility in the final design of the surface water drainage networks.

5.4.4 The revised drainage calculations apply the percentage impervious areas measured at the current application area over the entire site. This results in a 65% impervious surface and 62% stone surface coverage, with a total effective impermeable area of 1.08ha estimated. The drainage calculations have been re-run accounting for the revised surface finishes and updated climate change allowances.

Results

Return Period Rainfall Event (Yrs.)	Storage Requirement (m^3)
$Q_{BAR\ Urban}$	199
30	408
100	555

* Based on a 1.08ha u/s effective Impervious Area

Table 008: Surface Water Attenuation Requirements

5.5 Drainage Layout

5.5.1 A maximum rainwater storage requirement of 555m^3 has been estimated. This will be provided within the existing detention pond which is situated in the north western corner of the site and designed to accommodate rainfall for return period events of up to 100 years, including climate change, and without surcharge. A 300mm freeboard is incorporated within the pond design to account for fluctuation in water levels, sedimentation and bank settlement.

5.5.2 Water will be conveyed to the storage area using a combination of surface contouring, piped drainage and perimeter filter drains.

Lower Severn IDB – Design Input

5.5.3 Analysis has been undertaken by the Lower Severn IDB to establish the full design requirements of the attenuation pond taking account of the wider IDB commitments and land drainage networks serving the area. Full copies of this investigation are located art Appendix II: *Workings*.

5.5.4 Based on the IDB analysis the following design considerations have been assumed for the attenuation facility:

- Depth (for flood storage): 1.30m
- Basal Area: 436m^2
- Area (Top of bank): 966m^2
- Volume: >615m^3
- Max. water level: 0.9m
- Freeboard: >300mm

5.5.5 A dual outfall arrangement is proposed, with a low level 0.45m diameter flapped outfall installed at the base of the pond to maintain low flows within local watercourses under standard flow conditions, and an overflow weir to allow discharge at higher rates during periods of flooding. Discharge from both outfalls will be restricted to greenfield rates.

5.5.6 This configuration will permit infiltration to ground where practicable, with surplus water discharging to local watercourses at greenfield rates via an existing gravity fed outfall to the drainage channel on the south western boundary. It is understood that the discharge point from the attenuation facility is fitted with a non-return valve to prevent backflow in the event of tide locking downstream.

5.5.7 The pond design includes a 1m deep retained water depth, with flood storage provided within the 1.3m section situated above this. The retained water will limit excessive reed growth and minimise long term maintenance requirements.

5.6 Network Capacity

5.6.1 Runoff from the facility will be conveyed into the surface water attenuation area via perimeter filter drains and piped networks, the latter fitted with a silt trap at the downstream end.

5.6.2 All flow conveyance networks are sized to convey runoff for return period storms up to and including 100 years, accounting climate change, without surcharge, with capacity present for short duration (high intensity) rainfall events, e.g. the 15 minute storm. Minor ground reprofiling may be necessary to facilitate pipe protection and gravitational discharge into the storage area.

5.6.3 The attenuation area is designed to become operational only following intense rainfall or storms. Capacity is present to accommodate rainfall events up to and including the 100 year storm, accounting for climate change and without surcharge.

5.6.4 Intercept drainage, including filter drains, will be placed at the property perimeter to direct runoff back into the on-site surface water management systems and to prevent the uncontrolled discharge of runoff to off-site areas.

5.6.5 Groundwater is indicated to be absent at this location. It is therefore anticipated that the surface water storage area will not suffer impacts to efficiency arising from groundwater ingress. Where groundwater is encountered during construction a clay liner should be incorporated within the design of the pond to prevent its ingress.

5.7 Health and Safety

5.7.1 The banks of the detention pond have been designed with slopes of 1:3 to allow safe '*crawl out'* in the event of accidental fall-in (where water is present).

5.7.2 The detention pond is located within an industrial setting with public access restricted by the presence of security fencing at the perimeter of the wider compound. The pond is also fenced to limit accidental fall in, with life buoys present which could be thrown to personnel in this event.

5.7.3 It is recommended that a risk assessment be completed for '*working near water*' with this shared with all personnel visiting the property.

5.8 Water Quality

5.8.1 The surface water management system incorporates a number of SuDS elements which have been designed in accordance with the SuDS Manual (CIRIA report no. C753) to provide on-site water quality treatment. These measures account for the Pollution Hazard and Mitigation Indices outlined within Tables 26.2 and 26.3 of the SuDS Manual, respectively; with these summarised in Tables 009 and 010 of this report.

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
General industrial (Energy Facility)	High	0.8	0.8	0.9

Table 009: Excerpt from CIRIA 753 Table 26.2 Pollution Hazard Indices for Different Land Use Classifications

5.8.2 Review of the SuDS Manual Table 26.2 indicates there to be no hazard classification which applies specifically to the nature of development proposed. However, as the proposals are industrial in nature a ***High Hazard*** has been assumed.

	SuDS Mitigation Indices		
SuDS Component	**Total Suspended Solids**	**Metals**	**Hydrocarbons**
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4	0.4	0.4
Detention Basin	0.5	0.5	0.6
Adjusted SuDS Mitigation Index[1]	**0.85**	**0.85**	**1.0**

[1] Applies where the Mitigation Index of individual SuDS component is insufficient to treat runoff in isolation and where 2 SuDS components (or more) are required in series

Table 010: Excerpt from CIRIA 753 Table 26.3 SuDS Mitigation Indices for Discharges to Surface Waters

5.8.3 Review of the above data indicates the Mitigation Index for each of the SuDS Components (considered in isolation) to be below the identified Pollution Hazard Index for each of the potential contaminants present within runoff generated by High Hazard sites.

5.8.4 The guidance notes within CIRIA 753, P.568 state that where the Mitigation Index of an individual SuDS component is insufficient to perform water treatment in isolation, two SuDS components (or more) in series are required, where:

$$\textbf{Total SuDS Mitigation Index} = \textbf{Mitigation Index}_1 + 0.5\ (\textbf{Mitigation Index}_2)$$

5.8.5 A factor of 0.5 is used to account for the reduced performance of secondary or tertiary components associated with already reduced inflow concentrations. For example, the adjustment for TSS would be calculated as follows:

$$\textbf{Total SuDS Mitigation Index (TSS)} = 0.4 + (0.5 \times 0.4) = 0.60$$

5.8.6 The adjusted SuDS Mitigation Indices are presented in the bottom row of Table 010. Based on this adjusted data it is concluded that the proposed SuDS Mitigation measures outlined above and expanded on below, are sufficient to mitigate potential contaminants present within the runoff from the proposed facility in isolation, with no requirement for further water quality treatment.

5.8.7 Nevertheless, an oil interceptor could be installed where required. This would be sized in accordance with the manufacturer's specification for oil separators within an industrial setting and accounting for the upstream drainage area.

Water Quality Treatment

5.8.8 Based on the above analysis, the following water quality treatment measures will be interspersed throughout the development and will service the different built elements as follows:

- **Roof drainage (where present)**: to pass to the detention pond via filter drains with no further treatment aside from silt traps located at the upstream end of all pipe runs to remove silts and sediments u/s of the attenuation area;
- **Potentially contaminated runoff from the plant, roads and hardstanding:** will discharge to the detention area via the following water quality treatment, designed in accordance with the requirements of the SuDS Manual section 4 (Table 4.3) and Section 26 (Tables 26.2 and 26.3):
    - **Filter Strips:** 1m wide grass / crushed stone strips present between facility / car parks / roads / filter drains to slow runoff and encourage sediment deposition;
    - **Filter Drains:** Situated at the property perimeter and designed to convey runoff into the detention facility via an underlying permeable pipe. Permeable pipework to be wrapped in membrane to prevent sediment ingress; and
    - **Detention Basin**: Reeds planting to reduce flows, encourage silt / sediment deposition and to further aid water quality polishing upstream of the outfall.

5.8.9 The inclusion of the above SuDS measures throughout the facility will encourage the settlement and retention of sediments, preventing blockage of the inlet(s) / outfall(s), the discharge of sediment laden water to local receiving waters and associated scour, and will ensure that only clean water is discharged, preventing potential detrimental impacts on downstream receptors.

5.8.10 The underlying clay geology and depth to groundwater will prevent the opening of contaminant pathways between surface and groundwater and ensure that the detention facility will not suffer impacts to efficiency arising from groundwater ingress. Where groundwater is encountered during construction of the detention area, clay liners should be installed to prevent its ingress.

First Flush Areas

5.8.11 In line with best practise, first flush storage is required to accept the first 5mm of rainfall from impervious surfaces and infiltrate it into the surrounding topsoil. This to reduce off-site surface water discharges during minor rainfall events.

5.8.12 A total first flush storage requirement of 54.20m^3 is calculated based on an effective impermeable area of 10,840m^2. It is anticipated that this would be easily accommodated within the on-site SuDS measures, which include filter drains and a detention basin. These will promote the interception and infiltration of runoff at source, limiting off-site discharges under general / low flow conditions.

5.9 Management and Maintenance Responsibility

5.9.1 **Forsa Energy Gas Holdings Ltd.** will be responsible for ensuring the ongoing management and maintenance of the surface water management systems serving the application area and car park, either directly or via an appointed contractor.

Inspection and Maintenance Schedule

5.9.2 It is proposed that a programme of inspection and maintenance be executed for the surface water management systems by the site facilities manager, or appointed drainage contractor. This should be undertaken in accordance with the schedule outlined below and following significant rainfall events and / or storm activity.

5.9.3 A photographic record of inspections should be undertaken to pick up long term changes that may not be apparent within a single inspection. Inspections should comply with all relevant Health and Safety legislation.

5.9.4 This maintenance schedule applies for the lifetime of the development.

Notes

5.9.5 All waste arisings should be collected by an approved contractor and should be subject to appropriate treatment and disposal. The site facilities manager should be contacted where pollution or blockage are identified.

Element	Frequency	Notes
Gulleys / Gulley Pots / Drainage grates	Quarterly / following storm activity	▪ Remove grill and check for debris / blockage. ▪ Remove accumulated debris to prevent blockage of below ground pipework. ▪ Rod / jet where required. Silt traps to be cleansed before **and** after rodding.
Manholes / Inspection Covers / pipework	Quarterly / following storm activity	▪ Visual inspection – remove cover, shine torch into manhole. ▪ Check every orifice for blockage / siltation. ▪ Pour water into each to verify through flow. ▪ Remove debris /silt and rod / jet where required.
Silt Traps	Quarterly / following storm activity	▪ Visual inspection, removal of accumulated silt. ▪ Where rodding of manholes is proposed silt traps should be cleansed before and after to prevent silt bypassing the traps.
Filter Strips	Quarterly / following storm activity	▪ Regular mowing and maintenance will be key to ensuring the continued efficiency of the filter strips. ▪ Reseeding or turfing should be undertaken where bald patches or die back occur.
Filter Drains	Quarterly / following storm activity	▪ Visual inspection for accumulated silt / vegetation (at surface). ▪ Check for surface clogging / ponding. Remove vegetation / silt. ▪ Remove siltation / blockage from the stone sub-base and/or underlying pipework serving the drainage blanket.
Attenuation Areas / Swales	Annually Twice annually (Mar. / Sept.) / following storm activity	▪ Visual inspection for accumulated silt. Where significant siltation is seen, remedial works should be undertaken. ▪ Visual inspection / removal of accumulated, debris, blockage.
Inlets / Outfalls	Quarterly / following storm activity	▪ Visual inspection for accumulated debris or blockage, at both upstream and downstream faces. ▪ Check every orifice / inlet / outlet / structure for blockage or siltation, pour water into each to verify through flow. ▪ Remove any debris and rod where required.
Oil Separator (where present)	In accordance with manufacturers' specification.	▪ NA

Table 011: Drainage Inspection and Maintenance Schedule

6.0 CONCLUSIONS & RECOMMENDATIONS

6.0.1 Amber Planning Ltd. has been appointed by Forsa Energy Gas Holdings Ltd. to prepare a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment in support of a revised application for the installation of a 50MW Energy Reserve Facility to provide back-up generation for the National Grid. This comprises a 0.6ha area, with associated hardstanding areas and access within a 1.76ha wider plot of land at Hallen Industrial Estate, Severn Road, Avonmouth, BS10 7SE. The Hallen Industrial Estate area falls within the administrative remit of Bristol City Council and South Gloucestershire Council.

6.0.2 This Flood Risk Assessment has been completed in accordance with the guidance set out in the NPPF, Section 14, and its accompanying PPG for '*Essential Infrastructure'* within defended Flood Zone 3a. The requirements of Local Planning Policy, including the SFRA, have been accounted for within the assessment of flood risk.

6.0.3 A scoping exercise has been completed which considers all potential flood risks, each of which have been fully assessed as part of this study, with flood mitigation and management measures proposed to ensure that all identified flood risks can be reduced to an acceptable level throughout the development lifetime and accounting for climate change predictions.

6.0.4 Residual risks associated with flood defence failure and extreme return period storm events have been assessed, with the flood risk concluded to be practicably low accounting for on-site flood risk mitigation and management measures. This would be further ameliorated by strategic flood defence works which are ongoing in the wider locale.

6.0.5 The surface water attenuation requirements for the facility have been assessed using the WinDes Micro Drainage software package for return period rainfall events up to and including 100 years, taking account of existing runoff rates and climate change consideration at 25% and with a total storage of 555m^3 proposed. Gravitational discharge to local watercourses is proposed at controlled (Greenfield) rates.

6.0.6 All drainage networks have been designed to account for industry best practise with regards system capacity, with safety factors accounted for within the surface water storage calculations to allow for successive rainfall events, fluctuations in flow, flood level, climate change sensitivity and losses in efficiency associated with siltation.

6.0.7 It is duly presented that the provision of a formal surface water management system, which incorporates on-site attenuation and water quality treatment, will ensure that potential detrimental impacts to flood risk and water quality are suitably mitigated throughout the anticipated development lifetime, in accordance with the National Planning Policy Framework and its accompanying Planning Practice Guidance. The requirements of Local Planning Policy and Technical studies have also been accounted for within this assessment.

6.0.8 **Forsa Energy Gas Holdings Ltd;** or its successor, will be responsible for the ongoing management and maintenance of the surface water management system(s), throughout the development lifetime, either directly or via an appointed contractor. The responsibility for management and maintenance will pass to the lessee, where the site is operated by a third party, and to the purchaser where the site is subject to sale.

6.0.9 The mitigation solutions noted within this report are subject to agreement with the EA / LSIDB, South Gloucestershire Council and Bristol City Council in their respective capacities within the Lead Local Flood Authority and as part of the application process.

6.0.10 It is duly presented that the application is appropriate within the context of the NPPF (Section 14) and Local Planning Policy.

7.0 CLOSURE

7.0.1 This report has been prepared by Amber Planning Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

7.0.2 Reliance has been placed on factual and anecdotal data obtained from the sources identified. Amber Planning Ltd cannot be held responsible for the scope of work, or any omissions, misrepresentation, errors or inaccuracies with the supplied information. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part in the event of delay between the writing of the report and submission of the planning application.

7.0.3 This report is for the exclusive use of the client; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from Amber Planning.

7.0.4 Amber Planning disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

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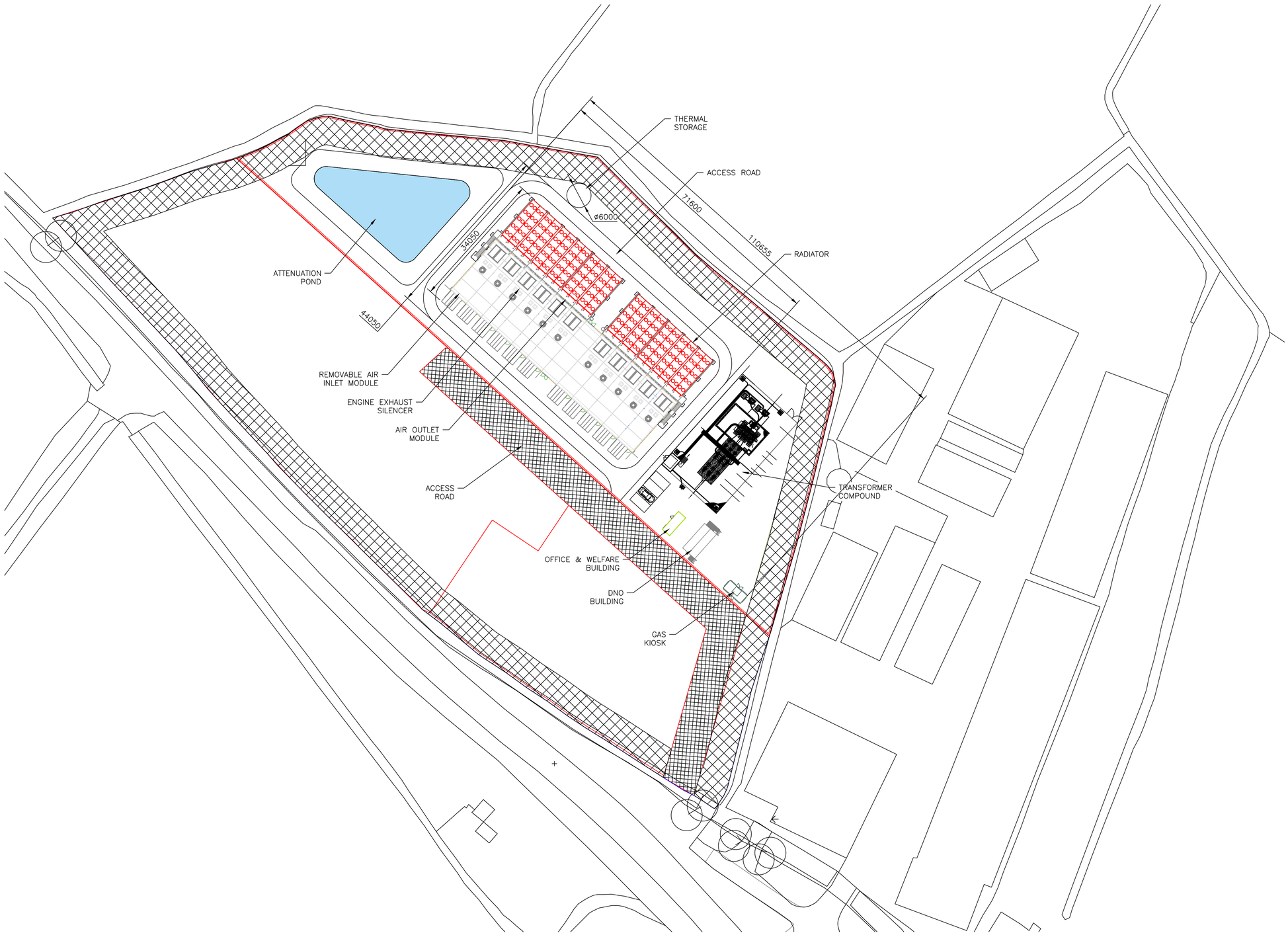

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TA	TENDER ISSUE	SR	N/A	N/A	LG	30.09.22

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TITLE	PLAN VIEW ON SITE LAYOUT OF 50MW ENERGY CENTRE
CLIENT	FORSA
SITE	AVONMOUTH

PAPER SIZE.	A1	SCALE.	1:500		
DRAWN BY.	SATHISH RAMASWAMY	DATE DRAWN.	30.09.22	ISSUE.	
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1063 Wt. 22438/0384 10M 7/45 (51) F.&S.

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only) 1

6-inch Map Registered No.

ST/58 SW 12

5436 8114

Name and Number of ~~Shaft or~~ Bore AVONMOUTH. No. 3. (WILLOW FARM)

For ~~Wagons~~ N.C.B.

Town or Village near Hallen

County Glos. Six-inch quarter sheet 67 SE.

6-inch Map Registered No. SN. 1175.

Exact site 1460 yd N.W. of Hallen Church and 530 yd due S. of Minors Farm

Attach a tracing from a map, or a sketch-map, if possible.

Purpose for which made Coal

Level at which ~~shaft~~ bore commenced relative to O.D. +21.45 ft (O.S.M.) State if ~~shaft~~ bore is ~~up~~, down, ~~horizontal~~ or ~~inclined;~~ in latter cases give angle of inclination and direction

Made by John Thom.

~~Information from~~ Cores examined by H.M. Geological Survey. Date of Sinking Nov. 1953 – 8 Jan. 1954.

Specimens

Additional Notes in Space Overleaf

For Survey use only) Geological Classification	Nature of Strata	Thickness Ft.	Thickness In.	Depth (M.)	Depth Ft.	Depth In.
Driller's log. No cores. Roller-rock bit.	ALLUVIUM Brown clay	7	6	(2.29)	7	6
	Light blue loam	61	0	(20.88)	68	6
	GRAVEL Sand and gravel	4	0	(22.10)	72	6
	TRIAS Red sandy marl	78	2	(45.92)	150	8
Cores start 150'8":	Tough brick red marly sandstone	1	1	(46.25)	151	9
	Red-green sandy marl with thin satin-spar veins	0	6	(46.41)	152	3
	Red marly sandstone with greenish mottlings					
	152'6"–9" Satinspar veins 152'0"–0½":					
	Small clots and stringers of satinspar and gypsum					
	156'6"–9" Large masses of sandstone full of					
	gypsum stringers 162'2"–168'4" Gypsum stringers 165'6–6"					
	Gypsum nodules (small) 167'10"–168'0", (large)					
	168'6"–169'0":	17	1	(51.61)	169	4
	Brick-red — chocolate coloured sandy marl, with					
	½" band of gypsum 169'8"	0	4	(51.71)	169	8
	Red and green clayey marl	0	4	(51.82)	170	0
	Gypsum layer	0	1	(51.84)	170	1
	COAL MEASURES Rotten red-grey clay	0	11	(52.12)	171	0
	Red-grey, hard, sandy ganisterised mudstone with					
	small rootlets filled with siderite (now decomposed					
	to reddish limonitic clay)	1	0	(52.48)	172	0
	Hard red-stained sandy mudstone or muddy sandstone	0	8	(52.63)	172	8
	Decomposed red-yellow sandy mudstone	0	3	(52.71)	172	11
	Red-grey-olive green fine grained muddy sandstone,					
	with thin satinspar veins in diagonal joints					
	from 174'0"–175'0":	2	7	(53.49)	175	6
	Hard purplish-red micaceous sandy mudstone	0	6	(53.624)	176	0
	Red stained sandstone	0	4	(53.75)	176	4
		Continued Overleaf				

Geological Survey and Museum, South Kensington, London, S.W.7.	Date received	Correspondence File No.	1" N.S. Map No.	1" O.S. Map No.	Site marked (use symbol) on 1" Map	on 6" Map

(For Survey use only) GEOLOGICAL CLASSIFICATION	NATURE OF STRATA (Continued)	THICKNESS Dip.	Ft	In	DEPTH (m)	Ft	In
	Hard purplish-grey micaceous sandy mudstone reddened on bedding planes		0	10	(54·00)	177	2
	Hard fine grained grey sandstone. Red stained		1	6	(54·46)	178	8
	Very hard, finely streaky, purple grey sandy mudstone (locally red stained)		5	0	(55·98)	183	8
	Softer, rotten, purplish red sandy mudstone with a few gypsum nodules on joints.		1	10	(56·54)	185	6
	Hard fine grained purple-grey sandy mudstone		1	0	(56·85)	186	6
	Hard purple muddy sandstone – sandy mudstone		0	8	(57·02)	187	2
	Fine grained purple silty micaceous mudstone with rotten red stained plant fragments	? 20° 188'0"	2	2	(57·71)	189	4
	Hard splintery streaky sandstone – sandy mudstone.		0	2	(57·76)	189	6
(Loss. 190'6" – 191'1½")	Fine grained grey, sandy – silty mudstone. Trace of Calamites. Staining only on some bedding planes	15° 190'0"	1	8	(58·22)	191	2
	Hard sandy mudstone – fine grained sandstone.		0	4	(58·37)	191	6
	Soft fine grained silty mudstone. Scattered red patches on some bedding planes. Occasional trace of decomposed reddened pisolites. Rolled siderite patches 192'0" – 9"		1	3	(58·75)	192	9
(Red staining ends at 193'4")	Grey silty mudstone with occasional siderite clots.						
(Omit Fill Cheshire)	Joints and bedding planes coated with Remains of Gypsum. Slightly streaky 195'6" – 9"	13° 195'0"	3	3	(59·74)	196	0
	Medium – dark grey silty – sandy micaceous mudstone with abundant small decomposed siderite nodules. Rock locally coarser and streaked with sandstone. Calamite stems	15° 196'6"					
	abundant from 196'2" – 198'9"		2	10	(60·60)	198	10
	Hard muddy sandstone with Calamite stems		0	4	(60·71)	199	2
(Loss. 203'10" – 204'3")	Soft decomposed micaceous mudstone with abundant siderite nodules. Calamites abundant.		6	10	(62·79)	206	0
	Medium – dark grey ganisterised mudstone – fireclay.						
	Irregularly bedded. Abundant siderite nodules.		2	5	(63·53)	208	5
	Dark fissile, laminated carbonaceous mudstone full of						
	Compressed Carbonaceous Calamite stems.		0	1	(63·55)	208	6

ADDITIONAL NOTES

ST 58 SW/12 3
5436 8114

Avonmoult No. 3. (contd. from 208'6")

	Dip.	Thickness Ft. In.	Depth Ft. In. (M)
Carried forward.			208 – 6 (63.55)
Dark soft decomposed fireclay with abundant rotted ironstone nodules		11 – 6	220 – 0 (67.06)
Medium-dark grey fireclay – mudstone. Numerous ironstone nodules. Pyrite films.		1 – 0	221 – 0 (67.36)
Fireclay with patches of ganisterised mudstone.		5 – 0	226 – 0 (68.88)
Dark ganisterised mudstone. Crushed to rashings 228'0 – 230'0.		4 – 8	230 – 8 (70.31)
Dark carbonaceous laminated mudstone full of compressed Calamite stems.		0 – 1	230 – 9 (70.34)
COAL		0 – 8	231 – 5 (70.54)
Dark grey fireclay with abundant ironstone nodules, passing into		8 – 7	240 – 0 (73.15)
Medium-dark grey, soft silty micaceous mudstone. Numerous flattened Calamite stems and occasional pinnules. Rock crushed & broken 240'8"–241'2"		1 – 2	241 – 2 (73.51)
Medium-grey, slightly harder silty ganisterised mudstone with rootlets and ironstone nodules		1 – 4	242 – 6 (73.91)
Medium-grey hard, sandy ganisterised mudstone		1 – 6	244 – 0 (74.37)
Medium-dark grey soft ganisterised mudstone with ironstone nodules. Less ganisterised below 246'0". Often Calamites and Neuropteris occur. Rock latter crushed and slick.		3 – 0	247 – 0 (75.29)
Medium-grey smooth silty plant mudstone. Scattered sideritic patches.		0 – 6	247 – 6 (75.44)
Medium-dark grey. Hard sandy ganisterised mudstone. Slick		0 – 6	248 – 0 (75.59)
Medium-dark grey, hard sandy mudstone – muddy sandstone with occasional Calamites and pinnules.		3 – 6	251 – 6 (76.66)
Medium grey, latter soft crushed mudstone, full of compressed plant fragments.		0 – 6	252 – 0 (76.81)
Dark grey mudstone – fireclay with rootlets and ironstone nodules, becoming harder with depth and passing into		1 – 0	253 – 0 (77.11)
Clunch with rootlets.		2 – 0	255 – 0 (77.72)
Firm medium grey sandy mudstone, slightly ganisterised. Calamites		0 – 6	255 – 6 (77.88)
Softer, silty-sandy, medium grey mudstone, very slightly ganisterised to 258'0". Rich band of plant pinnules 258'0" – 261'1". Calamites abundant 261'9" – 262'2".		6 – 8	262 – 2 (79.91)
Harder, more sandy mudstone: feebly ganisterised. Ironstone nodules. Calamites abundant 264'3" – 265'6".		3 – 4	265 – 6 (80.92)
Hard sleeky sandstone and sandy mudstone. Occasional Calamites.		0 – 6	266 – 0 (81.08)
Medium grey, slightly sleeky sandstone		1 – 7	267 – 7 (81.56)
Medium-grey, hard sandy micaceous mudstone with occasional rootlets and carbonised plant stems.		1 – 11	269 – 6 (82.14) (82.35)
Medium-dark grey, softer, silty micaceous mudstone with occasional pinnules.		0 – 8	270 – 2 (82.38)
Medium grey hard sandy mudstone. Calamite band 270'11" – 271'0".		1 – 3	271 – 5 (82.78)
Medium grey sleeky sandstone and sandy mudstone		0 – 7	272 – 0 (82.91)
Medium grey, smooth, silty mudstone, faintly sleeky.		1 – 0	273 – 0 (83.21)
Harder sleeky micaceous sandstone and sandy mudstone with occasional ironstone nodules and carbonised plant stems. Pinnules of Neuropteris. Rock fractures badly.	16° 275'3"	2 – 6	275 – 6 (83.97)
Smooth textured, softer, medium-dark grey silty micaceous mudstone with conchoidal fracture. Better bedded below 280'0". Rich band of plant pinnules 279'10" – 281'0".		6 – 0	281 – 6 (85.80)

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Avonmoult No 3. (Contd. from 281'6")

	Dip	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
				(85·80) M	
				281	6
Carried forward.					
Medium – dark grey, rather 'earthy' textured mudstone : soft and with compressed carbonaceous plant stems and occasional pinnules.		0	10	(86·06) 282	4
Medium – dark grey laminated carbonaceous mudstone full of compressed carbonaceous Calamites. Annularia. Neuropteris.		1	8	(86·56) 284	0.
Dark carbonaceous mudstone with coaly wisps	14° in seam.	1	8	(87·07) 285	8
No.1. SEAM / COAL.		6	2	(88·95) 291	10
[redacted]		[redacted]		[redacted]	
Medium grey, rather hard sandy fireclay with rootlets + ironstone nodules	12° 294'6"	3	2	(89·92) 295	0.
Grey, very hard gamisterised sandy mudstone with rootlets		0	11	(90·20) 295	11.
No core. Roller rock drilling before reducing diameter. Said to be mudstone.		5	1	(91·74) 301	0.
Medium-grey hard badly bedded sandy, sideritic mudstone with occasional ironstone nodules		1	0	(92·05) 302	0
Medium – dark grey smooth, silty mudstone. Ironstone bands 302'2"–2¼" and 302'5½"–5¾".	15° 302'5"	0	6½	(92·20) 302	6½
Harder, more sandy mudstone with very poorly preserved plant fragments.		0	6½	(92·38) 303	1
Medium – dark grey, smooth textured mudstone with sandy streaks from 303'8"– 304'0".		0	11	(92·66) 304	0
Harder, more sandy, sideritic mudstone. Badly bedded. Ironst. band 304'3".		2	9	(93·50) 306	9
Hard, sandy, faintly streaky mudstone with thin carbonaceous films of 'leaf-bed' to 307'2". Below this level rock becomes progressively less sandy, gradually passing into		0	10	(93·75) 307	7
Medium – dark grey, very smooth textured mudstone with sideritic bands 308'2"–2½". N.M.L. 308'10"– 309'4". Lepia. (1 specimen) at 309'5".		2	1	(94·39) 309	8
Hard splintery sandy, sideritic mudstone. Locally faintly streaky		1	4	(94·79) 311	0
Medium grey, hard, badly fracturing silty mudstone, becoming slightly better bedded at 311'6", and almost 'pond-mud' at 312'9". Sideritic bands 311'9"–10", 312'8", 314'3"–4".	15° 311'11"	3	8	(95·91) 314	8
Medium – dark grey, well bedded silty mudstone. Sideritic bands 315'7"–8", 316'11"– 317'0", 320'0", 321'10"–11", 323'7"–8". N.M.L. 315'4"– 317'11", Lepia 320'0" – 323'9".	15° 322'0"				
Between 318'0"– 319'0": Core broken and almost lashings. From 319'0"– 320'0": a small fold occurs in bedding. Core badly broken between 320'0" and 321'0".		9	4	(98·76) 324	0
Brown tinged cannelloid mudstone with NML. fragments at 324'1". Sheets of Lepia 324'3"– 326'0". From 325'1"– 325'4": scattered N.M.L. and plant fragments.		2	6	(99·52) 326	6
Brown cannelloid mudstone with compressed mat of carbonaceous plants		0	1	(99·54) 326	7
COAL		0	4	(99·64) 326	11
Medium – dark grey fireclay. Rootlets, stigmaria and ironstone nodules		2	1	(100·28) 329	0
Medium grey, lightly gamisterised mudstone with rootlets and abundant ironstone nodules		1	10	(100·84) 330	10
Streaky sandstone and mudstone		0	6½	(100·99) 331	4½
Medium grey, hard sandy mudstone with layers of 'plant-bed' Feebly gamisterised to 333'0"	15° 332'0"	1	7½	(101·50) 333	0

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5436 8114

Avonmouth No. 3 (Contd. from 333'0")

	Dip	Thickness Ft. In.	Depth Ft. In.
			(101.50) M
Carried forward			333 — 0
Smooth textured mudstone with occasional plant fragments.		1 — 6	(101.96) 334 — 6
Brownish Canneloid mudstone " " " "		0 — 2	(102.01) 334 — 8
Medium grey, badly bedded mudstone with 'earthy' texture.		0 — 4	(102.11) 335 — 0
Medium grey mudstone full of compressed carbonised plant stems		0 — 2	(102.16) 335 — 2
Carbonaceous mudstone, slightly canneloid		0 — 2	(102.21) 335 — 4
COAL. (inferior) with thin pyritic band in Centre.		0 — 1	(102.23) 335 — 5
Medium grey, smooth textured ganisterised mudstone with rootlets and ironstone nodules.		5 — 2	(103.81) 340 — 7
Laminated Canneloid mudstone with 'plant leaf'. Scattered Lepia throughout. I. NML at 340'7"		0 — 6	(103.96) 341 — 1
Dark coloured laminated canneloid mudstone with thin coaly films.		0 — 4	(104.07) 341 — 5
Medium grey fireclay or ganisterised mudstone		2 — 1	(104.70) 343 — 6
Laminated carbonaceous slightly canneloid mudstone with coaly films. I. spec. N.M.L.		0 — 3	(104.77) 343 — 9
Fireclay with ironstone nodules		2 — 9	(105.61) 346 — 6
Clunch, very sideritic		1 — 2	(105.97) 347 — 8
Medium-dark grey, muddy sandstone with darker layers of carbonised 'plant leaf' picking out the bedding.		3 — 2	(106.93) 350 — 10
Medium grey smooth textured, banded, silty mudstone with occasional sideritic patches. Calamites 352'11"		2 — 2	(107.39) 353 — 0
Faintly sheaky sandstone and mudstone		0 — 3	(107.67) 353 — 3
Sandy grey mudstone		0 — 10	(107.72) 354 — 1
Sandstone		0 — 2	(107.98) 354 — 3
Smooth grey mudstone		0 — 2	(108.03) 354 — 5
Medium grey sandstone		0 — 10	(108.28) 355 — 3
Medium grey, smooth textured mudstone, locally sheaky.		0 — 4	(108.38) 355 — 7
Medium grey Sandstone.		0 — 6	(108.53) 356 — 1
Medium-dark grey, smooth textured mudstone with sandstone band 356'5"—7". Rock slightly sheaky 356'10"—357'1". Lepia 357'2"—357'7". N.M.L. 357'9".	15° 358'8"	1 — 11	(109.12) 358 — 0
Brown canneloid mudstone full of sheets of N.M.L		0 — 2	(109.17) 358 — 2
Canneloid mudstone with flattened lenticles of decomposed ironstone.		0 — 4	(109.27) 358 — 6
Brown canneloid mudstone full of sheets of N.M.L		1 — 2	(109.63) 359 — 8
Medium grey smooth, silty mudstone. Sideritic bands 359'11"—360'0". N.M.L 361'1"—9".		3 — 7	(110.72) 363 — 3
Medium-pale grey slightly sandy mudstone with occasional plant fragments. Numerous sideritic bands 364'0"-1", 365'1"-2", 366'0"-1", 368'3"-4", 370'0"-1", 372'2½"-3", 373'2"-3". N.M.L. at intervals from 364'2"—373'1".	14° 363'9"	10 — 1	(113.39) 373 — 4
Mudstone, smooth textured, in alternating bands of dark and light grey (¼"-½" spacing). Numerous N.M.L 373'6"—375'6".	15° 375'7"	2 — 8	(114.60) 376 — 0
Medium-dark grey, non-striped, smooth textured mudstone. N.M.L. 376'1"—394'2½". Lepia 394'6½"—395'3".	15° 378'9"		
Sideritic bands. 376'9"-10", 377'3"-4", 377'8"-9", 378'7"-8", 379'6"-7", 380'1"-1½", 381'5½"-6½", 383'10"-384'0", 384'10"-11", 385'2½"-3", 386'0"-1", 386'9"-10", 387'11"-388'0", 388'11"-389'0", 389'5"-6", 389'10"-11". Small pyritic clots in basal 5. ins.	15° 385'6" / 13° 393'0"	19 — 5	(120.52) 395 — 5

6

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Avonmouth No 3. (Contd. from 395'5")

		Thickness Ft. In	Depth Ft. In.
			(120·58) M 395 – 5
Carried forward			
No. 2. SEAM.			
From penetrameter readings	Coal 28 in.		
	dirt 15 in		
	Coal 25 in		
	dirt 7 in		(122·53)
	Coal 4 in.	6 – 7	402 – 0
Fireclay		3 – 0	123·44 405 – 0
(3" Not recovered)	Bored to	0 – 3	123·52. 405 – 3

(*11932) Wt.30370/0370 10,000 9/39 A.& E.W.Ltd. Gp.685

RECORD OF SHAFT OR BORE FOR MINERALS

ST 58 SW/42.
c. 5437 8127.

County Glos.

6" Quarter Sheet 67 SE (W)

1" N.S. Geol. Map 264

1" O.S. Geol. Map

Whether Confidential

Name and Number of Shaft or Bore given by Geological Survey:

Name and Number given by owner (if different from above): No 2.

Town or Village Date of sinking 1945

Exact site

A sketch-map or tracing from a large-scale map is desirable.

Purpose for which made Trial bore to test alluvium

Level at which bore commenced relative to O.D. If not down bore, state if horizontal or up

Made by Soil Mechanics Ltd for Messrs. Port of Bristol Authority

Information from Date received 1946

Specimens Dip of strata

Geological Classification	Description	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
DRIFT DEPOSITS	Soft brown & blue clay	7	-	7	-
	Soft grey silty clay	11	-	18	-
	Black peaty clay	-	6	18	6
	Soft grey silty clay	7	6	26	-
	Black peat	-	9	26	9
	Soft grey silty clay with fine sand & organic fragts.	18	9	45	6
	occasional peaty bands				
	Very fine grey sand becoming silty	5	6	51	0
	Soft grey brown silty clay, organic matter, shell debris	3	0	54	0
	Firm reddish brown sandy clay flecked with blue	2	0	56	0
TRIAS	Red marl	3	6	59	6

Geological Survey and Museum,
South Kensington,
London, S.W.7.

G.S.M. Office File No.	Site marked on 6" Map by	Site marked on 1" Map by

ST59SW/67.

Trial Pit No. 4441

Sheet 1 of 1

Methods
Machine dug to 3.60m by Fiat/Hitachi 130.
No support used.
Logged on excavated material below 1.20m.

Dates 27/04/90

Job No. 7625

Coordinates 354318 E 181139 N

Site SECOND SEVERN CROSSING
Main Onshore Ground Investigation

Ground Level 6.65 mOD

Client Department of Transport

Sample/Test Depth m	Sample/Test	Level mOD	Depth m (Thick)	Description	Legend
			(0.60)	Firm dark brown to black friable clayey SILT with many limestone boulders. (MADE GROUND)	
		6.05	0.60		
0.80	B 1			Firm light brown mottled grey friable very closely fissured very silty CLAY with occasional roots. (ESTUARINE ALLUVIUM) Below 1.10m, becoming grey mottled orange brown. From 2.20 to 2.25m, black carbonaceous layer. At 2.40m, becoming soft brown mottled grey.	
0.80	D 2				
0.60	D 3				
0.60 - 2.00	B 4				
1.10	D 5				
			(2.00)		
2.00 - 2.60	B 6				
2.20	D 7				
2.40	D 8				
2.60	D 9	4.05	2.60		
2.60 - 3.50	B 10			Soft grey very silty CLAY (ESTUARINE ALLUVIUM)	
			(0.90)		
3.50	D 11	3.15	3.50		
3.50	B 12	3.05	3.60	Soft to firm grey to blue grey very silty CLAY with occasional sand laminae, many decayed roots and open root holes. (ESTUARINE ALLUVIUM)	

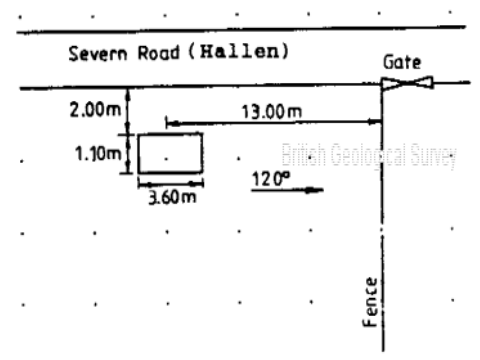
Remarks

Insitu Tests: CBR test at 0.80m
Groundwater: Slight flow from fissures at 2.10m
Variability of Faces: None
Stability of Faces: Unstable
Weather: Fine

See key sheet for symbols and abbreviations

100890/1240

Plan (Not to scale)



Scale 1:50

Logged by PA

GDS 1990-3

ST55SW/68.

Trial Pit No. 4442

Sheet 1 of 1

Methods
Machine dug to 3.60m by Fiat/Hitachi 130.
No support used.
Logged on excavated material below 1.20m.

Dates 27/04/90

Job No. 7625

Coordinates 354398 E 181051 N

Site SECOND SEVERN CROSSING
Main Onshore Ground Investigation

Ground Level 6.49 mOD

Client Department of Transport

Sample/Test Depth m	Sample/Test	Level mOD	Depth m (Thick)	Description	Legend
		6.29	(0.20) 0.20	TOPSOIL	
				Firm brown friable very closely fissured very silty CLAY with occasional roots. (ESTUARINE ALLUVIUM) Below 1.30m, becoming mottled grey. Below 1.80m, becoming firm and grey mottled orange brown with occasional shells.	
0.90	B 1				
0.90	D 2				
0.20	D 3				
0.20 - 1.80	B 4				
1.30	D 5		(2.40)		
1.80	D 6				
1.80 - 2.60	B 7				
2.60	D 8	3.89	2.60		
2.60 - 3.60	B 9			Soft grey very silty CLAY. (ESTUARINE ALLUVIUM) Below 3.10m, becoming very soft.	
3.10	D 10		(1.00)		
		2.89	3.60		

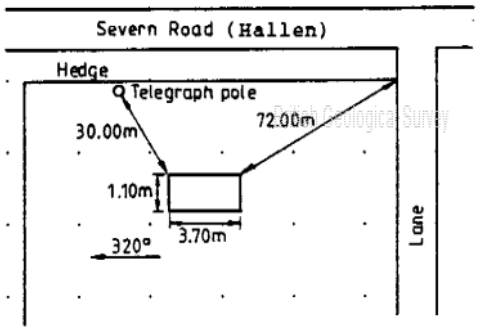
Remarks

Insitu Tests: CBR test at 0.90m
Groundwater: Seepage at 2.10m.
Variability of Faces: None
Stability of Faces: Stable
Weather: Fine

See key sheet for symbols and abbreviations

100890/1241

Plan (Not to scale)



Scale 1:50

Logged by PA

GDS 1990-3

1948 Wt. 22438/0384 10M 7/45 (51) F.&S.

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)
1" Map Registered No. 264/146

Name and Number of ~~Shaft~~ or Bore Avonmouth No. 3. ST58|21
(Willow Farm)
ST 5433 8115

For ~~Messrs.~~ N.C.B.

Town or Village Nr. Hallen.

County Glos. Six-inch quarter sheet 67 S.E/W

6-inch Map Registered No. SN.1175

Exact site 1460 yds. N.E. of Hallen Church and 530 yds. Due S of Minors Farm.

Attach a tracing from a map, or a sketch-map, if possible.

Purpose for which made For Coal

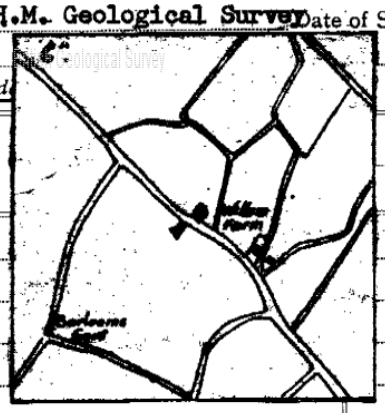
Level at which ~~shaft~~ bore commenced relative to O.D. 21.45 A.O.D. State if ~~shaft~~ bore is up, down, horizontal or inclined; in latter cases give angle of inclination and direction Down

Made by John Thom, Patricroft, Manchester.

~~Abstract~~ Cores examined by H.M. Geological Survey Date of Sinking November 1953- 8. Jo- 1954.

Specimens

Ad



(For Survey use only) Geological Classification	Nature	Thickness Ft.	Thickness Ins.	Depth Ft.	Depth Ins.
Driller's log.	Alluvium				
	(Brown clay.	7	6	7	6
No.cores.	(Light blue loam	61	-	68	6
Roller rock bit.	(GRAVEL				
	(Sand and gravel.	4	-	72	6
	(TRIAS				
	(Red sandy marl.	78	2	150	8
Cores	Tough brick red marly sandstone.	1	1	151	9
start 150'8".	Red-green sandy marl with thin satin-spar veins.	-	6	152	3
	Red marly sandstone with greenish mottlings 152'6"-9". Satinspar vein 152'0"-0¼".				
	Small clots and strings of satinspar and gypsum 156'6"-9". Large masses of sandstone full of gypsum strings 162'2"-163'4". Gypsum strings 165'0"-6". Gypsum nodules (small) 167'10"-168'0" (Large) 168'6" - 169'0".	17	1	169	4
	Brick-red - chocolate coloured sandy marl, with ½" band of gypsum 169'8".	-	4	169	8
	Red and green clayey marl.	-	4	170	-
	Gypsum layer.	-	1	170	1
	COAL MEASURES.				
	Rotten red-grey clay.	-	11	171	-
	Red-grey, hard, sandy ganisterised mudstone with small rootlets filled with siderite (now decomposed to reddish limonitic clay).	1	-	172	-
	Hard red-stained sandy mudstone or muddy sandstone.	-	8	172	8
	Decomposed red-yellow sandy mudstone.	-	3	172	11
	Red-grey-olive-green fine grained muddy sandstone, with thin satinspar veins in diagonal joints from 174'0" - 175'0".	2	7	175	6
	Hard purplish-red micaceous sandy mudstone.	-	6	176	-
	Red stained sandstone.	-	4	176	4
	Hard purplish-grey micaceous sandy mudstone reddened on bedding planes.	-	10	177	2
	Hard fine grained grey sandstone. Red stained.	1	6	178	8
	Very hard, finely streaky, purple-grey sandy mudstone (locally red stained).	5	-	183	8
	Softer, rotten, purplish red sandy mudstone with a few gypsum nodules on joints.	1	10	185	6
	Hard fine grained purple-grey sandy mudstone	1	-	186	6

Continued Overleaf

Geological Survey and Museum, South Kensington, London, S.W.7.	Date received	Correspondence File No.	1" N.S. Map No.	1" O.S. Map No.	Site marked (use symbol) on 1" Map	on 6" Map
					⊙	⊙

(For Survey use only) Geological Classification	Nature of Strata (*Continued*)	Thickness	Ft.	Ins.	Depth	Ft.	Ins
	Hard purple muddy sandstone - sandy mudstone.		-	8		187	2
	Fine grained purple silty micaceous mudstone with rotten red stained plant fragments.	? 20° 188'0"	2	2		189	4
	Hard splintery streaky sandstone - sandy mudstone.		-	2		189	6
	Fine grained grey, sandy-silty mudstone. Trace of Calamites. Staining only on some	15°					
(Loss 190' 11"-191'1½")	bedding planes.	190'0"	1	8		191	2
	Hard sandy mudstone - fine grained sandstone.		-	4		191	6
	Softer fine grained silty mudstone. Scattered red patches on some bedding planes. Occasional trace of decomposed reddened pinnules. Rotted siderite patches 192'0"-9".		1	3		192	9
Red staining ends at 193' 4").	Grey silty mudstone with occasional siderite clots. Joints and bedding planes coated with	13°					
	laminae of . Slightly streaky 195'6"-9".	195'0"	3	3		196	-
	Medium-dark grey silty-sandy micaceous mudstone with abundant small decomposed siderite nodules. Rock locally coarser and streaked with sandstone. Calamite stems	15°					
	abundant from 196'2" - 198'9".	196'6"	2	10		198	10
	Hard muddy sandstone with Calamite stems.		-	4		199	2
(Loss 203' 10"-204'3")	Soft decomposed micaceous mudstone with abundant ironstone nodules. Calamites abundant.		6	10		206	-
	Medium-dark grey ganisterised mudstone - fireclay. Irregularly bedded. Abundant iron-						
	stone nodules.		2	5		208	5
	Dark fissile, laminated carbonaceous mud- stone full of compressed carbonaceous						
	calamite stems.		-	1		208	6
	Dark soft decomposed fireclay with abundant rotted ironstone nodules.		11	6		220	-
	Medium-dark grey fireclay-mudstone. Numerous ironstone nodules. Pyrite films.		1	-		221	-
	Fireclay with patches of ganisterised mudstone.		5	-		226	-
	Dark ganisterised mudstone. Crushed to rashings 228'0" - 230'0".		4	8		230	8
	Dark carbonaceous laminated mudstone full of compressed calamite stems.		-	1		230	9
	COAL		-	8		231	5
	Dark grey fireclay with abundant ironstone nodules, passing into		8	7		240	-
	Medium-dark grey, soft silty micaceous mudstone. Numerous flattened calamite stems and occasional pinnules. Rock crushed and broken 240'8" - 241'2".		1	2		241	2
	Medium-grey, slightly harder silty ganister- ised mudstone with rootlets and ironstone nodules.		1	4		242	6

ADDITIONAL NOTES

(*40549) Wt.10120/a161 5,000 4/50 A.& E.W.Ltd. Gp.685

Name and Number of Shaft or Bore given by Geological Survey:
Avonmouth No. 3 Borehole (Willow Farm)

County Glos.
Quarter Sheet 67 S.E.

ST58[2]

264/146

Geological Classification	Description	Thickness			Depth	
	Medium-grey hard, sandy ganisterised mudstone.		1	6	244	-
	Medium-dark grey soft ganisterised mudstone with ironstone nodules. Less ganisterised below 246'0", where Calamites and Neuropteris occur. Rock rather crushed and slick.		3	-	247	-
	Medium-grey smooth silty plant mudstone. Scattered siderite patches.		-	6	247	6
	Medium-dark grey, hard sandy ganisterised mudstone. Slick.		-	6	248	-
	Medium-dark grey, hard sandy mudstone - muddy sandstone with occasional calamites and pinnules.		3	6	251	6
	Medium grey, rather soft crushed mudstone, full of compressed plant fragments.		-	6	252	-
	Dark grey mudstone - fireclay with rootlets and ironstone nodules, becoming harder with depth and passing into		1	-	253	-
	Clunch with rootlets.		2	-	255	-
	Firm medium grey sandy mudstone, slightly ganisterised. Calamites.		-	6	255	6
	Softer, silty-sandy, medium grey mudstone, very slightly ganisterised to 258'0". Rich band of plant pinnules 258'0" - 261'1". Calamites abundant 261'9" - 262'2".		6	8	262	2
	Harder, more sandy mudstone, feebly ganisterised. Ironstone nodules. Calamites abundant 264'3" - 265'6".		3	4	265	6
	Hard streaky sandstone and sandy mudstone. Occasional Calamites.		-	6	266	-
	Medium grey, slightly streaky sandstone.		1	7	267	7
	Medium-grey, hard sandy micaceous mudstone with occasional rootlets and carbonised plant stems.		1	11	269	6
	Medium-dark grey, softer, silty micaceous mudstone with occasional pinnules.		-	8	270	2
	Medium grey hard sandy mudstone. Calamite band 270'11" - 271'0".		1	3	271	5
	Medium grey streaky sandstone and sandy mudstone.		-	7	272	-
	Medium grey, smooth, silty mudstone, faintly streaky.		1	-	273	-
	Harder streaky micaceous sandstone and sandy mudstone with occasional ironstone nodules and carbonised plant stems. Pinnules of Neuropteris. Rock fractures badly.	16° 275'3"	2	6	275	6
	Smooth textured, softer, medium-dark grey silty micaceous mudstone with conchoidal fracture. Better bedded below 280'0". Rich band of plant pinnules. 279'10" - 281'0".		6	-	281	6
	Medium-dark grey, rather 'earthy' textured mudstone: soft and with compressed carbonaceous plant stems and occasional pinnules.		-	10	282	4
	Medium-dark grey laminated carbonaceous mudstone full of compressed carbonaceous calamites. Annularia. Neuropteris.		1	8	284	-
	Dark carbonaceous mudstone with coaly wisps.	14° in seam.	1	8	285	8
	No. 1 Seam					
	COAL		6	2	291	10
	Medium grey, rather hard sandy fireclay with rootlets and ironstone nodules.	12° 294'6"	3	2	295	-
	Grey, very hard ganisterised sandy mudstone with rootlets.		-	11	295	11
	No core. Roller rock drilling before reducing diameter. Said to be mudstone.		5	1	301	-
	Medium-grey hard badly bedded sandy sideritic mudstone with occasional ironstone nodules.		1	-	302	-
	Medium-dark grey smooth silty mudstone. Iron-					

(*11932) Wt.30370/0370 10,000 9/39 A.& E.W.Ltd. Gp.685

Name and Number of Shaft or Bore given by Geological Survey: Avonmouth No. 3 (Willow Farm) ST58/21

264/146

County Glos. M

6" Quarter Sheet 67 S.E.

Geological Classification	Description	Thickness			Depth	
	stone bands 302'2" - 2¼" and 302'5½"-5¾".					
	Sandstone band 302'6"-6½".		-	6½	302	6½
	Harder, more sandy mudstone with very poorly preserved plant fragments.		-	6½	303	1
	Medium-dark grey, smooth textured mudstone with sandy streaks from 303'8"-304'0".		-	11	304	-
	Harder, more sandy, sideritic mudstone. Badly bedded. ironstone band 304'3".		2	9	306	9
	Hard, sandy, faintly streaky mudstone with thin carbonaceous films of 'leaf-hash' to 307'2". Below this level rock becomes progressively less sandy, gradually passing into Medium-dark grey, very smooth textured mudstone with siderite band 308'2"-2½". N.M.L. 308'10" - 309'4". Leaia (1 specimen) at 309'5".		-	10	307	7
	Hard splintery sandy, sideritic mudstone.		2	1	309	8
	Locally faintly streaky.		1	4	311	-
	Medium grey, hard, badly fracturing silty mudstone, becoming slightly better bedded at 311'6", and almost 'pond mud' at 312'9".	15° 311'11"				
	Siderite bands 311'9"-10", 312'8", 314'3"-4".		3	8	314	8
	Medium-dark grey, well bedded silty mudstone. Siderite bands 315'7"-8", 316'11"-317'0", 320'0", 321'10-11", 323'7"-8". N.M.L. 315'4"-317'11", Leaia 320'0" - 323'9".					
	Between 318'0" - 319'0" core broken and almost rashings. From 319'0" - 320'0" a small fold occurs in bedding. Core badly broken between 320'0" and 321'0".	15° 322'0"	9	4	324	-
	Brown tinged canneloid mudstone with N.M.L. fragments at 324'1". Sheets of Leaia 324'3"-326'0". From 325'1"-325'4". scattered N.M.L. and plant fragments.		2	6	326	6
	Brown canneloid mudstone with compressed mat of carbonaceous plants.		-	1	326	7
	COAL		-	4	326	11
	Medium-dark grey fireclay. Rootlets, stigmaria and ironstone nodules.		2	1	329	-
	Medium grey, highly ganisterised mudstone with rootlets and abundant ironstone nodules.		1	10	330	10
	Streaky sandstone and mudstone.	15°	-	6½	331	4½
	Medium grey, hard sandy mudstone with layers of 'plant hash'. Feebly ganisterised to 333'0".	332'0"	1	7½	333	-
	Smooth textured mudstone with occasional plant fragments.		1	6	334	6
	Brownish canneloid mudstone with occasional plant fragments.		-	2	334	8
	Medium grey, badly bedded mudstone with 'earthy' texture.		-	4	335	-
	Medium grey mudstone full of compressed carbonised plant stems.		-	2	335	2
	Carbonaceous mudstone, slightly canneloid.		-	2	335	4
	COAL (inferior) with thin pyritic band in centre.		-	1	335	5
	Medium grey, smooth textured ganisterised mudstone with rootlets and ironstone nodules.		5	2	340	7
	Laminated canneloid mudstone with 'plant hash' Scattered Leaia throughout. 1. N.M.L. at 340'7".		-	6	341	1
	Dark coloured laminated canneloid mudstone with thin coaly films.		-	4	341	5
	Medium grey fireclay or ganisterised mudstone.		2	1	343	6
	Laminated carbonaceous slightly canneloid mudstone with coaly films. 1 spec. N.M.L.		-	3	343	9
	Fireclay with ironstone nodules.		2	9	346	6
	Clunch, very sideritic.		1	2	347	8
	Medium-dark grey, muddy sandstone with darker layers of carbonised 'plant hash' picking out the bedding					

(*11932) Wt.30370/0370 10,000 9/39 A.& E.W.Ltd. Gp.685

Name and Number of Shaft or Bore given by Geological Survey:

Avonmouth No. 3 (Willow Farm)

ST58/21

264/146

County Glos. M

Sheet 67 S.E.

Geological Classification	Description	Thickness			Depth	
	Medium grey smooth textured, barren, silty mudstone with occasional sideritic patches. Calamites 352'11".		2	2	353	-
	Faintly streaky sandstone and mudstone.		-	3	353	3
	Sandy grey mudstone.		-	10	354	1
	Sandstone.		-	2	354	3
	Smooth grey mudstone.		-	2	354	5
	Medium grey sandstone.		-	10	355	3
	Medium grey, smooth textured mudstone, locally streaky.		-	4	355	7
	Medium grey sandstone.		-	6	356	1
	Medium-dark grey, smooth textured mudstone with sandstone band 356'5"-7". Rock slightly streaky 356'10" - 357'1". Leaia 357'2"-357'7". N.M.L. 357'9".	15° 356'8"	1	11	358	-
	Brown canneloid mudstone full of sheets of N.M.L.		-	2	358	2
	Canneloid mudstone with twisted lenticles of decomposed ironstone.		-	4	358	6
	Brown canneloid mudstone full of sheets of N.M.L.		1	2	359	8
	Medium grey smooth, silty mudstone. Siderite bands 359'11"-360'0". N.M.L. 361'1"-9".		3	7	363	3
	Medium-pale grey slightly sandy mudstone with occasional plant fragments. Numerous siderite bands 364'0"-1", 365'1"-2", 366'0"-1", 368'3-4", 370'0"-1", 372'2½"-3", 373'2"-3". N.M.L. at intervals from 364'2"-373'1".	14° 363'9"	10	1	373	4
	Mudstone, smooth textured, in alternating bands of dark and light grey (¼"-½" spacing). Numerous N.M.L. 373'6" - 375'6".	15° 375'7"	2	8	376	-
	Medium-dark grey, non-striped, smooth textured mudstone. N.M.L. 376'1"-394'2½". Leaia 394'6½" - 395'3".	15°				
	Siderite bands 376'9"-10", 377'3"-4", 377'8"-9", 378'7"-8", 379'6"-7", 380'1"-1½", 381'5½"-6½", 383'10"-384'0", 384'10"-11", 385'2½"-3", 386'0"-1", 386'9"-10", 387'11"-388'0", 388'11"-389'0", 389'5"-6", 389'10"-11".	378'9" 15° 385'6" 13°				
	Small pyritic clots in basal 5 ins.	393'0"	19	5	395	5
	No.2 Seam (Coal 28 in. (Dirt 15 in. From penetrometer readings (Coal 25 in. (Dirt 7 in. (Coal 4 in.		6	7	402	-
	Fireclay		3	-	405	-
	(3" Not recovered) Bored to		-	3	405	3

1063 Wt. 22438/0384 10M 7/45 (51) F.&S.

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)
1-inch Map Registered No. 264/M

Name and Number of Shaft or Bore: Avonmouth No 3. Willow Farm ST58/21

For Messrs. NCB

Town or Village: Nr. Avonmouth

County: Glos Six-inch quarter sheet: 67SE/w

6-inch Map Registered No. 46

Exact site

Attach a tracing from a map, or a sketch-map, if possible.

Purpose for which made: Proving Coal Seams.

Level at which shaft / bore commenced relative to O.D. State if shaft / bore is up, down, horizontal or inclined; in latter cases give angle of inclination and direction

Made by

Information from: NCB. Date of Sinking

Specimens

Additional Notes in Space Overleaf

(For Survey use only) Geological Classification	Nature of Strata	Thickness	Depth
	Drift	56 0	
	Lias	59 0	
	No 1 Seam	291' 10	
	No 2 Seam	400 0.	
	Dip 12° NNE		
	Sited on Glos. 67 SE/W. 24.4.54 AF.		

Continued Overleaf

Geological Survey and Museum, South Kensington, London, S.W.7.	Date received	Correspondence File No.	1" N.S. Map No.	1" O.S. Map No.	Site marked (use symbol) on 1" Map	on 6" Map

ST 58/24
A-J

Port of Bristol Authority. Chittening Estate.

Records of a series of boreholes carried out on alluvial flats north of Avonmouth. 6" Glos. 67 SW. NW, SE.

'Boreholes show site to be underlain by a variable depth of soft clay in which lenses of peat & of fine sand occur resting on .. the Keuper Marl.'

Borehole No.	Depth to top marl.
ST58/24C 1	46
" D 2	56
" E 3	57
MRE 4	22 N/R.
" G 5	44
NRH 6	58 N/R
" A A	53
" B B	42
N/RJ C	35 NR

The peat beds are nearly all lenses less than 1'0" in thickness, the thickest in Borehole No 1 being 1-3". They do not seem to be confined to any definite horizon & peaty material occurs at many levels in the soft clay.

The sand varies greatly in thickness over the site. It is absent in B.H. No 4 & reaches a maximum thickness of 38'0" in B.H. No 6.

Soft silty clay. 20% fine sand, 47% silt & 33% clay. av. shear strength value 360 lb/sq.ft. Exceptional value 820 lb/sq.ft. from B.H. 3. This corresponds to a safe bearing press. for foundations of ½ ton/sq.ft. Allowance would have to be made for consolidation of silty clay & also for included peat.

Sand – fine sand grade almost entirely. Particle av. size .2 mm diam. Range of size of particles small.

Extr. from rep. by Soil Mechanics Ltd.

(*11932) Wt.30370/0370 10,000 9/39 A.& E.W.Ltd. Gp.685

RECORD OF SHAFT OR BORE FOR MINERALS

County Glos.
6" Quarter Sheet 67 SE (W)
1" N.S. Geol. Map 264
1" O.S. Geol. Map
Whether Confidential
ST [illegible] 4D

Name and Number of Shaft or Bore given by Geological Survey: ST5440 8126

Name and Number given by owner (if different from above): No 2.

Town or Village Date of sinking 1945

Exact site

A sketch-map or tracing from a large-scale map is desirable.

Purpose for which made Trial bore to the alluvium

Level at which bore commenced relative to O.D. If not down bore, state if horizontal or up

Made by Soil Mechanics Ltd for Messrs. Proj of Bristol Authority

Information from Date received 1946

Specimens Dip of strata

Geological Classification	Description	Thickness Ft	Thickness In	Depth Ft	Depth In.
DRIFT DEPOSITS.	Soft. brown + blue clay	7	–	7	–
	Soft. grey silty clay	11	–	18	–
	Black peaty clay	–	6	18	6
	Soft grey silty clay	7	6	26	–
	Black peat	–	9	26	9
	Soft grey silty clay with fine sand + organic fragts. occasional peaty bands	18	9	45	6
	Very fine sand becoming silty	5	6	51	0
	Soft grey brown silty clay, organic matter, shell debris	3	0	54	0
	Firm reddish brown sandy clay flecked with blue	2	0	56	0
TRIAS	Red marl	3	6	59	6

GEOLOGICAL SURVEY AND MUSEUM,
SOUTH KENSINGTON,
LONDON, S.W.7.

G.S.M. Office File No.	Site marked on 6" Map by	Site marked on 1" Map by

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	50.000	Urban	0.000
SAAR (mm)	800	Region Number	Region 8

Results l/s

QBAR Rural	256.8
QBAR Urban	256.8
Q100 years	621.5
Q1 year	200.3
Q30 years	489.5
Q100 years	621.5

Summary of Results for 2 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.176	0.176	6.0	0.0	6.0	83.2	O K
30 min Summer	0.214	0.214	6.4	0.0	6.4	102.8	O K
60 min Summer	0.256	0.256	6.5	0.0	6.5	125.1	O K
120 min Summer	0.297	0.297	6.5	0.0	6.5	147.5	O K
180 min Summer	0.317	0.317	6.5	0.0	6.5	158.6	O K
240 min Summer	0.328	0.328	6.5	0.0	6.5	165.0	O K
360 min Summer	0.342	0.342	6.5	0.0	6.5	172.7	O K
480 min Summer	0.348	0.348	6.5	0.0	6.5	176.4	O K
600 min Summer	0.350	0.350	6.5	0.0	6.5	177.6	O K
720 min Summer	0.350	0.350	6.5	0.0	6.5	177.4	O K
960 min Summer	0.355	0.355	6.5	0.0	6.5	180.4	O K
1440 min Summer	0.352	0.352	6.5	0.0	6.5	178.6	O K
2160 min Summer	0.333	0.333	6.5	0.0	6.5	168.1	O K
2880 min Summer	0.310	0.310	6.5	0.0	6.5	154.5	O K
4320 min Summer	0.240	0.240	6.5	0.0	6.5	116.2	O K
5760 min Summer	0.194	0.194	6.2	0.0	6.2	92.1	O K
7200 min Summer	0.164	0.164	5.8	0.0	5.8	76.9	O K
8640 min Summer	0.144	0.144	5.4	0.0	5.4	67.2	O K
10080 min Summer	0.131	0.131	5.0	0.0	5.0	60.4	O K
15 min Winter	0.196	0.196	6.3	0.0	6.3	93.5	O K
30 min Winter	0.239	0.239	6.5	0.0	6.5	115.9	O K
60 min Winter	0.286	0.286	6.5	0.0	6.5	141.5	O K
120 min Winter	0.333	0.333	6.5	0.0	6.5	168.1	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	43.975	0.0	32
30 min Summer	27.676	0.0	44
60 min Summer	17.419	0.0	70
120 min Summer	10.963	0.0	126
180 min Summer	8.362	0.0	180
240 min Summer	6.900	0.0	212
360 min Summer	5.263	0.0	278
480 min Summer	4.342	0.0	346
600 min Summer	3.741	0.0	416
720 min Summer	3.312	0.0	486
960 min Summer	2.805	0.0	628
1440 min Summer	2.220	0.0	904
2160 min Summer	1.757	0.0	1304
2880 min Summer	1.488	0.0	1684
4320 min Summer	1.118	0.0	2388
5760 min Summer	0.913	0.0	3072
7200 min Summer	0.780	0.0	3760
8640 min Summer	0.686	0.0	4496
10080 min Summer	0.615	0.0	5160
15 min Winter	43.975	0.0	32
30 min Winter	27.676	0.0	45
60 min Winter	17.419	0.0	72
120 min Winter	10.963	0.0	126

Summary of Results for 2 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.357	0.357	6.5	0.0	6.5	181.8	O K
240 min Winter	0.370	0.370	6.5	0.0	6.5	189.3	O K
360 min Winter	0.382	0.382	6.5	0.0	6.5	196.1	O K
480 min Winter	0.387	0.387	6.5	0.0	6.5	199.1	O K
600 min Winter	0.387	0.387	6.5	0.0	6.5	199.0	O K
720 min Winter	0.383	0.383	6.5	0.0	6.5	196.9	O K
960 min Winter	0.383	0.383	6.5	0.0	6.5	196.8	O K
1440 min Winter	0.366	0.366	6.5	0.0	6.5	186.8	O K
2160 min Winter	0.325	0.325	6.5	0.0	6.5	162.9	O K
2880 min Winter	0.279	0.279	6.5	0.0	6.5	137.8	O K
4320 min Winter	0.190	0.190	6.2	0.0	6.2	90.3	O K
5760 min Winter	0.147	0.147	5.5	0.0	5.5	68.5	O K
7200 min Winter	0.125	0.125	4.8	0.0	4.8	57.5	O K
8640 min Winter	0.111	0.111	4.3	0.0	4.3	50.7	O K
10080 min Winter	0.101	0.101	3.9	0.0	3.9	45.9	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	8.362	0.0	180
240 min Winter	6.900	0.0	234
360 min Winter	5.263	0.0	298
480 min Winter	4.342	0.0	376
600 min Winter	3.741	0.0	454
720 min Winter	3.312	0.0	530
960 min Winter	2.805	0.0	684
1440 min Winter	2.220	0.0	978
2160 min Winter	1.757	0.0	1388
2880 min Winter	1.488	0.0	1768
4320 min Winter	1.118	0.0	2432
5760 min Winter	0.913	0.0	3112
7200 min Winter	0.780	0.0	3768
8640 min Winter	0.686	0.0	4496
10080 min Winter	0.615	0.0	5160

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.313	Cv (Winter)	0.840
Return Period (years)	2	E (1km)	0.292	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.350	Winter Storms	Yes		
D2 (1km)	0.441	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 1.084

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.217	4-8	0.217	8-12	0.217	12-16	0.217	16-20	0.216

Model Details

Storage is Online Cover Level (m) 1.350

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	436.0	1.300	966.0

Hydro-Brake® Outflow Control

Design Head (m) 0.387 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 6.5 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Orifice Overflow Control

Diameter (m) 0.076 Discharge Coefficient 0.600 Invert Level (m) 0.505

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.400	0.400	6.5	0.0	6.5	207.1	O K
30 min Summer	0.464	0.464	6.6	0.0	6.6	246.5	O K
60 min Summer	0.532	0.532	6.8	0.3	7.1	289.7	O K
120 min Summer	0.592	0.592	7.1	2.3	9.4	329.7	O K
180 min Summer	0.617	0.617	7.2	3.3	10.4	346.5	O K
240 min Summer	0.627	0.627	7.2	3.5	10.7	353.5	O K
360 min Summer	0.636	0.636	7.3	3.7	10.9	359.9	O K
480 min Summer	0.640	0.640	7.3	3.8	11.0	362.7	O K
600 min Summer	0.641	0.641	7.3	3.8	11.0	363.0	O K
720 min Summer	0.639	0.639	7.3	3.7	11.0	361.6	O K
960 min Summer	0.644	0.644	7.3	3.8	11.1	365.4	O K
1440 min Summer	0.640	0.640	7.3	3.8	11.0	362.7	O K
2160 min Summer	0.623	0.623	7.2	3.4	10.6	350.6	O K
2880 min Summer	0.604	0.604	7.1	2.8	9.9	337.8	O K
4320 min Summer	0.542	0.542	6.8	0.5	7.4	295.9	O K
5760 min Summer	0.458	0.458	6.6	0.0	6.6	242.7	O K
7200 min Summer	0.375	0.375	6.5	0.0	6.5	192.4	O K
8640 min Summer	0.302	0.302	6.5	0.0	6.5	150.3	O K
10080 min Summer	0.247	0.247	6.5	0.0	6.5	119.9	O K
15 min Winter	0.442	0.442	6.5	0.0	6.5	232.8	O K
30 min Winter	0.513	0.513	6.7	0.0	6.8	277.3	O K
60 min Winter	0.585	0.585	7.0	2.0	9.1	324.8	O K
120 min Winter	0.649	0.649	7.3	3.9	11.2	369.0	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	106.318	0.0	33
30 min Summer	63.745	0.0	47
60 min Summer	38.220	0.5	76
120 min Summer	22.916	10.8	130
180 min Summer	16.989	22.3	184
240 min Summer	13.740	31.3	238
360 min Summer	10.186	43.7	294
480 min Summer	8.238	51.6	356
600 min Summer	6.987	56.1	424
720 min Summer	6.107	57.9	494
960 min Summer	5.070	65.2	632
1440 min Summer	3.900	68.0	908
2160 min Summer	3.000	63.4	1312
2880 min Summer	2.491	53.1	1712
4320 min Summer	1.819	7.4	2560
5760 min Summer	1.456	0.0	3352
7200 min Summer	1.224	0.0	4048
8640 min Summer	1.063	0.0	4752
10080 min Summer	0.943	0.0	5360
15 min Winter	106.318	0.0	33
30 min Winter	63.745	0.0	47
60 min Winter	38.220	7.1	74
120 min Winter	22.916	27.6	128

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.679	0.679	7.5	4.4	11.9	389.7	O K
240 min Winter	0.692	0.692	7.5	4.7	12.2	399.5	O K
360 min Winter	0.701	0.701	7.6	4.8	12.4	405.5	O K
480 min Winter	0.704	0.704	7.6	4.8	12.4	408.0	O K
600 min Winter	0.702	0.702	7.6	4.8	12.4	406.5	O K
720 min Winter	0.697	0.697	7.5	4.7	12.3	402.6	O K
960 min Winter	0.696	0.696	7.5	4.7	12.3	402.1	O K
1440 min Winter	0.678	0.678	7.5	4.4	11.9	389.6	O K
2160 min Winter	0.643	0.643	7.3	3.8	11.1	364.6	O K
2880 min Winter	0.611	0.611	7.1	3.1	10.3	342.5	O K
4320 min Winter	0.527	0.527	6.8	0.2	7.0	286.6	O K
5760 min Winter	0.392	0.392	6.5	0.0	6.5	202.3	O K
7200 min Winter	0.269	0.269	6.5	0.0	6.5	131.8	O K
8640 min Winter	0.198	0.198	6.3	0.0	6.3	94.4	O K
10080 min Winter	0.162	0.162	5.8	0.0	5.8	75.8	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	16.989	42.4	182
240 min Winter	13.740	53.5	236
360 min Winter	10.186	69.2	300
480 min Winter	8.238	79.6	374
600 min Winter	6.987	86.6	452
720 min Winter	6.107	91.0	528
960 min Winter	5.070	103.8	678
1440 min Winter	3.900	109.1	968
2160 min Winter	3.000	97.3	1388
2880 min Winter	2.491	76.6	1796
4320 min Winter	1.819	2.9	2736
5760 min Winter	1.456	0.0	3520
7200 min Winter	1.224	0.0	4112
8640 min Winter	1.063	0.0	4680
10080 min Winter	0.943	0.0	5344

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.313	Cv (Winter)	0.840
Return Period (years)	30	E (1km)	0.292	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.350	Winter Storms	Yes		
D2 (1km)	0.441	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 1.084

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.217	4-8	0.217	8-12	0.217	12-16	0.217	16-20	0.216

Model Details

Storage is Online Cover Level (m) 1.350

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	436.0	1.300	966.0

Hydro-Brake® Outflow Control

Design Head (m) 0.387 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 6.5 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Orifice Overflow Control

Diameter (m) 0.076 Discharge Coefficient 0.600 Invert Level (m) 0.505

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.565	0.565	6.9	1.3	8.2	311.6	O K
30 min Summer	0.637	0.637	7.3	3.7	11.0	360.8	O K
60 min Summer	0.710	0.710	7.6	4.9	12.5	412.1	O K
120 min Summer	0.773	0.773	7.9	5.8	13.7	458.5	O K
180 min Summer	0.798	0.798	8.0	6.1	14.1	477.9	O K
240 min Summer	0.808	0.808	8.1	6.2	14.3	485.2	O K
360 min Summer	0.813	0.813	8.1	6.3	14.4	489.3	O K
480 min Summer	0.814	0.814	8.1	6.3	14.4	489.7	O K
600 min Summer	0.811	0.811	8.1	6.2	14.3	487.4	O K
720 min Summer	0.805	0.805	8.1	6.2	14.2	483.2	O K
960 min Summer	0.808	0.808	8.1	6.2	14.3	485.2	O K
1440 min Summer	0.796	0.796	8.0	6.1	14.1	476.4	O K
2160 min Summer	0.766	0.766	7.9	5.7	13.6	453.5	O K
2880 min Summer	0.734	0.734	7.7	5.3	13.0	429.6	O K
4320 min Summer	0.647	0.647	7.3	3.9	11.2	367.5	O K
5760 min Summer	0.591	0.591	7.0	2.3	9.3	328.7	O K
7200 min Summer	0.543	0.543	6.8	0.6	7.4	296.5	O K
8640 min Summer	0.470	0.470	6.6	0.0	6.6	249.6	O K
10080 min Summer	0.393	0.393	6.5	0.0	6.5	202.6	O K
15 min Winter	0.620	0.620	7.2	3.4	10.5	349.0	O K
30 min Winter	0.699	0.699	7.6	4.8	12.3	404.4	O K
60 min Winter	0.778	0.778	7.9	5.8	13.8	462.9	O K
120 min Winter	0.849	0.849	8.3	6.7	14.9	517.4	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	158.426	3.0	34
30 min Summer	92.929	18.7	47
60 min Summer	54.510	42.4	74
120 min Summer	31.974	71.5	128
180 min Summer	23.404	90.4	184
240 min Summer	18.756	104.1	240
360 min Summer	13.728	123.4	296
480 min Summer	11.002	136.4	360
600 min Summer	9.266	145.4	426
720 min Summer	8.053	151.7	496
960 min Summer	6.624	169.8	634
1440 min Summer	5.031	185.9	910
2160 min Summer	3.821	182.6	1312
2880 min Summer	3.143	174.2	1704
4320 min Summer	2.266	117.3	2472
5760 min Summer	1.797	58.8	3248
7200 min Summer	1.501	10.5	4112
8640 min Summer	1.296	0.0	4928
10080 min Summer	1.144	0.0	5640
15 min Winter	158.426	13.3	33
30 min Winter	92.929	35.8	47
60 min Winter	54.510	64.9	74
120 min Winter	31.974	99.6	128

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.880	0.880	8.4	7.0	15.4	541.7	O K
240 min Winter	0.893	0.893	8.5	7.1	15.6	552.3	O K
360 min Winter	0.897	0.897	8.5	7.2	15.7	554.8	O K
480 min Winter	0.896	0.896	8.5	7.2	15.7	554.2	O K
600 min Winter	0.890	0.890	8.5	7.1	15.6	549.3	O K
720 min Winter	0.880	0.880	8.4	7.0	15.4	541.6	O K
960 min Winter	0.875	0.875	8.4	6.9	15.3	537.6	O K
1440 min Winter	0.846	0.846	8.3	6.6	14.9	515.1	O K
2160 min Winter	0.792	0.792	8.0	6.0	14.0	473.5	O K
2880 min Winter	0.742	0.742	7.8	5.4	13.1	435.5	O K
4320 min Winter	0.634	0.634	7.2	3.6	10.9	358.3	O K
5760 min Winter	0.571	0.571	7.0	1.5	8.4	315.3	O K
7200 min Winter	0.480	0.480	6.6	0.0	6.6	256.5	O K
8640 min Winter	0.351	0.351	6.5	0.0	6.5	178.3	O K
10080 min Winter	0.246	0.246	6.5	0.0	6.5	119.8	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	23.404	122.0	182
240 min Winter	18.756	138.4	238
360 min Winter	13.728	161.7	310
480 min Winter	11.002	177.6	378
600 min Winter	9.266	189.0	456
720 min Winter	8.053	197.3	532
960 min Winter	6.624	220.2	682
1440 min Winter	5.031	246.4	972
2160 min Winter	3.821	246.6	1388
2880 min Winter	3.143	229.5	1792
4320 min Winter	2.266	139.2	2564
5760 min Winter	1.797	45.4	3456
7200 min Winter	1.501	0.0	4400
8640 min Winter	1.296	0.0	5096
10080 min Winter	1.144	0.0	5560

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.313	Cv (Winter)	0.840
Return Period (years)	100	E (1km)	0.292	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.350	Winter Storms	Yes		
D2 (1km)	0.441	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 1.084

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.217	4-8	0.217	8-12	0.217	12-16	0.217	16-20	0.216

Model Details

Storage is Online Cover Level (m) 1.350

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	436.0	1.300	966.0

Hydro-Brake® Outflow Control

Design Head (m) 0.387 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 6.5 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Orifice Overflow Control

Diameter (m) 0.076 Discharge Coefficient 0.600 Invert Level (m) 0.505