

**FLOOD RISK ASSESSMENT AND SURFACE
WATER DRAINAGE STRATEGY**

**BRISTOL AND AVON RECYCLING LTD
BRISTOL**

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GENERAL NOTES

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1 INTRODUCTION

1.1 Background

A Planning Application is being prepared for the construction of a new wash plant at Bristol and Avon Recycling Ltd, Bristol, henceforth referred to as 'the site'.

Hafren Water has been commissioned to produce the requisite Flood Risk Assessment (FRA) and Outline Surface Water Drainage Strategy (SWDS) in support of the application.

1.2 Scope of the assessment

This FRA considers the risk of flooding to and from the site. Consideration is given to the risk from fluvial and rainfall events, with a return period of 1 in 100-years, and tidal events with a return period of 1 in 200 years, unless otherwise stated. An adjustment for the potential effects of future climate change has been included.

1.3 National Planning Policy and Guidance

This FRA has been undertaken in accordance with the statutory requirements of the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) regarding development and flood risk.

1.4 Data sources

The following data sources were used in this assessment:

Bristol & Avon Ltd

- Red Line Plus Attenuation Area DWG file
- Site location plan, 10/06/2022 (Drawing ref. 772-025-02)
- B&A yard spot level, 14/06/2024 (Drawing ref. DR-G-0001-S2-01)
- Indicative drainage plan, 15/08/2024 (Drawing ref. 772-025-25)
- Proposed site plan, June 2014 (Drawing red. 4167-SK2)

Ordnance Survey (OS)

- 1:10,000 scale mapping

British Geological Survey (BGS)

- Geological maps 1:50,000-scale (England & Wales), via the GeolIndex

Environment Agency (EA)

- Flood Map for Planning (River, Sea and Surface water)
- Tidal Breach map (ref. 363603-WX) (received 26th June 2024)

- Product 8 data (received 26th June 2024)
- Product 4 data (received 26th June 2024)

South Gloucestershire County Council (SGCC)

- Level 1 SFRA (November 2021)
- Local Flood Risk Management Strategy 2022 – 27 (July 2022)
- Adopted Core Strategy (December 2013)
- SEA Environmental Report (July 2022)
- Pre-app response referenced: PRE23/0634 (April 2024)

2 SITE DESCRIPTION

2.1 Location and setting

The site is located approximately 1 kilometre (km) north – northwest of Hallen, Avonmouth and approximately 2 km southeast of the Plining and Severn Beach. It is centred on National Grid Reference (NGR) ST 545 810, postcode BS10 7G and is 3.81 hectares (ha) in size. The site location is shown on *Drawing 3713/FRA/01*.

Severn Road runs parallel to the site's southwestern boundary. Approximately 50 m southeast of the site is the M49 motorway. The site is within an existing industrial area.

2.2 Existing Site Operations

Bristol & Avon Recycling Ltd Waste Transfer Station (WTS) is a waste reception, processing and transfer facility, which accepts construction demolition and excavation wastes. This operation is licensed through an existing, approved, environmental permit.

The operating WTS is currently separated into two main areas by the main access road, which runs northeastwards from the southeastern site entrance. The eastern side of the site comprises offices, parking bays and the current vehicle wash area that currently drain east to the Monks Well Rhine. The western side of the site is used for material storage and sorting. Plans of the current site layout and application area are provided within *Appendix 3713/FRA/A1*.

2.3 Topography

The topography of the site and surrounding area has been reviewed using spot levels obtained in May 2024, supplemented by LiDAR data.

Ground elevations generally range between 7 – 8 metres Above Ordnance Datum (mAOD). However, the topography of the site is irregular due to the nature of operations. Multiple storage mounds are located within the site, which had a maximum elevation of approximately 20 mAOD at the time of the survey.

Ground elevations surrounding the site generally decline northwest towards the estuary.

2.4 Ground conditions

British Geological Survey (BGS) data shows bedrock geology beneath the site comprises Mercia Mudstone Group. This group is identified by the EA to be a 'Secondary B Aquifer' and is comprised of 'Predominantly lower permeability layers which may store and yield limited

amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering'.

Superficial deposits comprise layers of tidal flat deposits composed of clay and silt. This is defined by the EA as '*unproductive strata*' and has '*low permeability*'.

A BGS borehole record from within the site boundary has been reviewed (ref. ST58SW65). This recorded tidal flat deposits to 3.5 m below ground level (bgl) with a topsoil depth of 0.2 mbgl. This is directly underlain by estuarine fissured clay to a further depth of 2.5 mbgl. Groundwater seepage was recorded at 1.4 mbgl and groundwater flow was recorded at 2 mbgl.

The ground surface comprises a mixture of made ground, loose earth and concrete.

The site does not lie within a Source Protection Zone (SPZ) or a Drinking Water Safeguard Zone for Groundwater.

2.5 Hydrology

Hydrological characteristics of the site and its environs have been derived from Ordnance Survey (OS) and other online mapping.

2.5.1 Severn Estuary

The site is located within the Severn Estuary Coastal Zone. This zone comprises low-lying land adjacent to the estuary, generally below 10 mAOD in elevation. Numerous wetland areas associated with the Severn Estuary are located along the shoreline. The high tide line of the Severn Estuary is approximately 2 km northwest of the site.

Raised embankments along the Severn Estuary coastline protect the area from tidal flooding. Improvements to these flood defences are scheduled as part of the Avonmouth Severnside Enterprise Area (ASEA) ecological mitigation and flood defence project. This involves increasing the crest height of existing earth embankments and walls. The new flood defences will allow for anticipated rising sea levels and will ensure that any flood risk is reduced for at least 60 years. The project is jointly funded by the West of England Combined Authority / West of England Local Enterprise Partnership, Department for Environment, Flood & Rural Affairs (DEFRA) and the Wessex Regional Flood and Coastal Committee.

The closest EA designated flood defence embankment is located approximately 1.7 km northwest of the site and comprises an earth embankment. According to the EA's Asset Management database, the condition of the embankment is 'Good' and the crest height is 9.5 mAOD.

2.5.2 Watercourses and drainage

The vicinity of the site and surrounding area is drained by an extensive network of rhines (small watercourses). These receive run-off from smaller drains that discharge to the Severn Estuary. The Rhines in the vicinity of the site are approximately 4 m wide, managed and maintained by the Lower Severn Internal Drainage Board (IDB) and experience ephemeral flows. The closest Rhine to the site is Monks Well Rhine, 75 m northeast of the site boundary. Numerous drainage channels connect into Monks Well Rhine before it eventually discharges into the Severn Estuary approximately 2.75 km northeast of the site.

An unnamed channel is located approximately 30 m southeast. This channel parallels the southeastern boundary of the site and discharges into the Monks Well Rhine.

2.5.3 Waterbodies

There are no waterbodies within the site boundary. To the north of the site there is a waterbody of approximately 95 square meters (m²). It is situated below ground level and discharges into the Monks Well Rhine. To the northwest of the site, within the Hallen Industrial Estate, are two below surface ponds. Approximately 240 m northeast of the site is a small waterbody that discharges into to the Monks Well Rhine. There are no other waterbodies at or in the vicinity of the site.

3 PROPOSED DEVELOPMENT

It is proposed to modify the existing inert recycling facility, including a new wash plant towards the centre of the site. A 10,563 m² area of additional impermeable concrete is proposed.

A proportion of surface water run-off will be utilised within the wash plant process. An attenuation feature is proposed in the north of the site.

No changes are proposed to the existing weighbridge, wheel wash, gatehouse building or office building.

The proposed site layout is shown within *Appendix 3713/FRA/A2*.

4 BACKGROUND AND KEY DOCUMENTS

4.1 Flood zone and vulnerability classifications

In accordance with the NPPF and associated PPG, all sites within Flood Zone 3 or over 1 hectare (ha) in size must be accompanied by an FRA. As the site is located within Flood Zone 3 an FRA is required.

Under NPPF and PPG guidance, 'Waste treatment' and 'general industry' are considered to be 'Less Vulnerable'. According to Table 2 of the PPG, it is considered appropriate for this classification of development to be located within Flood Zone 3. The Sequential Test is therefore considered to be passed and the Exception Test does not need to be applied.

4.2 Local Policies and Guidance

4.2.1 South Gloucestershire Council Level 1 Strategic Flood Risk Assessment

The NPPF states that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA), which refines information regarding the probability of flooding, taking all sources of flooding and the impacts of climate change into account. SFRAs provide the foundation for applying the Sequential Test, on the basis of the flood zones.

The South Gloucestershire Level 1 SFRA was completed by JBA in November 2021. Key points of the SFRA relevant to the site include:

- There are EA maintained tidal defence schemes along the majority of the South Gloucestershire coastline
- The ASEA scheme will upgrade existing defences along the Severn Estuary
- The areas identified to be most at risk of tidal flooding within the study area are Severnside, Severn Beach, New Passage and Oldbury/Sheppardine. All of which are located in the Severn Estuary floodplain, approximately 2 km northwest to the site.
- Several incidents of flooding have been recorded within South Gloucestershire, due to a mixture of tidal, fluvial and surface water influences.
- The most significant flood incident was due to tidal flooding in 1977 that prompted the construction of tidal defences along the Severn Estuary.
- In 2009 surface water run-off exceeded capacity of the rhine system and caused internal flooding of properties
- In 2013/14 extensive rainfall led to localised flood incidents associated with main rivers
- The vast majority of South Gloucestershire is considered to be at low risk of groundwater flooding

- The SFRA provides guidance for developers, which has been considered throughout the preparation of this FRA

The content of the SFRA has been considered throughout this assessment.

4.2.2 South Gloucestershire County Council Local Flood Risk Management Strategy (LFRMS)

The South Gloucestershire LFRMS was published in July 2022 and details how partnerships in South Gloucestershire will manage local flood risk from all sources. Key points of the LFRMS relevant to this assessment include:

- The Risk of Flooding from Surface Water map within the LFRMS does not indicate the site to be at risk of surface water flooding
- The site is not indicated to be at risk of groundwater flooding
- Flood defences as part of the ASEA scheme are designed to offer a 1 in 200 yr (0.5% AEP) standard of protection over a 60 year design life
- SGCC have identified the site to be within the 'Priority Catchment' of Chestle Pill. Key points from the catchment specific action plan relative to the site, include:
 - 251 flood events have been recorded across the catchment
 - Work is in progress with the Lower Severn IDB to assess options to manage flood risk
 - It must be ensured that development proposals incorporate additional surface water storage into site design

The LFRMS raises no concerns for this development.

4.2.3 South Gloucestershire Adopted Core Strategy 2006 - 2027

A Local Development Framework (LDF) is a spatial planning strategy for District Councils in England and Wales. The LDF comprises of Local Development Documents (including Local Plans), Supplementary Planning Documents (SPD's), Statements of Community Involvement and other documents as required.

The South Gloucestershire Adopted Core Strategy 2006 – 2027 was adopted in December 2013. The specific policy and associated information of the Adopted Core strategy to this assessment is as follows:

Policy CS25 -

'New proposals demonstrate through the preparation of appropriate Flood Risk Assessments, surface water management plans and drainage strategies, how flood risk will be managed.'

Proposals should not:

- a) significantly effect the ecology and conservation assets of the Severn Estuary and cause significant and irreparable damage to estuarine and floodplain ecology.
- b) reduce flooding capacity without improvement to flood defences and increase the risk of flooding to third parties.
- c) damage the network of rhines which provide the local drainage network and which are of ecological interest.'

This strategy has been considered throughout this assessment.

4.2.4 South Gloucestershire Strategic Environmental Assessment (SEA) Report

The South Gloucestershire SEA Report was published in July 2022 to review the impacts of the LFRMS. This report states that additional surface water storage should be considered to reduce the impact of flooding on existing developed land. This has been considered throughout this assessment.

4.3 Climate change

4.3.1 Rainfall Allowances

According to the EA the site lies within the 'Avon Bristol and North Somerset Streams Management Catchment'. Climate change allowances have been obtained from the EA's Hydrology Data Explorer (accessed June 2024) for this rainfall catchment.

Climate change allowances for peak rainfall intensity, as defined in EA guidance, are specified for different development lifetimes (epoch's).

Peak rainfall allowances for this catchment are shown within *Table 3713/FRA/T1*.

3713/FRA/T1: Avon Bristol and North Somerset Streams Management Catchment peak rainfall allowances				
	30-yr return period		100-yr return period	
	Central	Upper	Central	Upper
2050's	20%	35%	25%	40%
2070's	25%	40%	25%	45%

According to EA guidance, the central allowance is considered appropriate for 'Less Vulnerable' developments within Flood Zone 3. The lifetime of non-residential developments

is generally considered to be 75 years. The central allowance for the 2070's epoch is considered to be applicable to the site and therefore the 25% allowance has been used within this drainage strategy.

4.3.2 Tidal

A range of climate change allowances have been identified by the EA for each river basin district and epoch, for sea level rise. These are based on percentiles and are as follows:

'The:

higher central allowance is based on the 70th percentile

upper end allowance is based on the 95th percentile

An allowance based on the 70th percentile is exceeded by 30% of the projections in the range. At the 95th percentile it is exceeded by 5% of the projections in the range.

For flood risk assessments and strategic flood risk assessments, assess both the higher central and upper end allowances.'

As defined by the EA, the site is within the 'Southwest' district. Sea Level Rise allowances applicable to the site are shown in Table 3713/FRA/T2.

3713/FRA/T2: Southwest Sea Level Rise Allowances						
Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative Rise 2000 to 2125 (m)
South West	Higher Central	203	264	351	393	1.21
South West	Upper End	245	342	480	552	1.62

Due to the site's operational timeline, it is necessary to consider the cumulative rise for both the 'Upper' and 'Higher Central' allowances.

5 FLOOD RISK

5.1 Potential sources of flooding

A qualitative assessment of the consequences of flooding to the site has been made from a range of potential flood sources:

- Fluvial (river)
- Tidal
- Pluvial (surface water run-off)
- Groundwater
- Sewers and drains
- Reservoirs, canals and lakes
- Other artificial sources

5.2 History of flooding at the site

There are no records of the site having flooded in the past within local documents, although there have been issues with localised ponding on site.

5.3 Fluvial flooding

Fluvial (river) flooding occurs when a watercourse cannot accommodate the volume of water draining into it, from the surrounding catchment.

The EA Flood Map for Planning as shown on *Drawing 3713/FRA/02*, shows that the site is located within Flood Zone 3 (>1% chance of fluvial flooding or a 0.5% chance of flooding from the sea).

Upon review of the EA's flood modelling data and flood zone mapping, it is considered that the designation of Flood Zone 3 at the site is due to its proximity to the sea and not fluvial flood risk. Tidal flooding is discussed in Section 5.4.

Water levels within the Rhine network are managed by the Lower Severn IDB. Therefore, the risk of flooding within them is considered to be low.

The proposals will not result in a loss of floodplain storage or change fluvial flood flow paths.

The overall risk of fluvial flooding to and from the site is therefore considered to be low.

5.4 Tidal flooding

Tidal flooding is the temporary inundation of coastal areas during high tides or storm surges.

The site's location within Flood Zone 3 is due to its proximity to the sea, therefore this zone has a 1 in 200 or greater annual chance of flooding from the sea. The EA Flood Map for Planning shows areas at risk of flooding if undefended, therefore there is a residual risk associated with a breach of the tidal flood defences.

The proposed development lifetime is estimated to be beyond the 2070's, therefore the long-term effect of climate change on tidal levels must be considered.

Proposals as part of the ASEA project, are in place to upgrade flood defences along the estuary. This includes flood defences to the north and west of the site.

Flood risk data (Product 4 and Product 8) has been obtained from the EA and is included in Appendix 3713/FRA/A3.

Product 4

Product 4 data provides detailed flood depths and elevations for the site, for the existing scenario, post-construction of the new ASEA defences, and a breach scenario of the new defences.

The EA Product 4 data (included in Appendix 3713/FRA/A3) is summarised in Table 3713/FRA/T3:

3713/FRA/T3: EA Product 4 predicted flood elevation data							
	Pre-Development 2076 (with existing defences)		Post Development 2076 (new defences in place)		Post Development 2098 (new defences in place)		Post Development Breach of new defences 2098
	1 in 200 year	1 in 1000 year	1 in 200 year	1 in 1000 year	1 in 200 year	1 in 1000 year	1 in 200 year
Flood Elevation (mAOD)	0	7.69	0	0	0	7.75	-

As the flood depths for the 1 in 200-year event reflect future scenarios only (2076 & 2098, as was appropriate at the time the model was produced), it is difficult to apply the latest climate change allowances to the data, as flood levels for the 1 in 200-year (baseline) event are not known. Therefore, as a conservative approach, flood elevations and depths for the 1 in 1000-year event have been taken to represent the 1 in 200-year plus the latest climate change allowance event (design storm event).

EA Product 4 data shows that the site has only been modelled to be affected by tidal flooding during the pre-development 2076, 1 in 1000-year scenario and the post-development 2098 1 in 1000-year scenario, with flood elevations of 7.69 mAOD and 7.75 mAOD respectively.

Taking the lowest site level to be 7 mAOD, the data suggests that the site may experience depths of flooding up to approximately 0.75 m during the 1 in 1000-year 2098 scenarios. Due to the less vulnerable nature of the site, this is considered to be acceptable. It must be noted that EA flood modelling does not consider the impacts of drainage systems on flood extents and depths, therefore it is likely that flood waters would dissipate before reaching the site.

However, in the unlikely event that flooding occurs as EA modelling suggests, the site will be evacuated until flood levels recede.

Product 8

EA Product 8 data (included in *Appendix 3713/FRA/A3*) is based upon breach/asset failure modelling that was commissioned in 2014 using the Wessex North Coast Tidal 2012 model. This modelling is not understood to have incorporated the ASEA flood defences.

Breach Hazard, Depth and Velocity mapping shows that the site has not been modelled to be affected by a breach in the existing flood defences.

Given that the site does not introduce vulnerable development and will not be occupied, mitigation measures are not deemed necessary for tidal flooding.

5.5 Surface water flooding

Surface water (pluvial) flooding occurs when rainwater does not drain away through the normal drainage system or soak into the ground, but instead lies on or flows over it. This typically happens following high rainfall storm events, when a drainage system is unable to accommodate the amount of surface run-off generated or when ground contours facilitate ponding.

The EA's 'Risk of Flooding from Surface Water' mapping is shown on *Drawing 3713/FRA/03*. This shows that the great majority of the site has not been identified to be at risk of surface water flooding (less than a 1 in 1000-year annual probability). A very small areas of 'low' risk (1 in 1000-year annual probability) is shown in the east of the site and is likely to be associated with a minor topographical depression.

Despite the introduction of additional impermeable areas, the proposals will involve improvements to the existing surface water drainage system that will ensure run-off from the site will not exceed greenfield discharge rates – see Section 6. Therefore, surface water run-off will not increase post-development.

The proposals will not impact any existing surface water flow paths. The risk of surface water flooding is considered to be low.

5.6 Groundwater flooding

Groundwater flooding occurs when the watertable rises above the ground surface. It is most likely in areas above an aquifer, where water levels can rise following prolonged rainfall.

As the site is situated above low permeability clay, groundwater emergence is unlikely.

No significant, below ground excavations are proposed, therefore interaction with groundwater during construction is unlikely.

There are no records of groundwater flooding affecting the site and the risk of groundwater flooding is considered negligible.

5.7 Flooding from sewers and drains

Sewer flooding generally results in localised short-term effects caused by intense rainfall events overloading sewer capacity. Flooding can also occur due to blockage, poor maintenance, structural failure or surcharging of a system due to high water levels in a receiving watercourse.

Existing private sewers and drains are present within the site boundary, as shown on the existing site layout in *Appendix 3713/FRA/A1*. A private package treatment plant is also located to the east of the site boundary. Should flooding of this network occur, localised ponding would result, before flows moved generally northeastwards, towards the Monks Well Rhine.

A new connection to the foul water drainage system, or the public sewerage system is not proposed.

Should flooding from sewers in the nearby highways occur, such as within the Severn Road or M49, flows would likely enter the unnamed ditch and be directed into Monks Well Rhine and not affect the site.

Therefore, it is considered that the risk of flooding from sewers and drains is low.

5.8 Reservoirs, canals and lakes

There are no reservoirs, canals or lakes which would pose a flood risk to the site.

5.9 Other artificial sources

There are no artificial sources that would pose a flood risk to the site.

6 SURFACE WATER DRAINAGE

6.1 Existing surface water drainage

Surface water run-off from the operational area currently drains towards a catch pit in the west of the site. This in turn drains via gravity into the Monks Well Rhine via a 600 mm concrete pipe. The catch pit has a cover level of 7.65 mAOD and an invert level of 5.60 mAOD.

Run-off from the existing offices and gate house building is assumed to discharge into the Monks Well Rhine.

6.2 Proposed surface water drainage

6.2.1 Principles of the Surface Water Drainage Strategy

To comply with local planning policy, surface water run-off leaving the site should be restricted to as close to greenfield run-off rates as possible. To ensure this can be achieved, attenuation storage is required.

Due to ground conditions (clay), disposal of surface water via infiltration is not viable.

Surface water run-off will continue to drain into the Monks Well Rhine via a new attenuation basin and the existing 600 mm outfall pipe.

The site will drain towards two catchpits located in the west and centre of the site, from which water will be collected for re-use on site. Excess run-off from both catchpits will discharge into the existing 600 mm pipe. Run-off will then enter a new attenuation basin in the north of the site. Discharge from this feature will be into the Monks Well Rhine at the greenfield run-off rate.

Run-off from the office building and gate house building will continue to drain as existing and will not be affected by the proposals.

6.2.2 Greenfield run-off rates

Using the IH124 method, the greenfield run-off rate has been calculated for the total site area (3.81 ha).

The calculated greenfield run-off rate for the site is shown within *Table 3713/FRA/T4* with full results in *Appendix 3713/FRA/A4*.

3713/FRA/T4: Greenfield run-off rates		
Storm event	Greenfield run-off rate (l/s/ha)	Greenfield run-off rate for whole site area (3.81 ha) (l/s)
Q _{bar}	5.5	20.9
1-year	4.7	17.7
30-year	10.4	39.5
100-year	13.2	50.5

Discharge from the site will be restricted to the greenfield run-off rate of the impermeable area: 20.9 l/s.

6.2.3 Attenuation requirements

To achieve the Q_{Bar} greenfield run-off rate attenuation storage is required. Attenuation has been designed based on the following criteria:

- Run-off from the whole site area of 3.81 ha
- A run-off coefficient of 1, which assumes the whole site is impermeable and no infiltration will occur (worst case scenario)
- Side slopes of 1 in 3
- Pond depth of 1.3 m
- Attenuation top area of 2,603 m²
- The volume of water that will be re-used has been excluded
- Run-off from the 1 in 100-year + 25 % climate change event to be accommodated, with a critical storm duration of 16 hours

An attenuation volume of approximately 2,789 cubic metres (m³) is required. This will be provided within an attenuation basin in the north of the site.

A pond with a surface area of 2,603 m² and depth of 1.3 m will provide attenuation storage of 2,978 m³. This is sufficient to accommodate run-off from more extreme storm events in excess of the design storm.

Discharge into the Monks Well Rhine will be restricted using an orifice plate or similar. Details of inlet and outlet arrangements will be subject to subsequent detailed design.

An indicative drainage layout is shown on *Drawing 3713/FRA/04* with full calculations included in *Appendix 3713/FRA/A5*.

Pipe Gradients and Invert Levels

The existing 600 mm pipe into which the pond will discharge is understood to have a gradient of 1 in 378 (based on a fall of 0.74 m over 280 m pipe length). Based on this, at the point where the proposed pond will outfall, the pipe is assumed to have an invert level of approximately 4 mAOD.

The pond will have a top elevation of approximately 8 mAOD and bed elevation of approximately 6.7 mAOD. Therefore, gravity discharge into the existing pipe is achievable.

6.3 Designing for exceedance

The surface water drainage system has been designed to minimise the risk of flooding to the site and surrounding area in the event of exceedance during extreme storm events. In the event of blockage or an extreme storm event, the local topography indicates that exceedance flows would be conveyed westwards, towards the Monks Well Rhine. They would therefore not affect any external receptors.

6.4 Water Quality Management And Pollution Mitigation

To ensure the risk to surface water is minimised, oil interceptor(s) will be located at suitable location(s) before discharge into the attenuation basin.

On implementation of the maintenance schedules provided in Section 8, it is considered highly unlikely that run-off from the proposed development will increase the risk to pollution of the downstream network.

7 ADOPTION AND MAINTENANCE

7.1 Adoption

The proposed surface water drainage system will be owned and maintained by the landowner(s) for the development lifetime.

7.2 Maintenance

A suggested maintenance regime for the attenuation basin is provided in *Table 3713/FRA/T5* below.

The maintenance schedule should be enacted immediately following construction of the drainage system.

3713/FRA/T5: Attenuation Basin maintenance schedule	
Regular Maintenance	
Monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation)
Six Monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period)
Annually	<ul style="list-style-type: none"> Remove sediment from pre-treatment structures
As Required	<ul style="list-style-type: none"> De-silt as required
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	<ul style="list-style-type: none"> Inspect and carry out essential recovery works to return the feature to full working order

Maintenance of the oil interceptor(s) will be in accordance with manufacturers' instructions.

8 SUMMARY AND CONCLUSIONS

A planning application has been prepared for alterations to an existing inert recycling facility at Bristol & Avon Recycling Ltd, Bristol. These include a new wash plant. No changes are proposed to the existing weighbridge, wheel wash, gate house building or office building.

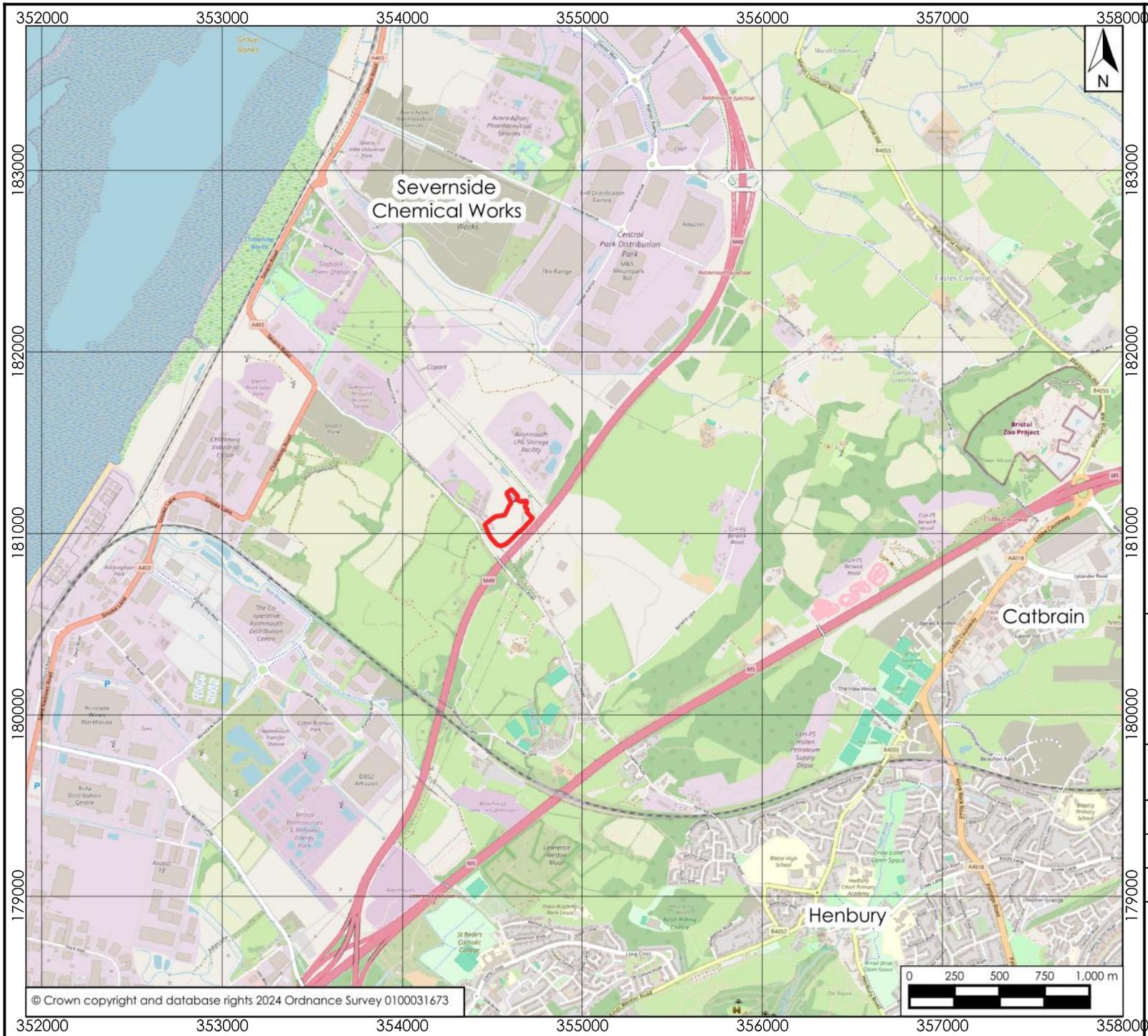
The majority of the site is located within Fluvial Flood Zone 3. EA modelling suggests that flood depths of up to 0.75 m could occur on site during the 1 in 1000-year + climate change flood event. However, dissipation of flood waters is likely to occur prior to reaching the site. Due to the less vulnerable nature of the proposals, this level of risk is considered to be acceptable.

The site is considered to be at low risk of flooding from all other sources. The proposals will not increase flood risk to offsite receptors and all surface water run-off will be retained on-site.

Surface water run-off from the whole site will be into the Monks Well Rhine at the QBAR greenfield run-off rate of 20.9 l/s. An attenuation basin will be provided in the north of the site, which will accommodate run-off from the 1 in 100-year + climate change storm event.

Based upon the outcome of the assessment, it is considered that the proposals are appropriate in terms of flood risk and can be suitably drained for the development lifetime.

DRAWINGS



Key
 Site Boundary

Scale correct at A4

Client B&A Group
 Bristol & Avon Transport & Recycling Ltd

Title Site Location

Project Bristol and Avon Recycling

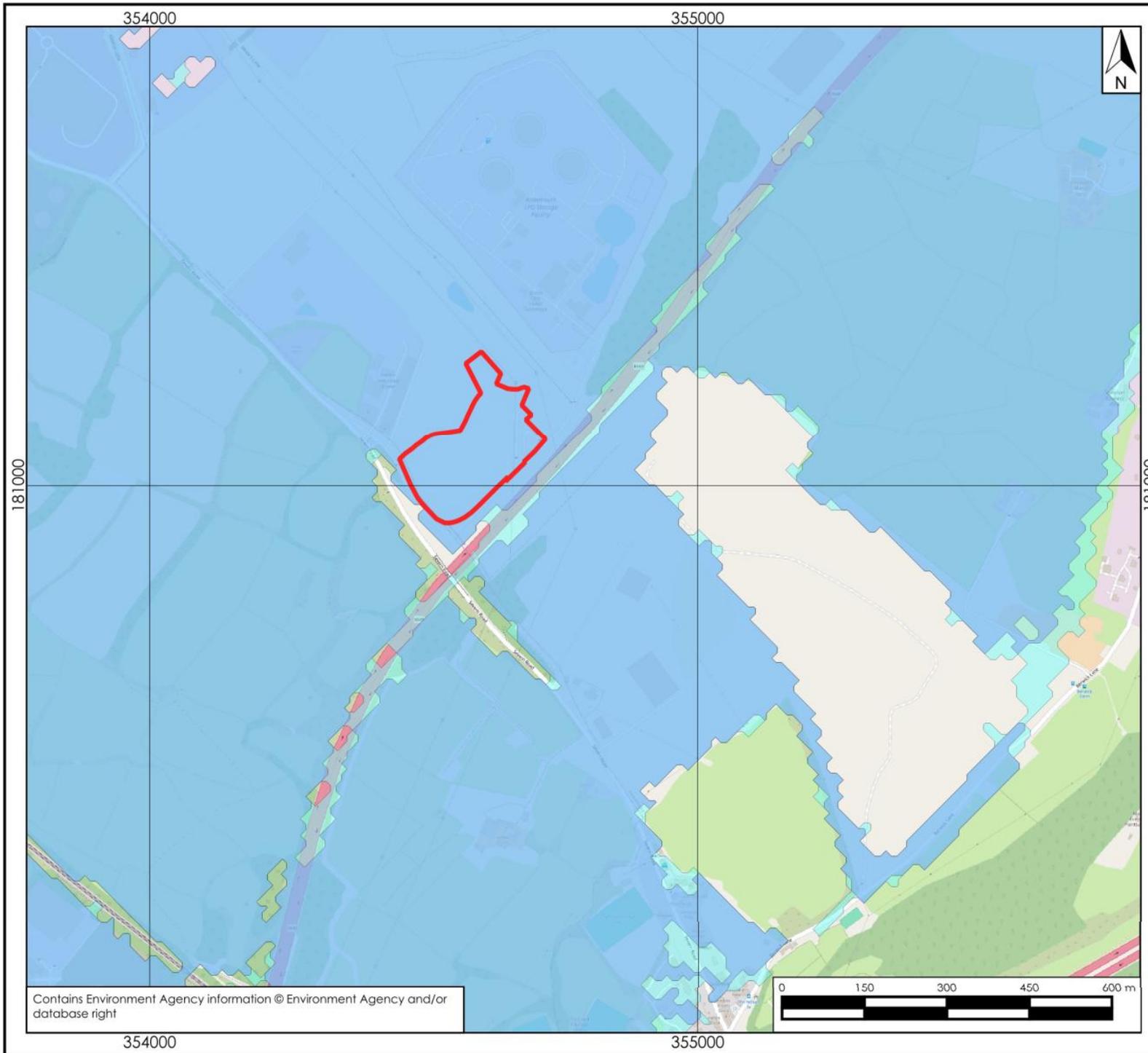
Drawing 3713/FRA/01 Version 1

Date Sep 2024 Scale 1:30,000

hafrenwater 
 environmental water management

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 www.hafrenwater.com • Tel. 01743 355 770

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Key

- Site Boundary
- Fluvial Flood Zone 3
- Fluvial Flood Zone 2

Scale correct at A4

Client B&A Group
Bristol & Avon Transport & Recycling Ltd

Title Fluvial Flood Zones

Project Bristol and Avon Recycling

Drawing 3713/FRA/02	Version 1
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Date Sep 2024	Scale 1:10,000
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Key

- Site Boundary (24-09-13)

Surface Water flood risk

- High risk (1 in 30 year)
- Medium risk (1 in 100 year)
- Low risk (1 in 1000 year)

Scale correct at A4

Client B&A Group
Bristol & Avon Transport & Recycling Ltd

Title Surface Water Flood Risk

Project Bristol and Avon Recycling

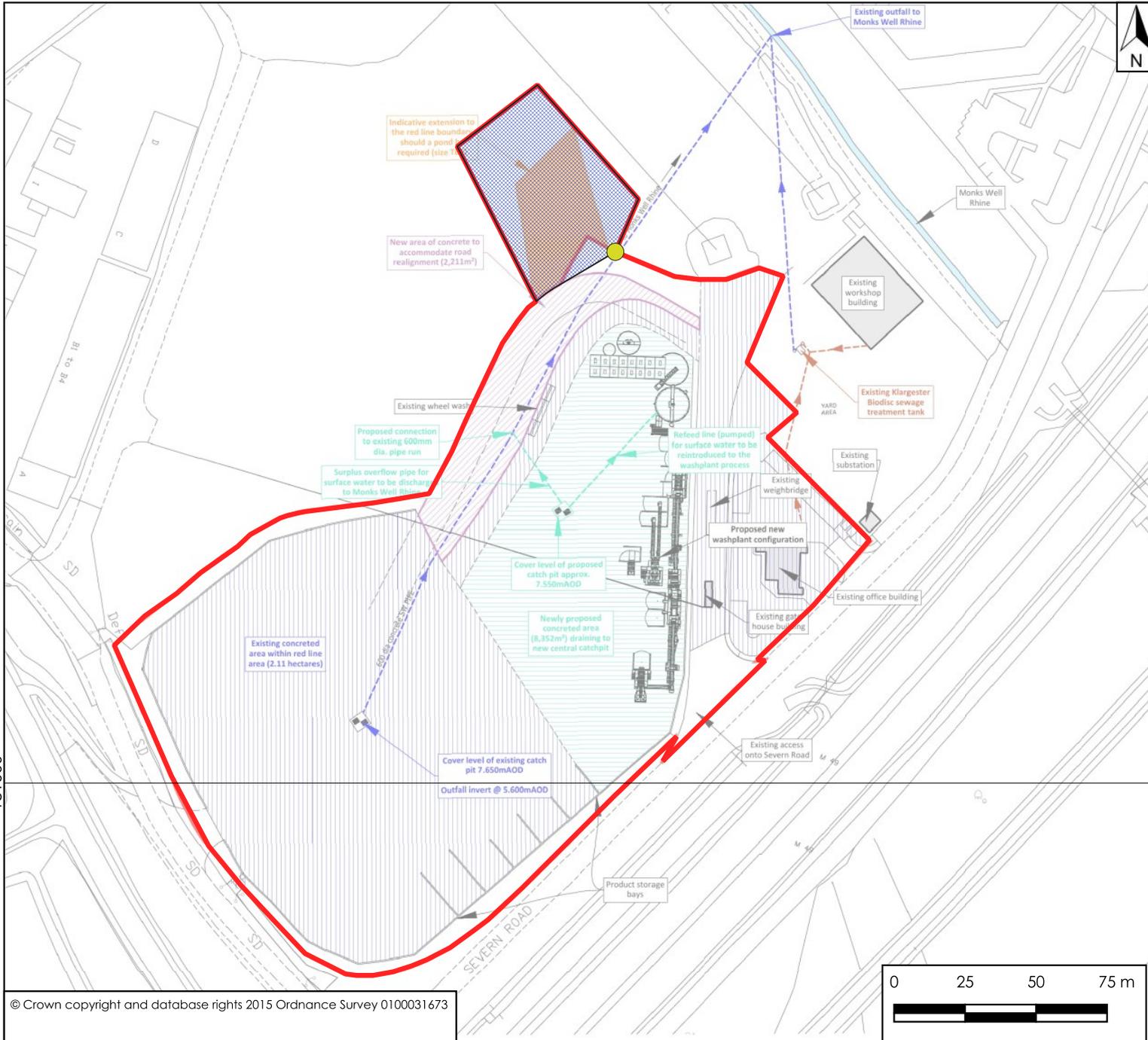
Drawing 3713/FRA/03 Version 1

Date Sept 2024 Scale 1:4,000

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- Key**
- Application Boundary
 - Proposed pond
 - Proposed connection with existing sewer

Scale correct at A4

Client B&A Group
Bristol & Avon Transport & Recycling Ltd

Title Outline Surface Water Drainage Strategy

Project Bristol and Avon Recycling

Drawing 3713/FRA/04	Version 1
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Date Sep 2024	Scale
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hafrenwater

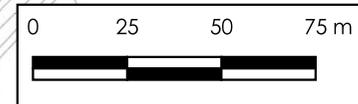
environmental water management

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APPENDIX 3713/FRA/A1

Existing site layout

APPENDIX 3713/FRA/A2

Proposed site layout

APPENDIX 3713/FRA/A3

EA Product 4 and 8 data

Douglas Purce
Douglas.Purce@hafrenwater.com

Our ref: 363603-WX
Date: 26th June 2024

Dear Douglas Purce

Thank you for your enquiry which was received on 7th June 2024. We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Abstract

Name	Product 4
Description	Detailed Flood Risk Assessment Map for Bristol And Avon Recycling NGR: ST5456881035
Licence	Open Government Licence
Information Warnings	<i>The mapping of features provided as a background in this product is © Ordnance Survey. It is provided to give context to this product. The Open Government Licence does not apply.</i>
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. Contains Ordnance Survey data © Crown copyright 2017 Ordnance Survey 100024198.

Open Data

The following Environment Agency published datasets are now available on the weblink below as part of the Government's 'Open Data' project and are available for you to download free of charge.

Environment Agency published datasets: <https://data.gov.uk/data/search?publisher=environment-agency&unpublished=false>

You will need to search and select the name of the following datasets to take you directly to the weblink to enable you to download the data:

- Flood Map for Planning (Rivers and the Sea) – Flood Zones 2 and 3
- Flood Map for Planning (Rivers and Sea) – Areas Benefiting from Defences
- Flood Map for Planning (Rivers and Sea) Flood Storage Areas
- Flood Map for Planning – Spatial Flood Defences (without Standard attributes)
- Recorded Flood Outlines
- Historic Flood Map
- Risk of Flooding from Surface Water Extent for:
 - 3 percent annual chance
 - 1 percent annual chance
 - 0.5 percent annual chance

You can also access the Flood Map for Planning here: <https://flood-map-for-planning.service.gov.uk/>

You can also access the Risk of Flooding from Surface Water maps and Risk of Flooding from Reservoirs information here: <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>

If you have requested this information to help inform a development proposal, then you should also note the detail in the attached advisory text on the use of Environment Agency Information and Further Guidance for FRAs.

Recorded Historic Flood Events

We no longer produce pdf copies of the Historic Flood Map. This information is available to search select, and download free of charge as part of the Government's 'open data' as

- Recorded Flood Outlines
- the Historic Flood Map

These are GIS layers and can be downloaded from: <https://data.gov.uk/publisher/environment-agency>

Please note: we cannot guarantee that this is an exhaustive list of all past flood events in this location. All reasonable care has been taken to ensure that the historical flood event data is as accurate as possible. The Environment Agency will update its records if new evidence emerges.

ASEA Coastal Inundation model

South Gloucestershire Council, Bristol City Council and the Environment Agency are working together to improve flood defences and create new habitats for important wildlife species as part of the Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project. For further details about this project, including progress to date, please see the following link:

<https://www.asea-flood-ecology.co.uk/>

Contractors BMMjv have been on site since summer 2019 and have commenced work at each sub section area. Please refer to our [website](#) for the latest programme for completion dates.

As part of this project, a new coastal inundation model was produced in 2018 for the Avonmouth/Severnside area to represent the impact of the new flood defence.

The 2018 version of the model includes pre development (i.e. representing the defences as they were before work commenced in 2020) and post development (representing the impact of the defences currently in construction) scenarios, for both present day and future dates (2076 and 2098). A scenario representing the breach of the proposed flood defences in 2098 was also modelled in 2018. However, the 2018 version of the model used UKCP09 sea level rise allowances, which have been superseded by UKCP18 allowances.

Please let us know if you wish to obtain a copy of the modelling report or model.

Due to changes in the flood defence design and a need to re-run breach scenarios in the Bristol City Council local authority boundary, we are only supplying post development 2098 depths and levels and post development 2098 breach scenarios from the 2018 version of the model as this is currently the best available data.

A further update of the ASEA coastal inundation hydraulic model is underway with post-development scenarios (including 0.5% AEP / 1 in 200 year) representing the final detailed design of the flood defence scheme (Defended) in the present day and future epochs (2083, 2098 and 2123) and separate breach scenarios. The model will include the latest UKCP18 sea level rise guidance. The results from this modelling update are anticipated later in 2023 or early 2024.

Customer & Engagement, Wessex
Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS
Email: wessexenquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

We understand that Bristol City Council are updating their SFRA Level 2 and it depends on timing as to whether the updated modelled results will be available or have to be added in at a later date.

Flood Levels

From the ASEA model we have provided the flood level and depth for the pre and post development 2076, post development 2098 and breach 2098 for your proposed site:

Pre-Development 2076 (with existing defences)

Pre-Development 2076 0.5% (1 in 200 year) AEP Depth	0.00m	Depth
Pre-Development 2076 0.1% (1 in 1000 year) AEP Depth	1.33m	Depth
Pre-Development 2076 0.5% (1 in 200 year) AEP Level	0.00mAOD	Level
Pre-Development 2076 0.1% (1 in 1000 year) AEP Level	7.69mAOD	Level

Post Development 2076 (new defences in place)

Post Development 2076 0.5% (1 in 200 year) AEP Depth	0.00m	Depth
Post Development 2076 0.1% (1 in 1000 year) AEP Depth	0.00m	Depth
Post Development 2076 0.5% (1 in 200 year) AEP Level	0.00mAOD	Level
Post Development 2076 0.1% (1 in 1000 year) AEP Level	0.00mAOD	Level

Post Development 2098 (new defences in place)

Post Development 2098 0.5% (1 in 200 year) AEP Depth	0.00m	Depth
Post Development 2098 0.1% (1 in 1000 year) AEP Depth	1.00m	Depth
Post Development 2098 0.5% (1 in 200 year) AEP Level	0.00mAOD	Level
Post Development 2098 0.1% (1 in 1000 year) AEP Level	7.75mAOD	Level

Post Development Breach of new defences 2098

Post Development 2098 0.5% (1 in 200 year) AEP Depth (Breach Composite)	0.00m	Depth
---	-------	-------

N.B. Levels and depths have been extracted based upon the site boundary plan provided.

Strategic Flood Risk Assessment (SFRA)

When preparing your Flood Risk Assessment (FRA) to support the planning application, you should also refer to South Gloucestershire's Level 1 SFRA available to download at the following link:

<https://www.southglos.gov.uk/documents/pte110277.pdf>

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www.environment-agency.gov.uk

As outlined above we understand that in due course the SFRA Level 2 for Bristol will be updated by the Local Planning Authority but currently there are no timescales for this.

Planning

If you have questions regarding the planning nature of your enquiry, or require advice on floor levels, please contact our Sustainable Places team on NWX.SP@environment-agency.gov.uk. Please be aware that we now charge for planning advice when consulted on pre-application enquiries. This new approach provides advice to developers in two ways. Firstly, there is the provision of 'free' advice available to everyone where we give a preliminary opinion on a proposed development. This sets out the environmental constraints together with any issues this raises for us. Should you wish us to review in detail any of these issues then we can do this through a chargeable scheme aimed at recovering our costs.

Flood Defences

Please find enclosed details of Flood Defences within the vicinity of the site boundary. This information has been taken from our Asset Information Management System database(AIMS).

Please note that flood defences can increase water levels elsewhere eg through channels being restricted by defences, or because defences prevent flood water flowing back into the river channel.

Extreme Tide Level (Still Water) Information

IMPORTANT. If you are carrying out a Flood Risk Assessment you should also review the Still Water Tide Level data from the Coastal Flood Boundary Study 2018. You should be mindful that in some locations the predicted Still Water Tide Levels are higher than the locally modelled water levels provided above. When this is the case the higher water levels should be taken into account in your Flood Risk Assessment.

For more information on climate change allowances please see guidance on the Gov.UK website here: [Flood risk assessments: climate change allowances - GOV.UK](#)

The updated Still Water Tide Level Data (baseline 2017) from the Coastal Flood Boundary Study 2018 is also available to download from our [data.gov.uk](#) site. Please search for 'Coastal Design Sea Levels'.

For your information you can view the Coastal Flood Boundary Study 2018 technical summary report and the user guide below.

<https://www.gov.uk/government/publications/coastal-flood-boundary-conditions-for-uk-mainland-and-islands-design-sea-levels>

Environmental Permit for Flood Risk Activities

In addition to any other permission(s) that you may have already obtained e.g. planning permission, you may need an environmental permit for flood risk activities (formerly known as Flood Defence Consent prior to 06 April 2016) if you want to do work:

- in, under, over or near a main river (including where the river is in a culvert)
- on or near a flood defence on a main river
- in the flood plain of a main river
- on or near a sea defence

For further information and to check whether a permit is required please visit:

<https://www.gov.uk/guidance/flood-risk-activities-environmental-permits>.

For any further advice, please contact your local Environment Agency Office, at bridgwater.frap@environment-agency.gov.uk.

Further Information

We advise that you also contact the Flood Risk Management Team, by email LeadLocalFloodAuthority@southglos.gov.uk, or by telephone, 01454 868000, at South Gloucestershire Council, Council Offices, Badminton Road, Yate, Bristol, BS37 5AF, as they may be able to provide further advice with respect to localised flooding and drainage issues.

Further details about the Environment Agency information supplied can be found on our website:

<https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for FRAs:

<https://www.gov.uk/planning-applications-assessing-flood-risk>

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

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

Yours sincerely

Amanda Dimarco

Customer & Engagement, Wessex

Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS

Email: wessexenquiries@environment-agency.gov.uk

Enc: Use of Environment Agency Information for Flood Risk Assessments (below)

Customer & Engagement, Wessex

Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS

Email: wessexenquiries@environment-agency.gov.uk

www.environment-agency.gov.uk

Use of Environment Agency Information for Flood Risk Assessments (FRAs)

Important

Use of Environment Agency data: you should note that

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment (FRA) where one is required, but the use of Environment Agency information does not constitute such an assessment on its own.
2. As part of your data request, we have provided all of the modelled data we hold for your location. Please note that some of our modelled information may have been produced for purposes other than for flood zone generation. This may mean that some of the modelled data you have been provided with has a lower confidence level, and has not been used in producing our flood map, nor definitively reflects the predicted flood water level at the property/development site scale. To check the suitability of the use of this information in your FRA please contact your local Partnership & Strategic Overview (PSO) team.
3. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or surface water runoff. The information produced by the Local Planning Authority and the Lead Local Flood Authority (LLFA) may assist in assessing other sources of flood risk.
4. Where a planning application requires a FRA and this is not submitted or deficient, the Environment Agency may well raise an objection.
5. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your Local Planning Authority.

Pre-Planning Advice from the Environment Agency

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:

Pre-application Preliminary Opinion:

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Pre-application Charged Service:

<https://www.gov.uk/government/publications/planning-advice-environment-agency-standard-terms-and-conditions>

Depending on the enquiry we may also provide advice on other issues related to our responsibilities, including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

Flood Risk Assessment (FRA) Guidance

You should refer to the Planning Practice Guidance of the National Planning Policy Framework (NPPF) and the Environment Agency's Flood Risk Standing Advice for information about Flood Risk Assessment (FRA) for new development in the different Flood Zones. These documents can be accessed via:

National Planning Policy Framework Planning Practice Guidance:

<http://planningguidance.planningportal.gov.uk/>

Environment Agency advice on FRAs:

Customer & Engagement, Wessex
Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS
Email: wessexenquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

<https://www.gov.uk/flood-risk-assessment-for-planning-applications#when-to-follow-standing-advice>

<https://www.gov.uk/government/publications/planning-applications-assessing-flood-risk>

Douglas Purce
Douglas.Purce@hafrenwater.com

Our ref: 363603-WX
Date: 26th June 2024

Dear Douglas Purce

Information request for:

Bristol And Avon Recycling

Thank you for your enquiry which was received on 7th June 2024.

The attached Product 8 data is based upon breach/asset failure modelling that was commissioned in 2014 using our Wessex North Coast Tidal 2012 model. This analysis has sought to provide the Environment Agency with an indication of risk associated with the breach/failure scenarios as well as an indication of the risk mitigation significance of a defence or structure at the 200yr still water level.

The Product 8 format shows the **combined** maximum of depth, hazard and velocity for individual breach/asset failure scenarios. The locations of the breach/asset failure are shown on the maps and further details may be found in the accompanying data table.

This study does not address the impact of wave overtopping on the scenarios modelled and presented here. Wave data, where applicable can be viewed in the Somerset North Coast Flood Warning Improvements (JBA, 2012). Models have been run to simulate low frequency events (200 yr still water level). When an asset failure is added to the event, the scenario becomes less likely in accordance with the strength of the structure simulated to fail. In addition, many structures are fitted with secondary defences such as penstocks on the landward side and these structures provide additional mitigation that has not been modelled in the scenarios.

Please be aware, the selection of the breaches and assets is not an indication of a probability of failure and breaches or failures could occur at any point of our coastal defences. As such, it is unlikely that the modelling and mapping will be representative of the highest potential source of breach hazard for your specific site. Please also note that the modelled scenarios will also include residual risk which exists in a 200yr still water event without any breach or failure.

As the modelling was not commissioned for the purposes of site-specific Flood Risk Assessments, we can make no guarantee that the results are suitable for this purpose. We do, however, hope that you will find it useful in your overall assessment of flood risk at your site.

Please also refer to the data Conditions and Information Warnings below

Name	Product 8
Description	North Coast Tidal Model 2014 Breach Hazard Map and Data
Sharefile Link	https://ea.sharefile.com/d-sac83be6231c445bc9fbbf847b7f19975
Conditions	<p>1.0 You may use the Information for your internal or personal purposes and may only sublicense others to use it if you do so under a written licence which includes the terms of these conditions and the agreement and in particular may not allow any period of use longer than the period licensed to you.</p> <p>2.0 Notwithstanding the fact that the standard wording of the Environment Agency Conditional Licence indicates that it is perpetual, this Licence has a limited duration of 5 years at the end of which it will terminate automatically without notice.</p> <p>3.0 We have restricted use of the Information as a result of legal restrictions placed upon us to protect the rights or confidentiality of others. In this instance it is because of sensitive data.</p>
Licence	Open Government Licence
Information Warnings	<p>1.0 This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.</p> <p>2.0 The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.</p> <p>3.0 The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.</p> <p>4.0 Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.</p>
Information Warning - OS background mapping	<i>The mapping of features provided as a background in this product is © Ordnance Survey. It is provided to give context to this product. The Open Government Licence does not apply to this background mapping. You are granted a non-exclusive, royalty free, revocable licence solely to view the Licensed Data for non-commercial purposes for the period during which the Environment Agency makes it available. You are not permitted to copy, sub-license, distribute, sell or otherwise make available the Licensed Data to third parties in any form. Third party rights to enforce the terms of this licence shall be reserved to OS.</i>
Attribution	<p>Contains Ordnance Survey data © Crown copyright 2021</p> <p>Ordnance Survey 100024198. Contains Environment Agency information © Environment Agency and/or database rights.</p>

Further Information

We advise that you also contact the Flood Risk Management Team, by email LeadLocalFloodAuthority@southglos.gov.uk, or by telephone, 01454 868000, at South Gloucestershire Council, Council Offices, Badminton Road, Yate, Bristol, BS37 5AF, as they may be able to provide further advice with respect to localised flooding and drainage issues.

Further details about the Environment Agency information supplied can be found on our website:

<https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

We hope you find this information helpful.

Yours sincerely

Amanda Dimarco

Customer & Engagement, Wessex
Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS
Email: wessexenquiries@environment-agency.gov.uk

Enc: 363603-WX - Breach hazard map
363603-WX - Breach depth map
363603-WX - Breach velocity map
Asset Summary Table



Scale: 1:10,000 At A3



Legend

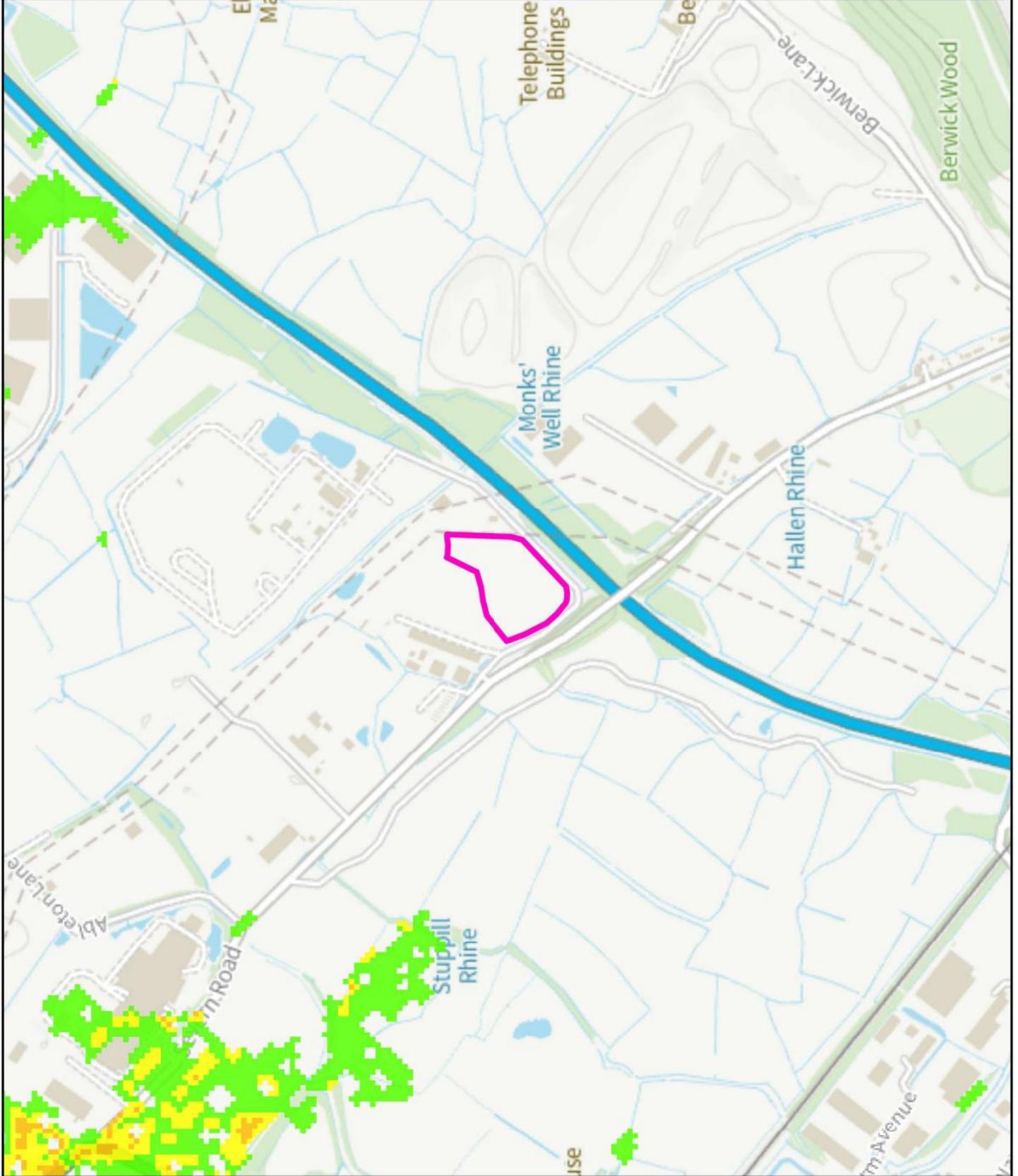
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- Asset_failure_locations
- Statutory_Main_Rivers

Avonmouth_39to49_Hazard

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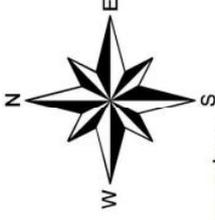
- <0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.0 (Danger for most)
- >2.0 (Danger for all)

We strongly advise that you refer to the caveats in the letter accompanying this map, regarding the usability and appropriateness of the information contained within the map.





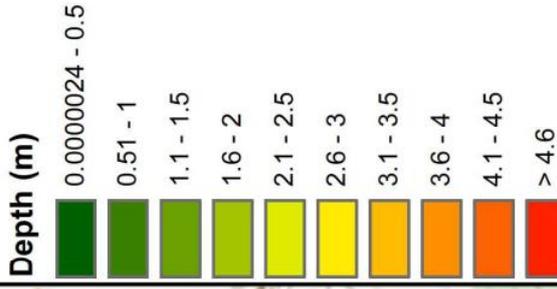
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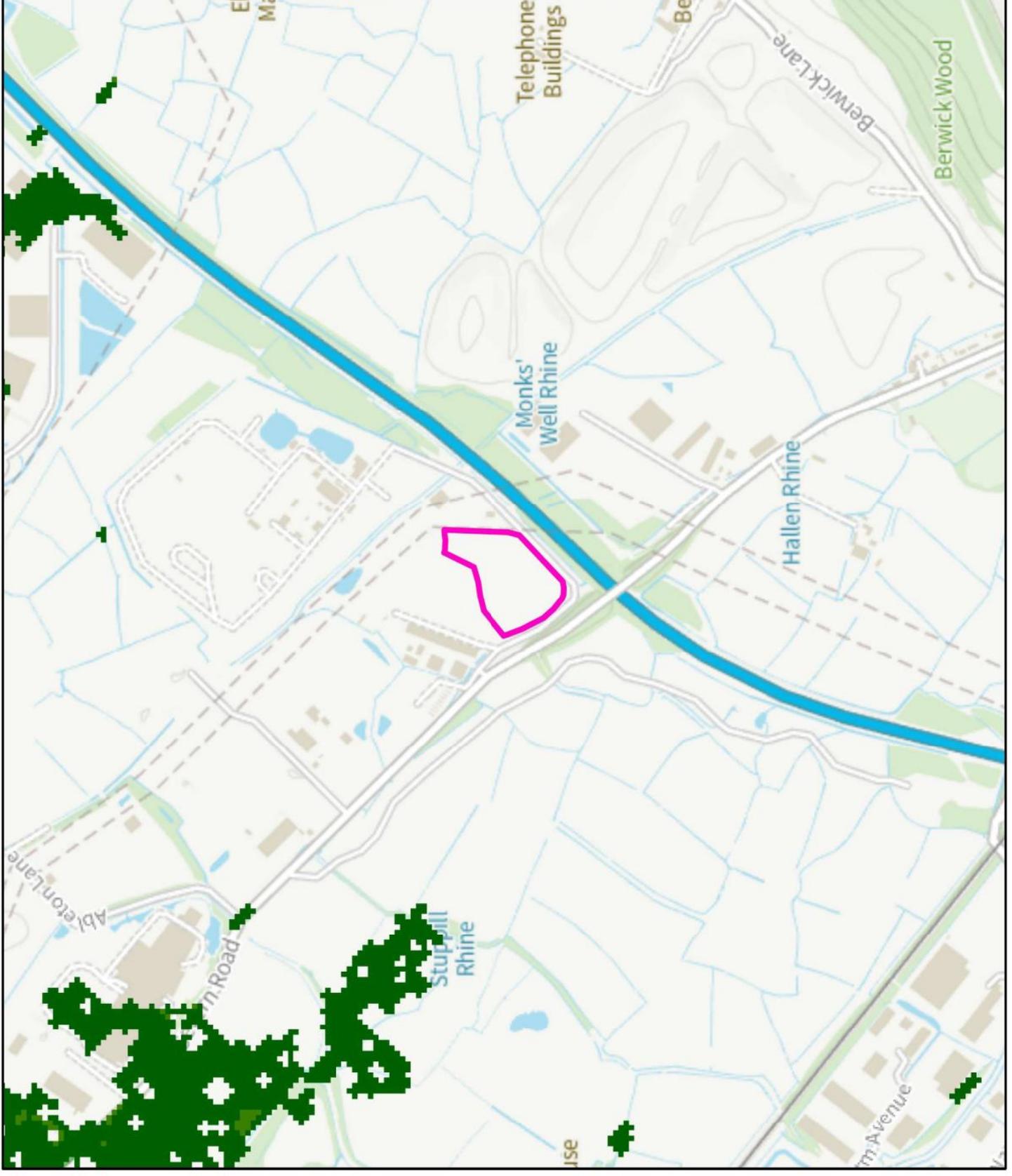
Legend

- 363603-WX_site_boundary
- Asset_failure_locations
- Statutory_Main_Rivers

Avonmouth_39to49_Depth

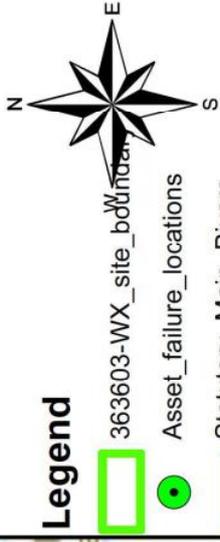


We strongly advise that you refer to the caveats in the letter accompanying this map, regarding the usability and appropriateness of the information contained within the map.



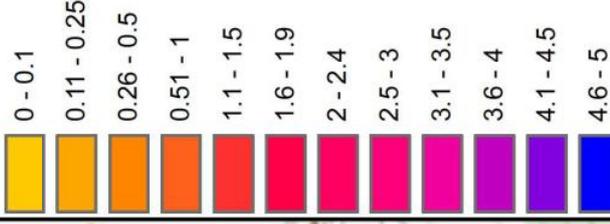


Scale: 1:10,000 At A3

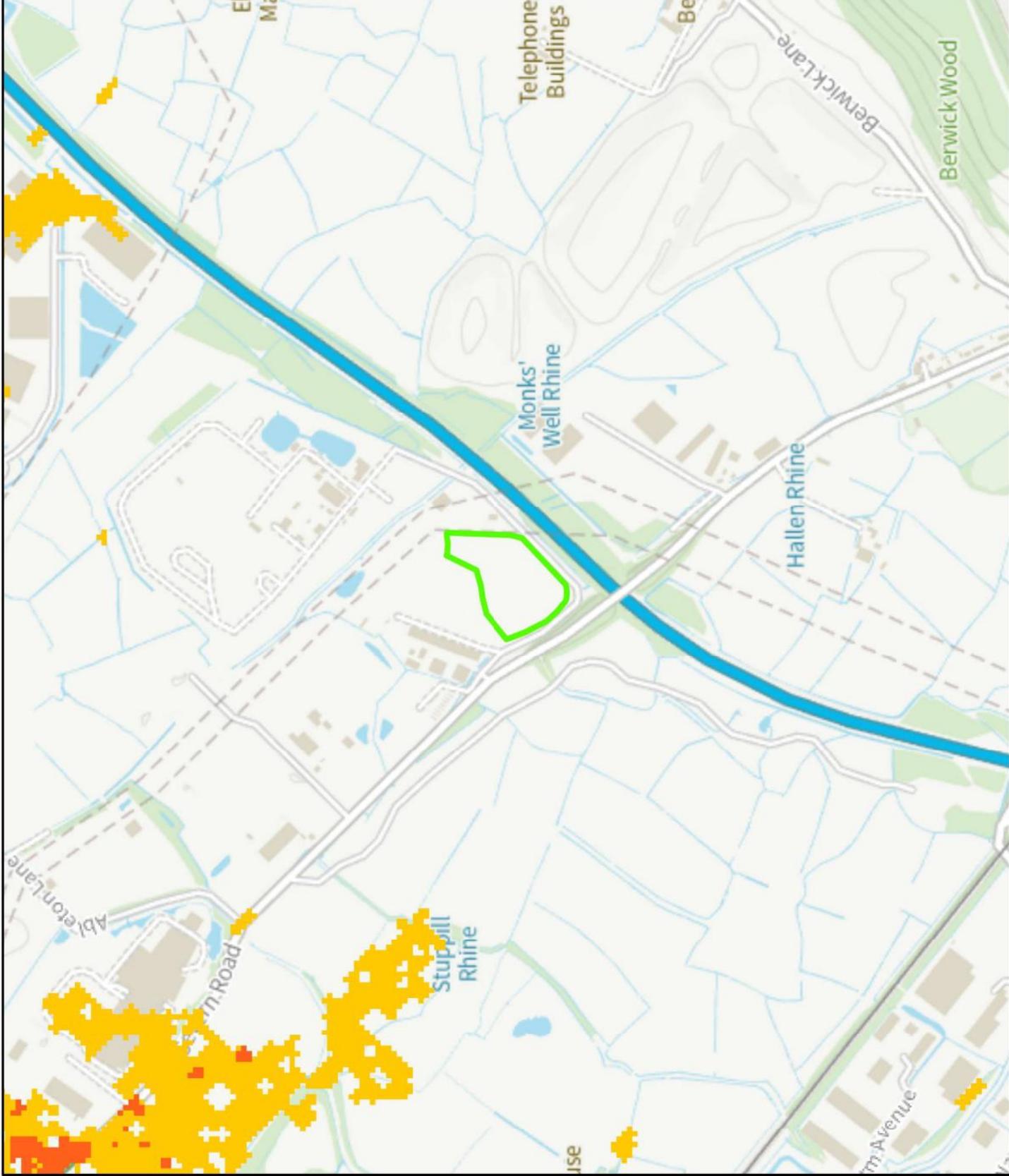


Avonmouth_39to49_Velocity

Velocity (m/s)



We strongly advise that you refer to the caveats in the letter accompanying this map, regarding the usability and appropriateness of the information contained within the map.



ID	Name	Description	Community	Grid Reference
1	Quay Street Flood Gate	Flood Gate in concrete flood wall. Gate approximately 4m wide and 1m high.	Minehead	SS 97197 46721
2	Minehead Seawall, Warren Road	Minehead Seawall. Seawall with 15m width esplanade is approximately 1m higher than the road behind. Ground level decreases landwards from the road to 5.8mAOD.	Minehead	SS 97886 46335
3	Warren Point (Butlin's Moat) Outfall	The asset drains Butlin's Moat through the sea defences to a culverted offshore outfall with a diameter of 5m approximately 125m from the sea wall. A triple penstock exists on the outward face of the moat.	Minehead	SS 98334 46429
4	Warren Point Flood Gate	Flood Gate in concrete flood wall. Gate approximately 4m wide and 1m high. Flood gate is the link between the Minehead Seawall and a cob and concrete wall.	Minehead	SS 98405 46488
5	Earth Bank, Dunster Marsh	Earth embankment reinforced with stone. Structure has a height of 8.6m, more than 2.5m higher than golf course behind.	Minehead	SS 99331 46246
6	Flapped Outfall, Dunster Beach	Flapped outfall. The asset drains water through the sea defences to a culverted offshore outfall approximately 33m from the earth embankment.	Minehead	SS 99731 45454
7	Earth Bank, Dunster Beach	Earth embankment with holiday homes located on top of structure. Crest height of 8.8m, approximately 2.8m higher than ground level behind.	Minehead	SS 99940 45025
8	Flapped Outfall, Pill Bridge, Blue Anchor	Flapped outfall adjacent to caravan park. The asset drains water through the sea defences to a culverted offshore outfall approximately 25m from the earth embankment.	Minehead	ST 02728 43468
9	Little Arch Outfall	Flapped outfall. Water is drained through the primary sea defences (earth embankment) with a shingle ridge in front acting as a secondary defence. Dimension unavailable in NFCDD and have therefore been estimated.	Stolford	ST 23390 45796
10	Combwich Common Flapped Outfall	Flapped Outfall. The asset drains water through an earth embankment into the River Parrett.	Combwich	ST 26056 42509
11	Combwich Common Earth Embankment	Earth Embankment. Embankment was described as being resistant to a 1 in 200yr flood event. It is approximately 2m higher than the road behind.	Combwich	ST 26067 42428

12	Combwich Pill Outfall	Outfall. Manually operated steel sluice gate controls flow into culvert.	Combwich	ST 26012 42181
13	Huntspill Sluice Sea Outfall	Flapped Outfall. Water level control structure. The asset drains water of the River Huntspill into the River Parrett.	Huntspill	ST 29269 45731
14	Highbridge Clyce	Flood Gate in sluice. Structure controls water level of River Brue. Right bank of river populated. Asset is approximately 14m wide and 2m high.	Newton	ST 31356 47248
15	Brue Pill (Right Bank)	Flood wall. Earth embankment with 1m high concrete wall on top. Asset approximately 2.5m higher than land behind.	Burnham-On-Sea	ST 30343 47964
16	Burnham on Sea (Pier) Flood Gate	Flood Gate set within a concrete wave return wall with esplanade behind. Gate is approximately 6m wide and 1.5m high.	Burnham-On-Sea	ST 30304 48814
17	Burnham Esplanade Sea Wall, Pavilion	Sea Wall. Esplanade sea wall is approximately 1m higher than the road behind.	Burnham-On-Sea	ST 30350 49114
18	Maddocks Slade Floodgate	Flood Gate. Gate is incorporated in vertical concrete wall adjoining wave return defence. Asset approximately 4m wide and 1m high.	Burnham-On-Sea	ST 30361 49693
19	Warren Farm	Dune with gabion and block work walling. 1m higher than the properties behind.	Brean	ST 29657 57110
20	Brean Cove Flood Gate	Twin flood gates plus single pedestrian flood gate. Assets within armoured seawall section. Approximately 3m wide and 1.2m high.	Brean	ST 29634 58556
21	River Axe (Left Bank)	Earth Embankment. Embankment protects a significant area of agricultural and recreational land. Asset is approximately 2m higher than the land behind.	Brean	ST 30423 58344
22	Brean Cross Sluice	Sluice. Asset within an earth embankment, adjacent to a caravan park, which controls water levels on the River Axe. Sluice is approximately 16m wide and 3m high.	Brean	ST 30858 56233
23	Uphill Sluice	The sluice is a water level control structure with only one eye. Approximately 5m wide. Dimension unavailable in NFCDD and have therefore been estimated.	Uphill	ST 31441 58490
24	Uphill Dunes	Dune system. The end of dune system marks the Interface between natural defences and man-made structures. The dunes are approximately 5m higher than the land behind.	Uphill	ST 31191 58807

25	Sandbay	Dune system. This natural defence is approximately 2m higher than the road behind. Ground level decreases landwards by further 1.5mAOD.	Kewstoke	ST 32976 63526
26	New Bow Sluice	Sluice, in earth embankment. Controls water levels on the River Banwell. Surroundings agricultural. Asset approximately 4m wide and 6m high.	Wick St Lawrence	ST 35311 66008
27	Hurditch's Sea Wall South	Sea wall. The sea wall is a major defence. Its crest is approximately 2.4m higher than the land behind.	Wick St Lawrence	ST 37789 67876
28	Kingston Seymour Mid 2 – Sea Wall	Sea wall with concrete toe. Adjacent to Kenn Outfall. Asset is approximately 3m higher than the land behind.	Clevedon	ST 38505 68775
29	Gullhouse Point	Sea wall with rock armoured toe. Asset is approximately 4m higher than the land behind.	Clevedon	ST 38715 69739
30	Blind Yeo Outfall	Outfall. Water level control structure for Nailsea, Tickenham & Kenn Moors SSSI. Penning controlled by tilting weir in RH Channel.	Clevedon	ST 39218 70221
31	Land Yeo Outfall	2 x flapped outfall. This is a water level control structure for Nailsea, Tickenham & Kenn Moors SSSI.	Clevedon	ST 39207 70532
32	Clevedon Marine Lake	Sea wall. Borders Marine Lake basin. Asset is approximately 3m higher than the land behind (recreational ground).	Clevedon	ST 39851 71161
33	Portbury Ditch Sea Outfall	Outfall. Water level control structure with 2x flaps and penstocks.	Portishead	ST 47793 77216
34	Portishead (Ashlands concrete Wall)	Concrete wall. Connects two earth embankments. Structure is approximately 3.2m higher than the land behind and permits local land drainage through the defence line.	Portishead	ST 48210 76474
35	Drove Rhyne Outfall	Tidal control structure adjacent to industrial area. Asset includes a 1.8m diameter steel flap.	Portishead	ST 49350 77247
36	Pill Flood Wall	Tidal flood wall. Masonry wall with raised pedestrian walkway behind. Road level at lower ground level.	Pill	ST 52501 76190
37	Pill Tidal Flood Gate	Flood Gate. Gate in masonry flood wall with pedestrian way and road behind. Approximately 2m wide and 1m high.	Pill	ST 52548 76101
38	Tidal Flood Gate	Flood Gate. Gate in masonry flood wall which is integrated into earth embankment structures. Road level behind wall is at a lower ground level. Flood gate is approximately 4m wide and 0.5m high.	Shirehampton	ST 52693 76265

39	Embankment	Earth Embankment. Adjacent to industrial area. Asset is approximately 1.7m higher than the land behind.	Avonmouth	ST 51678 77480
40	Avonmouth Docks Gates	Sluice in entrance lock of Avonmouth Docks. Approximately 30m wide.	Avonmouth	ST 50801 78670
41	Avonmouth Docks Outfall	Flapped twin outfall. The asset drains water through the sea defences. The structure is located underneath pipes and an access road.	Avonmouth	ST 51325 79834
42	Avonmouth Docks Northern Outfall	Flapped Outfall. The asset drains water through the sea defence at the northern end of Avonmouth Docks. The structure runs underneath the road and the outfall is adjacent to the refinery.	Avonmouth	ST 52531 81219
43	Chitting Industrial Estate Northern Outfall	Flapped twin outfall. The asset drains water through the sea defences.	Avonmouth	ST 52917 82008
44	New Pill Outfall, Severn Side	Flapped twin outfall. The asset underneath road drains water out through the sea defences.	Avonmouth	ST 53570 83072
45	Embankment, Severn View Industrial Park	Rail embankment. There is some evidence of geotextile material beneath stone ballast covering the embankment. The embankment is approximately 1.5m higher than the land in front.	Avonmouth	ST 53641 83255
46	Sea wall, Severn Beach	Sea wall. Concrete sea wall is approximately 2.3m higher than the land behind.	Severn Beach	ST 53860 84762
47	The Binn Wall Embankment	Earth Embankment. Concrete revetted earth embankment. Crest height of 10.2mAOD is approximately 3.5m higher than the populated area behind.	Severn Beach	ST 53952 85588
48	Chestle Pill Outfall	Flapped twin outfall. The asset allows water to drain through the earth embankment.	Northwick	ST 54614 86306
49	Cake Pill Outfall	Flapped outfall. The asset allows water to drain through the earth embankment.	Aust	ST 56105 88130
50	Littleton Pill Outfall	Flapped outfall. The asset drains water through an earth embankment.	Littleton-upon-Severn	ST 58797 91038
51	Oldbury Pill Outfall	Flapped twin outfall. The asset water drains through the sea defences.	Oldbury-on-Severn	ST 60285 92670
52	Oldbury Pill Embankment	Earth Embankment. Embankment is approximately 2m higher than the land in front.	Oldbury-on-Severn	ST 60129 93476

53	Oldbury Power Station Embankment	Earth Embankment. Embankment includes a 900mm diameter flapped outfall. The embankment is approximately 3.4m higher than the land behind. Adjacent to power station.	Oldbury-on-Severn	ST 60412 94328
54	Hill Pill Earth Embankment	Earth Embankment. Embankment is approximately 2m higher than the land behind.	Nupdown	ST 61646 96634
55	Hill Pill Outfall	Flapped outfall with penstock. The asset drains water through the earth embankment.	Nupdown	ST 62719 97199
56	Worlds End Embankment	Earth Embankment with inward stone revetment, concrete upstand and part concrete crest. Embankment approximately 3.5m higher than the land behind.	Nupdown	ST 64028 98253
57	Berkeley Pill Outfall	Outfall. Outfall within earth embankment. Controls water level of Berkeley Pill. Asset approximately 7m wide.	Berkeley	ST 66666 99886
58	Sanigar Outfall	Flapped outfall. The sheet piled asset drains water through the earth embankment.	Sharpness Docks	SO 66659 01309
59	Tutshill Sluice	Water level control structure for Congresbury Yeo. Twin eyes/flaps with secondary penstocks.	Tutshill	ST 38153 65834

APPENDIX 3626/FRA/A4

Greenfield run-off calculation

Greenfield Runoff Rates

Institute of hydrology report no. 124 (IH124)

$$Q_{BAR(rural)} = 0.00108 AREA^{0.89} SAAR^{1.17} SOIL^{2.17}$$

Where:

$Q_{BAR(rural)}$ mean annual flood (return period 2.3 years) (m³/s)
 AREA catchment area (km²)
 SAAR(4170) standard average rainfall for the period 1941 to 1970 (mm)
 SOIL soil index

$Q_{BAR(rural)}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

Parameters	
Area	3.81 ha 0.0381 km ²
SAAR	779
SOIL	0.47
FSR region	8
Return period	2
Growth curve factor	0.88

NB: calculation based on 0.5 km² and then scaled down to actual catchment size. The IH124 methodology is designed for sites > 0.5 km² but can be linearly interpolated to represent smaller catchments.

Q (1in1yr)*: approximate calculation using a ratio of 0.85 (R&D Technical Report W5-074/A Preliminary Rainfall Runoff Management For Developments. Revision D - January 2012)

Return period (yrs)	1*	2	QBAR	5	10	25	30 (interpolated)	50	100	200
Q (l/s/ha)	4.7	4.8	5.5	6.7	8.2	10.1	10.4	11.6	13.2	15.0
Q (l/s)	17.72	18.34	20.85	25.64	31.06	38.36	39.52	44.19	50.45	57.12

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Project: Bristol and Avon recycling		

APPENDIX 3626/FRA/A5

Attenuation calculations

Runoff of proposed concreted area	
Runoff Coefficient	1.00
Area Ha	3.8100

Climate change (% rainfall increase) *3	25	%
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Greenfield Discharge off-site	20.85	l/s
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*2 Obtained from FEH Web Service

	Rainfall *2	Rainfall intensity	Runoff of site	Greenfield discharge off-site *3	Net Inflow	Runoff volume
Duration	100 year event					
hours	mm	mm/hr	l/s	l/s	l/s	m ³
0.25	23.7	95.0	1257.2	-20.85	1236.40	1112.8
0.5	31.6	63.1	835.7	-20.85	814.85	1466.7
1	40.0	40.0	529.1	-20.85	508.21	1829.6
2	48.1	24.1	318.5	-20.85	297.64	2143.0
4	57.8	14.4	191.1	-20.85	170.30	2452.4
6	64.3	10.7	141.8	-20.85	120.93	2612.1
8	69.4	8.7	114.9	-20.85	94.01	2707.5
12	77.4	6.5	85.4	-20.85	64.55	2788.6
16	83.7	5.2	69.2	-20.85	48.38	2786.8
20	88.6	4.4	58.6	-20.85	37.77	2719.7
24	92.4	3.9	51.0	-20.85	30.14	2604.4
28	95.6	3.4	45.2	-20.85	24.37	2456.8
32	98.3	3.1	40.7	-20.85	19.84	2285.3
36	100.7	2.8	37.0	-20.85	16.17	2096.2
40	102.7	2.6	34.0	-20.85	13.15	1893.2
44	104.5	2.4	31.4	-20.85	10.60	1679.3
48	106.1	2.2	29.3	-20.85	8.43	1456.4

*3 Climate change factored into rainfall intensity at this stage

 environmental water management	Barkers Chambers Barker Street Shrewsbury, Shropshire SY1 1SB UK Tel: 01743 355770 www.hafrenwater.com	Client: <p style="text-align: center;">B&A Group</p>
	Title: 100-year plus climate change runoff rates and volumes of the full site area	
Project: Bristol and Avon recycling		
Calc Sheet: 1		Date: Sep-24