



RWE Renewables UK Swindon Ltd.

Pen March Wind Farm: Flood Consequence Assessment

Technical Appendix 6.3

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1 INTRODUCTION

- 1.1 This report provides a Flood Consequence Assessment for Pen March Wind Farm and associated infrastructure (hereafter, the Proposed Scheme').
- 1.2 The report forms a Technical Appendix to the Environmental Statement (ES) for the Proposed Scheme and should be read in conjunction with this document. It has been produced to address the potential for changes to flood risk in areas downstream of the Proposed Scheme and to set out principles by which this would be prevented. The assessment includes details of proposed water management and water treatment infrastructure including sustainable drainage options.
- 1.3 For the purposes of this technical appendix, the study area is considered to include the Site boundary plus an area up to 2km from the boundary. In terms of flood risk, downstream effects are considered for greater distances as impacts can be transmitted downstream for considerable distance without appropriate control.

Site location

- 1.4 The Site is located in South Wales, approximately 1.5 km north-east of Merthyr Tydfil and 1.5 km north-west of Rhymney. The site lies across the Merthyr Tydfil and Caerphilly County Borough Council areas. The land is currently a mix of common land and Countryside Right of Way (CRoW) land with open access.
- 1.5 The development area covers a broadly sloping area of Purple Moor Grass-dominated grassland, with small scattered areas of dense scrub, exposed rock, dry heath and standing open water habitats. The western side borders the town of Merthyr Tydfil, the northern side borders the Bannau Brycheiniog National Park (formerly Brecon Beacons National Park), the eastern side stops at the top of the valley slope down towards the Rhymney River, and the southern side borders the A465 Heads of the Valleys Road.
- 1.6 The natural drainage regime within the area has been extensively modified as a result of former mining and quarrying activity, as well as to attempt improvements to drainage through excavation of ditches and straightening of natural drainage channels.

Development proposals

- 1.7 The Proposed Scheme includes the following key elements:
- Six wind turbines, with a maximum tip height of 180m;
 - Hardstanding areas at the base of each turbine, with a maximum total area of approximately 9,147m²;
 - Approximately 5,376 m of new access track with associated watercourse crossings and passing places;

- Two temporary construction and storage compounds, one of which would form the energy storage facility.
- 1.8 Full details of the Proposed Scheme design are provided in **Chapter 2, (Volume 2)** of the ES.

Aims

- 1.9 This report aims to undertake a review of the current hydrological setting of the site, including available information concerning flood risk within the site and in areas downstream, in order to provide an outline strategy for water and drainage management during all stages of the Proposed Scheme process.
- 1.10 Recommendations will be made for water management and mitigation that would be implemented in order to minimise the risk of increasing downstream flood risk as a result of the Proposed Scheme works.
- 1.11 The outline strategy provided should be used to underpin relevant sections of the detailed design.

Assessment method

- 1.12 The assessment has involved the following stages:
- Desk study;
 - Site reconnaissance;
 - Hydrological assessment
 - Consideration of flood risk
 - Assessment of drainage characteristics and water storage.

2 DRAINAGE CHARACTERISTICS

- 2.1 This section of the document outlines the existing drainage characteristics of the site in order to determine a baseline against which to assess changes to the drainage regime. Natural drainage characteristics are determined by the site topography, existing drainage features and natural catchment areas, site rainfall characteristics, current land use and any existing drainage infrastructure.

Site topography

- 2.2 The Proposed Scheme is located on Pen March, part of the southern slope of Cefn y Ystrad. The area slopes down to the south and south-east, with the highest land lying on the northern boundary at approximately 535 m AOD and the lowest land at approximately 355 m AOD by the A465 Heads of the Valleys Road on the south-eastern boundary.
- 2.3 The area forms a broad ridge with watercourse valleys to east and west. As the watercourses diverge, the ridge becomes broader and less distinct, having more of the character of a wide slope along the southern margin. Across the Heads of the Valleys Road the ground rises to the south. The land in this area has undergone significant modification as a result of coal mining activity.
- 2.4 Two key topographical features are notably incised watercourse channels, one to the east and one to the west of the development area. These are associated with the main channels of the Nant Pitwellt to the east side and the Nant Morlais to the west. A pond or wetland feature on the northern boundary, Pwll Mere, has a notably steep back wall with a pronounced break-in-slope on the northern side.
- 2.5 In the area to the east of the Site, two reservoirs are visible. The northern one is on the Nant Pitwellt, and the southern where the Nant Pitwellt joins the Rhydney River.
- 2.6 Within the Site boundary, two reservoirs are indicated on the maps – Pitwellt Pond and Jepson's Pond. Pitwellt Pond is shown to be dry on aerial imagery and this was found to be the case during visits to the site. There are a number of watercourse channels that are either artificial or have been channelised, in addition to watercourses that appear to be fully natural.
- 2.7 Some bedrock exposure is apparent in parts of the site, notably between Pitwellt and Jepson's Ponds in the western part of the site and on the mid-part of the slope in the eastern part of the site.

Rainfall

- 2.8 The project area lies 2.5 km north-west of the Tredegar climate monitoring station (Met Office, 2022). Due to its proximity, the rainfall data from the climate station is likely to be representative of the whole site.
- 2.9 Average annual rainfall for the climate monitoring station is 1,674.2 mm. The altitude at this monitoring station is 324 m above sea level.
- 2.10 Snowfall in Wales is generally confined within the months from November to April. The average number of days of snowfall in Wales varies from 10 days or fewer per year along

the coast to 30 days over the Snowdonia. The Proposed Scheme's location and elevation means it is likely to fall somewhere between these two extremes.

Existing drainage and natural catchments

- 2.11 The Site lies across two surface water catchments: the River Rhymney and the River Taff catchments.

River Rhymney catchment

- 2.12 The River Rhymney catchment has a total area of approximately 73.9 km² down to Ystrad Mynach, and drains 68% of the site.
- 2.13 The River Rhymney lies immediately east of the site boundary. Within the site boundary, drainage is provided by the Nant Pitwellt and tributaries in the northern part of the site, and a number of unnamed and modified watercourses in the southern and central section.
- 2.14 Within the site, the Rhymney catchment has been described by NRW's Environmental Information Portal (NRW, 2022a) as an area of grassland and marshland mainly used for upland grazing. Smaller regions on steeper slopes are described as upland hills or plateau. The watercourses within the site have been modified during the period of mining and quarrying activity, with Jepson's Pond described as an industrial reservoir, with sluices upstream to divert flow into the pond; these form part of the Dowlais Free Drainage System (Roberts & Jones, 2007).

River Taff catchment

- 2.15 The River Taff catchment has a total area of 188.8 km² down to Abercynon, and drains 32% of the site.
- 2.16 The River Taff is formed by the confluence of the Taf Fawr and Taf Fechan at the west side of Merthyr Tydfil. The Taf Fechan is located approximately 1.5 km west of the site boundary. Within the site, drainage is provided by the Nant Morlais and a number of unnamed smaller watercourses.
- 2.17 Within the site, the Taff catchment has been described by NRW (2022a) as an area of grassland and marshland mainly used for upland grazing. Smaller sections on the steeper slopes surrounding the Taff Fechan are described as an upland valley. The watercourses within the site have been modified during the period of mining and quarrying activity, with part of the Nant Morlais diverted in the area near Pitwellt Pond and additional connections across the catchment divide towards Jepson's Pond. As with Jepson's Pond, Pitwellt Pond is an industrial reservoir with sluices upstream to divert flow into the pond. These modifications form part of the Dowlais Free Drainage System (Roberts & Jones, 2007).

Dowlais Free Drainage System

- 2.18 The interconnected system of reservoirs, ponds, leats and culverts in the area is known as the Dowlais Free Drainage System (Dowlais FDS). The full extent of the system is not clearly defined and much of it has not been mapped, partly as a result of poor documentary evidence of the drainage works (Roberts & Lawler, 2003). The system was

established to provide water to the Dowlais Iron Company and was developed over a period of roughly 50 years as required by the works, dating from the mid 19th Century.

- 2.19 As a result of the system's extent, the River Taff and River Rhymney catchments are now partially interconnected although the Dowlais FDS is no longer maintained and parts of the system have fallen into disrepair.

Table 2-1: Overview of watercourse catchment areas and infrastructure

Catchment	Total area (km ²)	% of site within catchment	% of catchment within site	Comments
River Taff	188.8	32%	0.8%	Includes Turbines 1, 2 and 3, part of the access track and the substation. T2 hardstanding lies across the catchment boundary.
River Rhymney	73.9	68%	4.3%	Includes Turbines 4, 5 and 6, part of the access track and the construction compound. A small part of T2 hardstanding is located in this catchment.

Rainfall characteristics

- 2.20 A review of the watercourse catchment and rainfall characteristics was undertaken using data from the FEH web service (CEH, 2022). Catchment statistics have been provided for both catchments within the site.
- 2.21 Standard average annual rainfall (SAAR) for the two site catchments are as follows:
- Taff: 1,725 mm
 - Rhymney: 1,490 mm
- 2.22 The average SAAR for the two sites is 1,608 mm, which is comparable with the records from the Tredegar monitoring station. This average value has been used in calculations in Section 3 below.

Catchment land use

- 2.23 The land is split between common land and open access land under the Countryside and Rights of Way Act 2000 (CRoW). There are no ground markers indicating the separation.
- 2.24 The land with the application boundary is used for rough grazing for sheep and horses. At present the land is under rough pasture dominated by Purple Moor Grass and other low-nutrient grasses, sedges and rushes. Some smaller areas with higher-quality pasture are present in places.
- 2.25 Land to the east and west is mainly improved grassland used for pasture. To the north lies the Bannau Brycheiniog National Park, with extensive areas of rough open moorland. Part of the area to the west is characterised by the Pengarnddu industrial estate. To the south, the land has been extensively modified for coal mining.

Existing drainage infrastructure

Waste water

- 2.26 There is no existing waste water infrastructure, either foul drainage or surface water drainage, present within the site.

Surface water

- 2.27 Surface water drainage within the site varies, depending on the dominant current and former land use. In areas with no or limited modification to drainage, the ground drains via infiltration and overland flow into the existing watercourse network. Much of the ground is seasonally boggy with a network of indistinct flow paths that coalesce to form more distinct drainage channels.
- 2.28 The natural drainage has been significantly modified historically as part of the Dowlais FDS and, more recently, to improve drainage for pasture. A number of artificial channels act as collector drains along the hill slopes, diverting water into Pitwellt and Jepson's Ponds and to other reservoirs beyond the planning application boundary. Two channels, which were mainly dry or boggy during all the site visits, appear to have been designed to divert water from Pitwellt Pond to Jepson's Pond, across the catchment divide. Other channels divert water between sub-catchments within the Nant Morlais sub-catchment.
- 2.29 Beyond the planning application boundary, extensive networks of drainage ditches are apparent in fields used for enclosed grazing and improved pasture.
- 2.30 Extensive artificial drainage is in place around the industrial estate, as well as alongside the Heads of the Valleys Road and adjacent minor road infrastructure.
- 2.31 All visible waterbodies within the planning application boundary and nearby are reservoirs, with the exception of Pwll Mere and Pwll Morlais. It is not possible to determine if any of the current reservoirs include former, smaller-sized, natural waterbodies. Pwll Mere is a wetland swamp which is likely to have been open water previously. Pwll Morlais, just outside the application boundary, appears to be a natural waterbody, although the watercourse channels around it have been considerably modified as part of the Dowlais FDS, and it is possible that the Pwll itself has also undergone some modification as a result.
- 2.32 Most of the artificial drainage is in poor condition and has not undergone any recent maintenance or management.
- 2.33 The photographs below provide examples of the key hydrological features within the site.



Photograph 6.1: One of the minor overland flow channels visible near the site. View W, NGR SO 0777 1134.



Photograph 6.2: An area of diffuse overland flow. View SE, NGR SO 0867 0998.



Photograph 6.3: Nant Pitwellt valley, looking downstream (SE). NGR SO 0880 1148.



Photograph 6.4: Pwll Morlais and the heavily modified channel adjacent to it. View E, NGR SO 0754 1116.



Photograph 6.5: Pitwellt Pond, showing the almost completely dry reservoir, with the constructed concrete outfall channel. View NW, NGR SO 0792 0969.



Photograph 6.6: Jepson's Pond showing one of the inflow channels and the main dam structure. View W, NGR SO 0872 0931.



Photograph 6.7: An old sluice gate formerly used to control flows into Jepson's Pond. View NW, NGR SO 0872 0931.



Photograph 6.8: Part of one of the cross-hill collector drains showing damage to the retaining bund as a result of livestock passage. View E, NGR SO 0871 0931.

Private water supply

- 2.34 Three private water supplies (PWS) have been identified within 2 km of the application boundary. All three PWS are located in separate sub catchments from all proposed infrastructure and are therefore not considered to be at risk from the Proposed Scheme.
- 2.35 Details of the risk assessment procedure are provided in the **Chapter 6 (Volume 2)** of the ES.

Flood risk

Flood risk within the site

- 2.36 Inspection of NRW's online Development Advice Map (NRW, 2022b) indicates that the entire site area lies within Flood Zone A and is considered to be at little or no risk of fluvial or coastal/tidal flooding.
- 2.37 Within the site boundary, the Flood Risk Assessment Wales Map (NRW, 2022b) indicates that some areas are at risk from flooding from surface water and small watercourses. These areas include all the main watercourse channels, both reservoirs within the site boundary and the key overland drainage pathways observed during the site visits. The areas identified as at risk from surface water flooding are small and confined to the main channels and waterbody outlines.
- 2.38 The area immediately downslope from Jepson's Pond is indicated to be at risk of flooding from reservoirs. This risk arises from the presence of Jepson's Pond and the potential for dam failure in this immediate area.

Flood risk downstream of the site

- 2.39 Flood risk downstream is a more serious consideration. Merthyr Tydfil is identified as a National Flood Risk Area (South Wales Valleys). The Flood Risk Assessment Wales Map indicates that areas within both the Taff and Rhymney river valleys have areas at risk of flooding for a considerable distance downstream of the site.
- 2.40 A key responsibility is to ensure that downstream flood risk is not exacerbated in any way as a result of the Proposed Scheme. Section 3 considers drainage requirements and a drainage strategy that would require implementation in order to manage surface water from the site.

Watercourse crossing infrastructure

- 2.41 All proposed watercourse crossing structures would be designed to permit conveyance of the 1 in 100 year storm of 6 hours duration (the 'Design Storm') plus climate change allowance, in order to prevent flooding upstream of structures. Sizing of structures would be undertaken as part of the detailed design process.

3 OUTLINE DRAINAGE STRATEGY

Introduction

- 3.1 This section provides an outline drainage strategy for the Site. The proposal is to maintain site runoff within the natural catchment areas, and to maintain drainage to the site watercourses following treatment and attenuation in order to mimic natural flow as closely as possible.

Waste water drainage

- 3.2 It is anticipated that waste water drainage for construction and operation would be provided by a suitably sized containment tank, which would be emptied by tanker and all waste water would be removed for disposal at a suitably licensed treatment facility. No discharge to ground or to a watercourse is proposed.

Surface water drainage

- 3.3 The surface water drainage network for the site would be designed taking into account the requirements of the Flood and Water Management Act 2010 (Schedule 3) and current best practice guidance from the Welsh Government (2018) and CIRIA Publication C753 – the SuDS Manual (CIRIA, 2015).
- 3.4 The following sections describe the requirements that lead to determination of the proposed drainage strategy and which inform SuDS provision recommendations.
- 3.5 The Welsh Government's document 'Statutory National Standards for Sustainable Drainage Systems' (2018) sets out a hierarchy of surface water runoff designations that must be followed. The Levels are as follows:
- Priority Level 1: Surface water runoff is collected for use;
 - Priority Level 2: Surface water runoff is infiltrated to ground;
 - Priority Level 3: Surface water runoff is discharged to a surface water body;
 - Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain or another drainage system;
 - Priority Level 5: Surface water runoff is discharged to a combined sewer.
- 3.6 Priority Levels 4 and 5 should only be used in exceptional circumstances. Priority Level 1 is the preferred option.

Site options for Priority Levels

Priority Level 1

- 3.7 There is limited potential within the site to make use of collected surface water runoff. The substation and control building would include a rainwater harvesting system, which would provide water for use within the operational phase welfare facilities.

Priority Level 2

- 3.8 Use of suitable SuDS features would encourage infiltration to ground in areas where ground conditions are suitable. Although much of the bedrock is noted to form aquifers, surface conditions within the site indicate that natural infiltration is highly restricted in some areas.
- 3.9 In addition, the northernmost part of the site, including Turbines 1, 2, 4 and 5, lies within one of NRW's Groundwater Source Protection Zones as the Carboniferous Limestone bedrock is classed as a Principal Aquifer. Particular care would be required for any infiltration systems within this part of the site to ensure that no potentially polluting materials are permitted to infiltrate into the groundwater in this area.

Priority Level 3

- 3.10 It is anticipated that surface water runoff that cannot be collected for use, and is either in an area where ground conditions make infiltration unsuitable or where potential for groundwater pollution is considered too high, would be collected within site drainage for treatment to remove suspended sediment and discharge into the existing surface water network.

Detailed design

- 3.11 Site-specific details and design proposals would be provided as part of the detailed design. This would include ground tests for infiltration potential in different parts of the site, and the establishment of suitability for infiltration as a method of surface water control within the Source Protection Zone.

SuDS components

- 3.12 The following SuDS features have been considered for inclusion within certain sections of the Proposed Scheme's drainage network in order to control, manage and treat surface water runoff during construction, operation and decommissioning of the Proposed Scheme.

Swales and filter strips

- 3.13 Swales are shallow, broad and linear vegetated drainage features that can be designed to store and/or convey surface runoff as well as providing water treatment. Where soil and groundwater conditions allow, swales can also promote infiltration. Vegetation within swales varies but typically comprises grass or dense vegetation that can act to slow down flow rates and trap particulate pollutants in the water.
- 3.14 Filter strips are gently sloping vegetated strips of land that provide off-the-edge diffuse drainage. They provide some flow attenuation and treatment, but little or no water storage.

Filter drains

- 3.15 Filter drains are also linear drainage features, but rather than incorporating vegetation they include coarse graded rock which provides good drain stability whilst also providing water storage and conveyance. Filter drains have a narrower footprint than swales and can be used in areas where space constraints prevent wider swales from being used. Filter drains provide some limited water treatment.

Check dams

- 3.16 For either swales or filter drains that cross slopes, check dams provide a valuable means of attenuating water flow. These are typically placed across the swale or drain at intervals of 10-20 m. The design is such that the toe of the upstream dam is level with the crest of the next downstream dam. A small opening or pipe is placed at or near the base of each dam to allow limited flow to pass through rather than over the dam, in order to maintain low flow conveyance.
- 3.17 Check dams should be built into the sides of the swale or filter drain, to ensure that water flow cannot bypass the dam.
- 3.18 When made of soil (as opposed to stone or rock), check dams are often called bunds or berms.

Silt fences and straw bales

- 3.19 Silt fences, constructed from a closely woven synthetic geotextile material, and straw bales both provide flow attenuation and excellent particulate filtration treatment for surface water runoff. These are particularly valuable for sediment management in runoff during construction works, as silt fences and pegged straw bales can be positioned along the main runoff routes to capture, slow and treat runoff. They can also provide temporary check dams if required in short-term drainage infrastructure.

Settlement ponds and detention basins

- 3.20 Settlement ponds provide storage for site runoff and are a highly effective method of treatment and attenuation of surface water. They are particularly useful for developments where bulk earthworks form a significant part of the works.
- 3.21 Detention basins are more usually used as long-term temporary storage for surface runoff during and subsequent to storm or high intensity rainfall events. They may be developed from construction-phase settlement ponds where conditions are suitable.

Site conditions for SuDS

- 3.22 It is anticipated that settlement ponds would be used at each turbine location, the substation and the construction compound to provide water storage, attenuation and treatment to remove suspended sediment from surface water runoff. The ponds would be established during construction to provide water management for the construction phase works. The ponds are anticipated to be fully reinstated at the end of the construction period.

- 3.23 Swales and filter strips would provide attenuation, storage and treatment for access tracks and turbine hardstandings, with swales forming the preferred option. During construction, small sumps with silt fencing would be established periodically along track routes in order to manage entrained sediment within the surface water. The sumps and silt fencing would be removed at the end of the construction phase, once vegetation on the filter strips and swales has become established.
- 3.24 Temporary cut-off drains and bunds would be required around excavation areas for the turbine bases and hardstanding areas, to capture clean runoff and divert it around construction areas. These may be converted into swales at the end of the construction phase if long-term drainage is required.
- 3.25 Settlement ponds and swales at locations within the SPZ may require to be lined to prevent infiltration, if the pollution risk is considered to be too high following on-site tests during the detailed design phase.
- 3.26 Should detailed design calculations determine the requirement for long-term temporary storm water storage, one or more of the settlement ponds could be retained as a detention basin through the operational phase of the Proposed Scheme.

Surface water runoff hydraulic control

- 3.27 The Welsh Government's document 'Statutory National Standards for Sustainable Drainage Systems' (2018) sets out a number of expectations for surface water systems in relation to runoff hydraulic controls, as follows:
 - Surface water should be managed to prevent, so far as possible, any discharge from the site for the majority of rainfall events of less than 5 mm.
 - The surface water runoff rate for the 1 in 1 year return period event (or agreed equivalent) should be controlled to help mitigate the negative impacts of the development runoff on the morphology and associated ecology of the receiving water bodies.
 - The surface water runoff (rate and volume) for the 1% (1 in 100 year) return period event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.
 - The surface water runoff for events up to the 1% (1 in 100 year) return period (or agreed equivalent) should be managed to protect people and property on and adjacent to the site from flooding from the drainage system.
 - The risks (both on and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be considered. Where the consequences are excessive in terms of social disruption, damage or risk to life, mitigating proposals should be developed to reduce these impacts.
 - Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or blockage) and the associated flood risks managed where possible.

Site results

- 3.28 HR Wallingford's Greenfield runoff rate estimation tool for sites (2022) allows estimation of runoff rates for greenfield sites. The tool makes use of site-specific data

including the total proposed site area, standard average annual rainfall (SAAR) and standard percentage runoff (SPR). SAAR and SPR are both provided by FEH webservice data sheets (CEH, 2022). A copy of the tool's output report is provided in Annex A.

- 3.29 In addition, it is possible to calculate the Long-Term Storage Volume required to maintain discharge from the site at the pre-development greenfield rates. Calculations make use of the Design Storm, defined as a 1 in 100 year storm of 6 hours duration. The figures used in calculation are derived from FEH webservice. A copy of the calculation is provided in **Annex A**.
- 3.30 For the Proposed Scheme, the details been used in calculations are provided in Table 3-1.

Table 3-1: Input parameters used for greenfield runoff rate and long-term storage volume calculations

Parameter	Value	Notes
Total site area	40.2 ha	Release land area
SAAR	1,608 mm	From FEH
SPR	0.45	From FEH
Design Storm rainfall	72.29 mm	From FEH, 1 in 100 year return period storm of 6 hours duration
Total impermeable surface	23.9%	Percentage of release land required for long-term infrastructure

- 3.31 Results from the calculations are provided in Table 3-2.

Table 3-2: Results from the greenfield runoff rate and long-term storage calculations.

Parameter	Value	Notes
Q _{BAR} runoff rate	467.29 l/s	Results from Greenfield Runoff Rate Estimation for Sites tool (HR Wallingford, 2022)
1 in 1 year runoff rate	411.22 l/s	
1 in 30 year runoff rate	831.78 l/s	
1 in 100 year runoff rate	1,018.7 l/s	
Long-Term Storage Volume	2,374 m ³	See Annex 1 for calculation details
Long-Term Storage Volume plus climate change allowance	2,900 m ³	Includes climate change uplift of 21%

- 3.32 Details of proposed water storage locations, storage capacity and discharge locations would be provided as part of the drainage infrastructure detailed design.

4 CONCLUSIONS

- 4.1 This report has assessed the relevant aspects of drainage associated with the Proposed Scheme. It sets out a drainage strategy on which to base detailed design plans, recognising the requirements of the Welsh Government and taking current best practice guidance into account.
- 4.2 The site currently drains naturally via overland flow and drainage ditches to the existing natural and artificial watercourses in and around the site. The proposed drainage strategy promotes maintenance of natural runoff characteristics where possible, and drainage infrastructure to mimic these characteristics where required. Runoff attenuation and treatment proposals are designed to prevent any detrimental effects to the water quality or quantity of existing waterbodies. The proposed strategy makes use of SuDS features within the detailed engineering design to mimic the existing runoff characteristics.
- 4.3 Proposed SuDS include use of settlement ponds, swales, filter strips, check dams and silt fences/straw bales at different stages of the development.
- 4.4 All necessary water environment authorisations would be put in place prior to any site works taking place.

5 REFERENCES

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6 ANNEX A

Calculations and input parameters for:

- Long-Term Storage Volume calculations
- HR Wallingford's Greenfield Runoff Rate Estimation for Sites tool

Long-Term Storage Volume Calculations

$$VOL_{xs} = RD \times A \times 10 \left[\frac{PIMP}{100} (\alpha \ 0.8) + \left(1 - \frac{PIMP}{100} \right) (\beta \ SPR) - SPR \right]$$

Equation 24.10 from CIRIA Report C753 The SUDS Manual.

Parameter	Units	Value used	Notes
VOL _{xs}	m ³		Extra runoff volume of development runoff over greenfield runoff
RD	mm	72.29	Design storm rainfall, for 1 in 100 year return period storm of 6 hour duration
A	ha	40.2	Actively drained area
PIMP		23.9%	Impermeable area as a percentage of the total area
α		1	Proportion of paved area draining to the network, with 80% assumed runoff. Taken as 1 for the calculation.
β		1	Proportion of the pervious area draining to the network or directly to the river. Taken as 1 for the calculation.
SPR		0.45	Standard percentage runoff (from FEH webservice)



HR Wallingford's Greenfield Runoff Rate Estimation for Sites tool

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Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by: Catherine Isherwood

Site name: Pen March

Site location: Merthyr Tydfil

Site Details

Latitude: 51.78346° N

Longitude: 3.3297° W

Reference: 1685750497

Date: Sep 08 2022 15:48

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 40.2

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Specify SPR manually

Soil characteristics

	Default	Edited
SOIL type:	5	5
HOST class:	N/A	N/A
SPR/SPRHOST:	0.53	0.45

Hydrological characteristics

	Default	Edited
SAAR (mm):	1601	1608
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 30 years:	1.78	1.78
Growth curve factor 100 years:	2.18	2.18
Growth curve factor 200 years:	2.46	2.46

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	663.1	467.29
1 in 1 year (l/s):	583.53	411.22
1 in 30 years (l/s):	1180.32	831.78
1 in 100 year (l/s):	1445.56	1018.7
1 in 200 years (l/s):	1631.23	1149.54

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.