DRAFT REPORT

THE BRIDGEWAY CENTRE

Flood Risk Assessment &

Drainage Strategy

Bridge Road, Wrexham, LL13 9QS

BCW-BML-ERD-ZZ-RP-C-0500

Friday, 12th March 2021

BarnsleyMarshall

BarnsleyMarshall Limited
1 Birch Court
Blackpole East
Worcester
WR3 8SG
Tel 01905 330 550
Web barnsleymarshall.co.uk
Company Registered in England No. 4926185

BarnsleyMarshall

Contents Amendment Record

This report has been issued and amended as follows:

Revision	Description	Issued by	Checked by	Date
P02	Revised to address SAB pre-app comments	V. Ivanov	A. Mavhunga.	2021-03-12
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Contents

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Appendices

DRAFT

1. Introduction

1.1 Project Background

Barnsley Marshall Ltd was appointed by FI Real Estate Management to provide a Flood Consequences Assessment & SuDS Drainage Strategy for the proposed development of 48 units on 3.35Ha of land off Bridge Road, Wrexham, postcode LL13 9QS.

The report provides foul and SuDS-based surface water drainage strategy for the proposed development based on Government and local authority guidance with regard to flood risk and sustainable drainage.

The report is based on currently available information and preliminary discussions.

Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material deviation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

Where the proposed works to which this report refers are undertaken more than twelve months following the issue of this report, Barnsley Marshall shall reserve the right to re-validate the findings and conclusions by undertaking appropriate further investigations at no cost to Barnsley Marshall.

1.2 Scope of Flood Risk Assessment

The assessment is to be undertaken in accordance with the standing advice and requirements of the Planning Policy Wales – Technical Advice Note - 15 (TAN 15) Development and Flood Risk as outlined in the Communities and Local Government Planning Policy Guidance to the Planning Policy Wales and Sustainable Drainage (SuDS) Statutory Guidance - Wales.

The development site is off Bridge Road in Wrexham, and approximately 3.35Ha. Following scrutiny of the Natural Resources Wales Flood Maps it has been identified that the existing site lies within an area classified as Flood Zone A or B in accordance with TAN15 (Flood Zone 1 in accordance with Environment Agency Flood Maps) indicating that the risk of flooding from rivers and sea is low, with an Annual Exceedance Probability of flooding of less than 0.1%. The site is however within 250m of an area at risk from extreme flooding from rivers and sea without defences and therefore a Flood Consequences Assessment (equivalent to a Flood Risk Assessment) would be advisable to check flooding effects on the site.

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In January 2019, the Government made changes to the National Planning Policy Framework which made Sustainable Urban Drainage Systems (SUDS) a material consideration in the determination of planning applications for new developments of more than 1 dwelling or with construction area greater than 100m^2. The SuDS Drainage Strategy, which is part of this report, has therefore been produced to support the Planning Application in accordance with the Town and Country Planning Order 2019.

The Strategy reviews the following information:

- Natural Resources Wales flood maps for rivers and sea flooding.
- Local Flood Risk Management Strategies
- Sustainable Drainage (SuDS) Statutory Guidance – Wales
- Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems 2018
- Design and Construction Guidance V1 – Oct 2019
- Part H of the Building Regulations: Drainage and waste disposal
- BE EN12056 Part 2 Gravity Drainage Systems Inside Buildings
- Technical Guidance to the National Planning Polity Framework
- CIRIA Report C753 SUDS Manual 2016.
- BS EN 752:2008 Drain and sewer systems outside buildings.
- BS 8582:2013, Code of Practice for surface water management for development sites.
- BS 8533:2011, Assessing and managing flood risk in development – Code of practice.
- CIRIA C635 Designing for exceedance in urban drainage - good practice
- Flood Estimation Handbook (FEH) /Flood Studies Report (FSR) methods.
- Institute of Hydrology (IH) Reports No. 124.
- Environmental Agency (EA) / Department for Environment, Food and Rural Affairs (DEFRA) recommendations.
- Technical Advice Note (TAN) 15: Development and Flood Risk (2004).
- Floods and Water Management Act 2010
- Flood plan guidance for communities and groups – EA
- Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities – EA
- Code for Sustainable Homes

2. Existing Site Details

2.1 Location and Description

The site is approximately 4.2km east of Wrexham city centre and it is located in the centre of Wrexham Industrial Estate. The site is currently occupied by existing commercial units. There are grass verges around the site and in between the units.

The site is surrounded by commercial units on the west and north and it is bounded by Bridge Road to the east, as shown on ***Figure 1***

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For a site location plan refer to ***Appendix A.***

Figure 1: Development Site shown with red border

(Source: Google Maps, Accessed on 2020-10-13, 0920hrs)

2.2 Topography

The site is generally flat from south-east to north-west but falls approximately 3.0m from south-west to north-east over a distance of 300m, giving an average longitudinal gradient of 1 in 100, refer to topographical survey in ***Appendix B.***

2.3 Existing Watercourses

An existing ditch passes along the north-west edge of the site. The ditch joins up with Redwither Brook that drain into River Clywedog, located approximately 1.1km to the east of the site.

2.4 Existing Public Drainage

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There are existing Welsh Water combined public sewers on site, with two of the sewers conveying flow from properties on the north-west through the site, to the south-east. The sewers will be diverted through site to ensure continuity of service to the properties on the north-west, and this is shown in ***Appendix D*** on Combined Drainage drawing BCW-BML-ERD-ZZ-DR-C-0500.

From the provided Welsh Water sewer maps (refer to ***Appendix G***), it can be seen that the existing sewers are crossing Bridge Road at three points. Any proposed connection / discharge to these sewers should therefore be made before they cross the road to avoid excavation of the public road and associated Traffic Management issues.

A detailed CCTV & Drainage Survey shall be commissioned to determine the exact layout of sewers on site, and proposed remedial works required to ensure continuity of the sewers during and after construction.

2.5 Existing Private Drainage

There are existing Surface Water and Foul sewers on site, some of which should be private. A detailed CCTV & Drainage Survey shall be commissioned to determine the exact layout of sewers on site, and proposed remedial works required to ensure continuity of the sewers during and after construction.

2.6 Site Geology

No Ground Investigation Survey had been carried out at the time this report was compiled, although it was in the process of being commissioned. A search on British Geological Survey online showed that the nearest boreholes logs dated April 1984 with references SJ34NE45/P (Grid Reference: Easting:337590, Northing:349360) and SJ34NE45/N (Grid Reference: Easting:337700, Northing:349240) are located close to the western site boundary, and gave the information on ***Table 1.***

Table 1: Geological Information from BGS

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From	To	Description
SJ34NE75/P		
Ground Level	0.9m below ground	Medium dense light brown silty SAND with roots and brick rubble.
0.9m below ground	1.7m below ground	Firm to stiff light brown slightly sandy CLAY S=90 kN/m^2
1.7m below ground	1.9m below ground (bottom of pit)	Very stiff fissured red/drown CLAY with grey inclusions, S > 120 kN/m^2
SJ34NE75/N		
Ground Level	1.25m below ground	Firm red/grey Clay with roots, gravel and brick rubble and black stained lenses.
1.25m below ground	3.0m below ground (bottom of pit)	Very stiff fissured red/brown Clay with grey Inclusions, S > 120 kN/m^2

(Source: British Geological Survey, Accessed on 2020-10-12, 1700hrs)

A copy of the borehole results is contained in ***Appendix C.***

The soil profile from the three boreholes indicate that the soil is predominantly clay for depths of more than 3m from the surface and would not support drainage via infiltration. However due to the dated nature of the boreholes, BRE Digest 365 Soakaway Tests shall be conducted at a number of locations across the site, and if infiltration is found to be possible, the proposed Geo-cellular Storage Tank shall be designed as an infiltration pond, and the controlled outflow to the ditch shall be reduced, or if infiltration is good enough, there shall be no outfall from the tank to the existing ditch.

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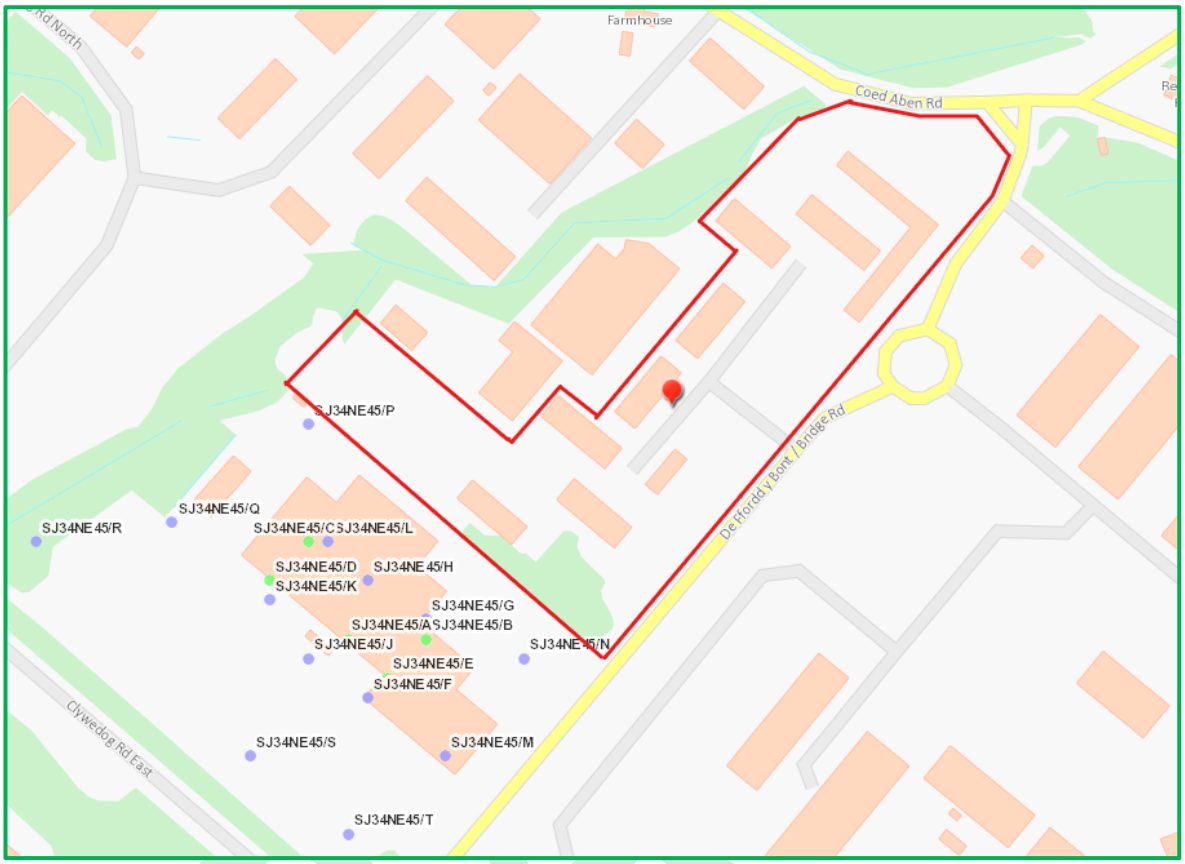

Figure 2: Historic Borehole Locations

(Source: British Geological Survey online, Accessed on 2020-10-12, 1700rs)

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3. Policy and Guidance

3.1 Planning Policy Wales (PWW), Welsh Assembly Government (WAG), March 2002

Land use planning policies of the Welsh Assembly Government are set out in Planning Policy Wales (PPW). The principle purpose of PPW is to reconcile the needs of development and conservation, securing economy, efficiency, and amenity in the use of land, protecting natural resources and the historic environment, thereby contributing to sustainable development.

In relation to flood risk, PPW aims to minimise the risks posed by, or to, development on, or adjacent to land liable to flooding. PPW recognises that the impacts of future climate change effects should be considered when planning development in flood prone coastal areas and floodplains. The likely impact to frequency and severity of floods expected during the lifetime of development must be addressed. More detailed guidance relating to development and flood risk is provided in Technical Advice Note 15: Development and Flood Risk (TAN15).

3.2 Technical Advice Note 15: Development and Flood Risk (TAN15), Welsh Assembly government (WAG), July 2004

The guidance in TAN 15 aims to direct new development away from areas of high flood risk. Where development in these areas can be justified, the guidance states that the risk of and consequences of flooding should be managed to an acceptable level.

TAN 15 guidance requires the assessment of consequence based on the consideration of whether flooding would be acceptable for the particular type of development under consideration. The justification test, as outlined in Section 6 of TAN 15, indicates that development can be justified if it can be demonstrated that:

- Its location in Zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement, or,
- Its location in Zone C is necessary to contribute to key employment objectives supported by local authority and other key partners, to sustain an existing settlement or region; and,
- It concurs with the aims of PPW and meets the definition of previously developed land; and
- The potential consequences of a flooding event for the particular type of development have been considered and in terms of the criteria contained in Section 5 and 7 and Appendix 1 (TAN15) found to be acceptable.

TAN 15 states that any new development on the floodplain will generally result in additional flood risk. The guidance indicates that the main criteria for determining whether such a development is acceptable will depend on whether additional flood

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risk can be effectively managed. The guidance states that the objectives of the Flood Consequence Assessment are to develop a full appraisal of:

- The consequences of flooding on development;
- The consequences (i.e. overall impacts) of the development on flood risk elsewhere within the catchment for a range of potential flooding scenarios up to that flood having a probability of 0.1% and,
- The assessment can be used to establish whether appropriate mitigation measures can be incorporated within the design of the development to ensure that the development minimises risk to life, damage to property and disruption to people living and working on the site or elsewhere in the floodplain.

3.3 Flood Zone Classification

TAN 15 Figure 1 describes the composition and use of flood zones to control and manage development. The figure enables identification of the amount of effort required to conduct flood risk assessment based on the flood zone in which the development falls. ***Table 2*** is a copy of TAN 15 Figure 1.

The development site is off Bridge Road in Wrexham, and approximately 3.35Ha. Following scrutiny of the Natural Resources Wales Flood Maps it has been identified that the existing site lies within an area classified as Flood Zone A or B in accordance with TAN15 (Flood Zone 1 in accordance with Environment Agency Flood Maps) indicating that the risk of flooding from rivers and sea is low, with an Annual Exceedance Probability of flooding of less than 0.1%. The site is however within 250m of an area at risk from extreme flooding from rivers and sea without defences and therefore a Flood Consequences Assessment (equivalent to a Flood Risk Assessment) would be advisable to check flooding effects on the site. Hence the decision to include this section (Chapter 3) in the report.

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Table 2: Flood Zone Classification

Description of Zone		Use within the precautionary framework
Considered to be at little or no risk of fluvial or tidal/coastal flooding.	A	Used to indicate that justification test is not applicable and no need to consider flood risk further.
Areas known to have been flooded in the past evidenced by sedimentary deposits.	B	Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further.
Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal).	C	Used to indicate that flooding issues should be considered as an integral part of decision making by the application of the justification test including assessment of consequences.
Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.	C1	Used to indicate that development can take place subject to application of justification test, including acceptability of consequences.
Areas of the floodplain without significant flood defence infrastructure.	C2	Used to indicate that only less vulnerable development should be considered subject to application of justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

(Source: TAN 15 Figure 1)

3.4 Flood Risk Vulnerability Classification

In accordance with TAN 15, particular flooding consequences may not be acceptable for particular types of development. For example, allowing residential development in areas which are subject to high risks of flooding can result in a traumatic impact on people's lives. The precautionary framework identifies the vulnerability of different land uses to flooding, and for this purpose, development has been subdivided into three categories in Figure 2. ***Table 3*** is a copy of TAN 15 Figure 2.

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Table 3: Flood Vulnerability Classification

Development Category	Types
Emergency Services	Hospitals, ambulance stations, fire stations, police stations, coastguard stations, command centres, emergency depots and buildings used to provide emergency shelter in time of flood.
Highly vulnerable development	All residential premises (including hotels and caravan parks), public buildings (e.g. schools, libraries, leisure centres), especially vulnerable industrial development (e.g. power stations, chemical plants, incinerators), and waste disposal sites.
Less vulnerable development	General industrial, employment, commercial and retail development, transport and utilities infrastructure, car parks, mineral extraction sites and associated processing facilities, excluding waste disposal sites.

(Source: TAN 15 Figure 2)

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4. Development and Flood Risk

4.1 Proposed Development Vulnerability Classification

The development site is off Bridge Road in Wrexham, and approximately 3.35Ha. Following scrutiny of the Natural Resources Wales Flood Maps it has been identified that the existing site lies within an area classified as Flood Zone A or B in accordance with TAN15 (Flood Zone 1 in accordance with Environment Agency Flood Maps) indicating that the risk of flooding from rivers and sea is low, with an Annual Exceedance Probability of flooding of less than 0.1%. The site is however within 250m of an area at risk from extreme flooding from rivers and sea without defences and therefore a Flood Consequences Assessment (equivalent to a Flood Risk Assessment) would be advisable to check flooding effects on the site. Hence the decision to include this section (Chapter 4) in the report.

In accordance with TAN 15 Figure 2 (***Table 3*** in this report), Bridgeway Centre is a ***Less Vulnerable Development.***

In accordance with TAN 15 Chapter 9: *Summary of Policy Requirements*, a Less Vulnerable Development in Flood Zone A is ***acceptable with no constraints*** relating to river or coastal flooding, other than to avoid increasing risk elsewhere, and the Justification Test is not applicable.

The following sections investigate the probability of flooding from various sources as a precautionary measure.

4.2 Flood Risk from Rivers and the Sea

The Natural Resources Wales Long Term Flood Map provides basic flood mapping data as a general guide to whether a site is at risk of flooding from various sources including rivers and seas for Flood Zoning classification.

This mapping indicates that the site is wholly located within an area with an undefended risk of flooding from rivers and the sea of less than 0.1% (or the 1 in 1000-year event), classified as Flood Zone 1 (Zone A in accordance to TAN 15). The development site is therefore at ***Very Low Risk*** of flooding from rivers and the sea. The development is however approximately 200m from the TAN 15 Flood Zone C, caused by Redwither Brook on the east side of the site.

Figure 3 shows the flood extents 200m to the east of the site.

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Figure 3: Flood Risk from Rivers and the Sea
(Source: https://maps.cyfoethnaturiolcymru.gov.uk/ , Accessed on 2020-10-12, 1620hrs)

4.3 Historic Flooding

There is no evidence or data to report any historic flooding within the site bounds. The site is bounded by an existing conveyance ditch along the north-western edge which shield the site from inundation by runoff flowing from the north-west towards Redwither Brook which otherwise might have found a flow path within the site boundary, causing flooding of the site.

4.4 Flood Defences

There are no formal flood defences recorded on the Natural Resources Wales Long Term Flood Map in the immediate vicinity of the site. The site is also not indicated as being used for flood storage, therefore, the flood risk to the development from failed or breached flood defences is considered to be low.

4.5 Flooding induced by Climate Change

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The nearest Flood Zone C (Flood Zone 2 in accordance with Natural Resources Wales Long Term Flood Map) is approximately 200m south-east of the site and is associated with the maximum flood extents of Redwither Brook. The ground levels at the flood extents caused by Redwither Brook are approximately 2.0m lower than the lowest part of Bridgeway Centre (corner Coed Aben Road & Bridge Road). It will be some time (order of decades) before the climate change effects can cause the flooding extents to reach the site.

4.6 Flooding from Groundwater

No Ground Investigation Survey had been carried out at the time this report was compiled, although it was in the process of being commissioned, hence there was no data to check in-situ ground water levels. Because the site is quite high compared Redwither Brook flood extents (approx. 2.0m), it is very unlikely that any seasonal rise in water table would result in surface flooding of the site.

4.7 Flooding from Adopted Sewers

There is no recorded history of flooding of public sewers on site. The proposed sewers shall be designed to be resilient to flooding, with surface water network designed not to flood for all storm events up to and including the 100-year + 40% CC storm.

4.8 Flooding from Private Drainage

There is no recorded history of flooding of private sewers on site. The proposed sewers shall be designed to be resilient to flooding, with surface water network designed not to flood for all storm events up to and including the 100-year + 40% CC storm.

4.9 Flooding from Surface Water and Small Watercourses

The Natural Resources Wales Long Term Flood Map was consulted to check the risk of site flooding from surface water and small watercourses; an extract from the map is presented in ***Figure 4***. The figure indicates that after severe or prolonged storms especially during the wet season, runoff turns to accumulate within the conveyance ditch that runs along the north-western edge of the site, with the ditch running full for short periods, but site is not flooded by water from the ditch.

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There is indication of localised surface water flooding on site, however this will not be the case on the new developed site due to the careful placement of drainage collection facilities (gullies, linear drains) at low points.

Nevertheless, all finished floor levels shall be at ***least 150mm above surrounding ground levels.***

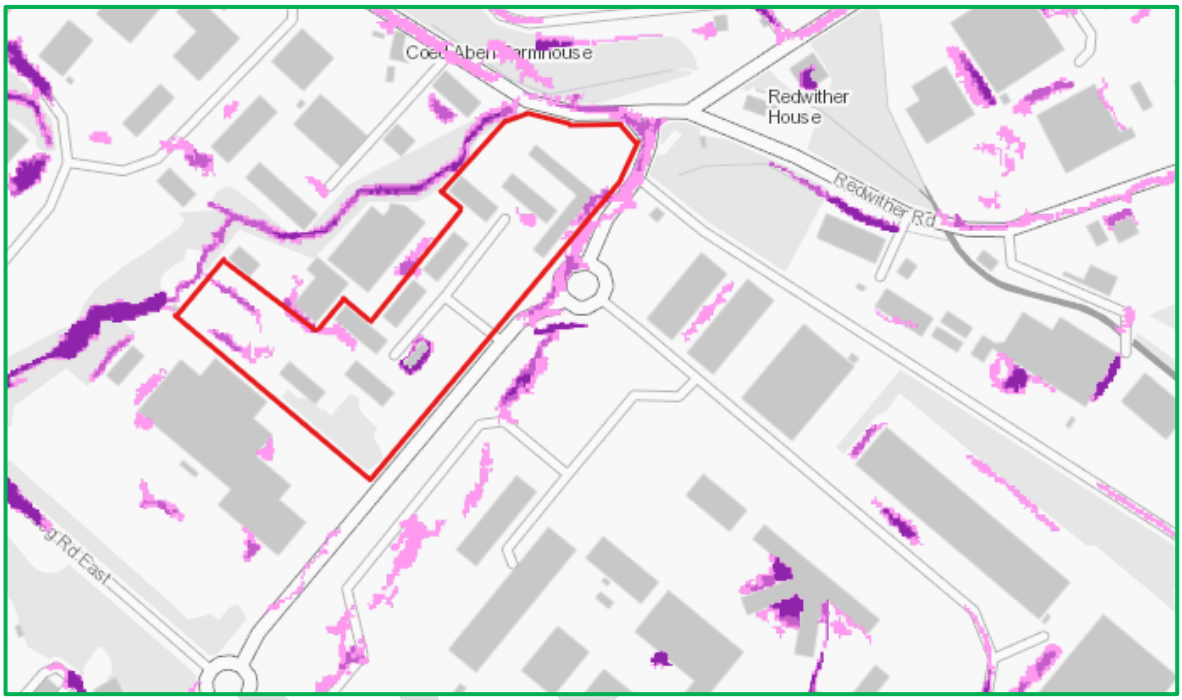

Figure 4: Flood Risk from Surface Water – Flood Extents

(Source: https://maps.cyfoethnaturiolcymru.gov.uk/, Accessed on 2020-10-12, 1645hrs)

4.10 Flooding from Reservoirs, Canals and Artificial Sources

The Natural Resources Wales Long Term Flood Map was consulted to check the risk of site flooding from reservoirs and it was found to be safe from such flooding effects because River Clywedog is far from the site (approx. 650m to the south-east of the site).

4.11 Overall Flood Risk

In accordance with TAN 15 Chapter 9: *Summary of Policy Requirements*, a Less Vulnerable Development in Flood Zone A is ***acceptable with no constraints***

relating to river or coastal flooding, other than to avoid increasing risk elsewhere, and the Justification Test is not applicable.

The site is therefore suitable for the type of development proposed.

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5. Drainage Strategy

5.1 Key Principles of SuDS

Figure 5 gives the four key design principles critical for the implementation of SuDS:

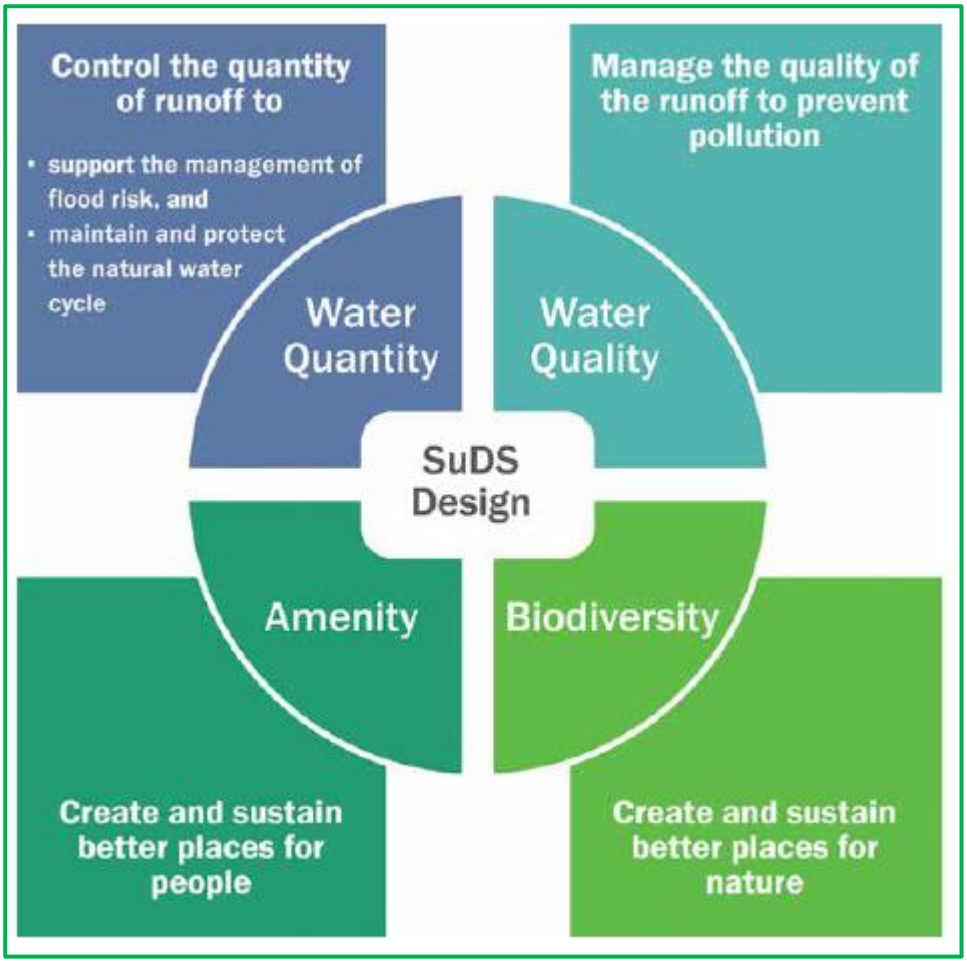

Figure 5: Four Main Categories of SuDS

(Source: CIRIA 753: The SuDS Manual)

Quantity Control : Achieved by controlling the quantity of surface water runoff reaching a watercourse, drainage system or sewer. Controlling runoff can aid in mitigating the risk of flooding. The benefits to quantity control include:

- Less surface water entering watercourses, thereby offsetting peak flows and reducing fluvial flood risk.
- Less surface water entering sewers, thereby freeing capacity and reducing flood risk
- Allows for adaption to climate change
- Allows for recharge of underground aquifer

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Quality Control : Achieved by improving the quality of surface water reaching a watercourse, drainage system or sewer. The benefits to quality control include:

- Reduces of pollution levels in surface water bodies
- Protects groundwater resources from contamination
- Enables compliance with the Water Framework Directive

Biodiversity and Amenity Value : Achieved by introducing SuDS that enhance the existing biodiversity of the area and/or add amenity value to the community. The benefits include:

- Contributes to community health & wellbeing by providing green spaces with value in terms of landscape, recreation and walking routes
- Provides opportunities for multifunctional areas
- Provides wildlife habitat and ecological benefits
- Increases property values

These key design principles should be considered in all aspects of SuDS selection and design. All SuDS should aim to achieve ***each of these principles.***

5.2 Discharge Hierarchy

Under the terms of Section H of the Building Regulations 2000, the SUDS Manual 2015 report C753, and the Technical Guidance to the National Planning Policy Framework, the disposal of surface water by means of soakaways should be considered as the primary method, refer to ***Figure 6.***

The soil profile from three British Geological Survey boreholes (refer to ***section 2.6*** of this report for details) indicate that the soil is predominantly clay for depths of more than 3m from the surface and would not support drainage via infiltration. However due to the dated nature of the boreholes, BRE Digest 365 Soakaway Tests shall be conducted at a number of locations across the site, and if infiltration is found to be possible, the proposed Geo-cellular Storage Tank shall be designed as an infiltration pond, and the controlled outflow to the ditch shall be reduced, or if infiltration is good enough, there shall be no outfall from the tank to the existing ditch.

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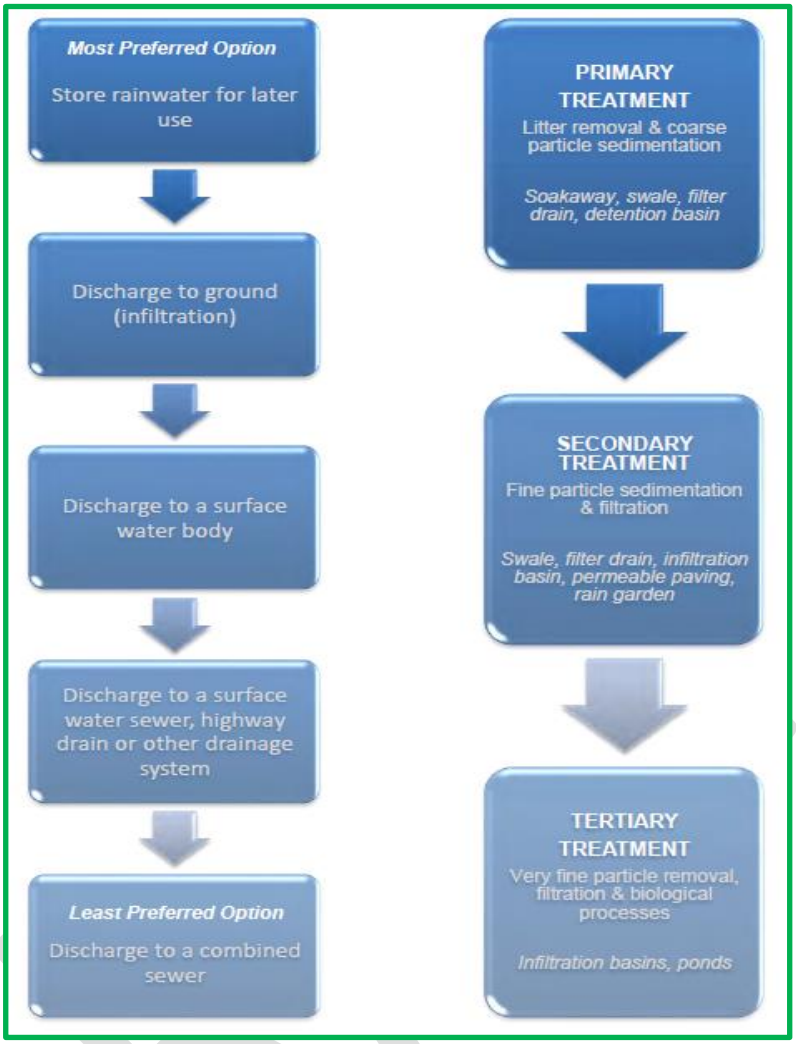

Figure 6: Recommended SuDS Discharge Hierarchy

(Source: Sustainable Drainage: Guide to Design, Adoption and Maintenance, June 2015, Birmingham City Council)

5.3 Sustainable Drainage Systems.

A SuDS appraisal was conducted based on the SuDS hierarchy given in ***Figure 6***. ***Table 4*** gives the results of the appraisal.

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Table 4: Scheme Appraisal of SuDS Drainage Features

SuDS Feature	Is feature suitable for the proposed site?	Comment
Soakaway	NO	Site is underlain with solid red brown clay.
Green/Brown Roofs	NO	Proposed roofs too steep for green roofs, also a maintenance liability.
Filter Trench/Drain	YES	Situated below swales to collect runoff that seeps through the swale layers
Swale	YES	Cascading swales have been proposed along the south-west and south-east edge of the site
Permeable Paving	YES	Proposed parking areas.
Infiltration Basin	NO	Site is underlain with solid red brown clay.
Detention Basin	NO	Insufficient area to incorporate basin.
Bioretention System (Rain Garden / Stormwater Planters)	YES	The proposed cascading swales also serve as bio-retention areas by virtue of the way they are designed to operate.
Pond	NO	Insufficient area to incorporate pond.
Storage System: Geo-cellular or Tank	YES	To be situated at south-eastern end of the site.

Based on the selected SuDS features as per ***Table 4***, the main SuDS features associated with the proposed drainage strategy are summarised below:

Filter Drains in Type H bedding: Provide physical filtration of the effluent at the point of runoff collection. Solid-bound pollutants are removed from the effluent before the runoff reaches the Attenuation Tank.

Rigistorm Separate Catchpit: The catchpits have been strategically placed to capture debris and silt before the runoff reaches proposed geo-cellular tanks.

Cascading Swales (Bioretention Areas):

The proposed cascading swales receive runoff from buildings' roofs and allow the runoff to seep through filter material to geo-cellular modules underneath the swales thereby undergoing a cleansing process. The flora (planted grass/lawn/reeds) within the swales absorb the pollutants via photosynthesis and reduce the concentrations in the runoff. These areas also provide physical treatment via adsorption of suspended soils to the flora (grass/lawn/reeds). Refer to ***Appendix D*** for the locations of proposed cascading swales (bioretention areas).

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Permeable Pavement: Permeable pavement underlaid by a drainage blanket (5-20mm sub-base) wrapped in impermeable geo-membrane will allow runoff to undergo cleansing by the sand layer and sub-base before being collected by the proposed Permavoid Diffuser Unit. This type of permeable pavement is termed System C to BS 7533-13:2009 Figure 4, refer to ***Figure 7.*** If Soakaway Test results prove that infiltration is possible, the Permavoid Diffuser Unit and drainage pipe will be omitted, allowing the water to percolate the subgrade below the sub-base.

Figure 7 gives a section through permeable pavement System C.

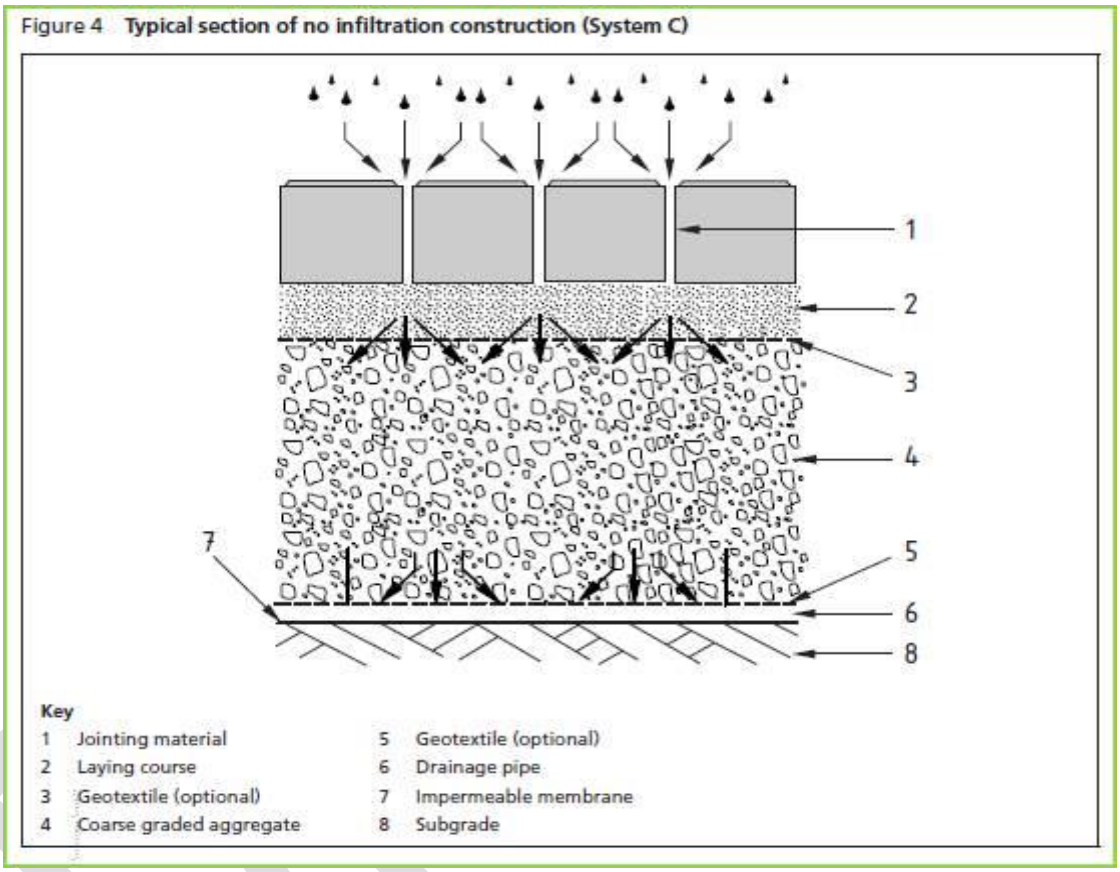

Figure 7: Permeable Pavement System C – for no infiltration

(Source: BS 7533-13:2009 Figure 4)

❖ ***Underground Geo-cellular Storage Tanks:*** The whole site was divided into sub-catchments, and storage provided for each sub-catchment either 100% by Permeable Pavement Storage or partly by standalone Underground Storage. Pass forward flow from each sub-catchment was limited to enable D150 pipes to be used downstream of the sub-catchment. This procedure was carried out throughout the whole site, resulting in the use of DN150 pipes throughout the 3.35Ha site and fairly shallow drainage (1.2m cover was ensured) and a gravity outfall to the existing ditch. ***Polystorm Xtra*** or another product of equal or greater strength were proposed for use under parking bays and access roads, with ***Polystorm Lite*** proposed under

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swales in landscaped (non-trafficked) locations. Refer to ***Appendix D*** for layout details.

❖ ***Flow Control Device:*** Runoff from the development shall be controlled to 14.5 l/s maximum for 1-year + 40% CC storm event, 17.4 l/s maximum for 30-year + 40% CC storm event, and 22.0 l/s maximum for 100-year + 40% CC storm event by a Complex Control (2 Hydro-brakes at different heights), details of which are shown in ***Appendix D.***

3.4 Proposed Surface Water Drainage Layout

The plan layout of the proposed surface water drainage is shown in ***Appendix D,*** which also contains the Pavement Design (External Surfaces) proposals. The drainage system has been designed so that no part of the system floods for all storm events up to and including the 100-year + 40% CC event.

Figure 8 gives a summary of the proposed SuDS Drainage Strategy.

The whole site was divided into sub-catchments, and storage provided for each sub-catchment either 100% by Permeable Pavement Storage or partly by standalone Underground Storage. Pass forward flow from each sub-catchment was limited (by use of suitably sized orifices and hydro-brakes) to enable D150 pipes to be used downstream of the sub-catchment. This procedure was carried out throughout the whole site, resulting in the use of DN150 pipes throughout the 3.35Ha site, achievement of a fairly shallow drainage (1.2m cover was ensured), and a gravity outfall to the existing ditch (as opposed to deep & large diameter pipes and a pumped outflow, which was submitted at pre-application stage). ***Polystorm Xtra*** or another product of equal or greater strength were proposed for use under parking bays and access roads, with ***Polystorm Lite*** proposed under swales in landscaped (non-trafficked) locations

The proposed development has a plan area of 3.35Ha. The IH124 method was used to estimate the greenfield runoff rates from the site since the site is less than 200Ha. Because the site is also less than 50ha, the ICP SUDS tool in Micro-drainage Source Control module was used to calculate the greenfield runoff rates. The tool uses the IH124 approach to calculate the greenfield runoff for 50ha, then linearly interpolate to get the flows for smaller catchments. The 1-year, 30-year, and 100-year Greenfield runoff rates were found to be 14.5 l/s, 34.2 l/s, and 44.9 l/s respectively, refer to ***Appendix E*****.**

Qbar is 17.5 l/s for both rural and urban.

Runoff from the development shall be controlled to 14.5 l/s maximum for 1-year + 40% CC storm event, 17.4 l/s maximum for 30-year + 40% CC storm event, and 22.0 l/s maximum for 100-year + 40% CC storm event by a Complex Control (2 Hydro-brakes at different heights), details of which are shown in ***Appendix D.***
A Discharge Consent will be required from the Land Drainage Authority (or SuDS Approval Body) to discharge into the ditch.

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Refer to ***Appendix D*** for proposed drainage plan layout. Hydraulic calculations for the proposed drainage are contained in ***Appendix E.***

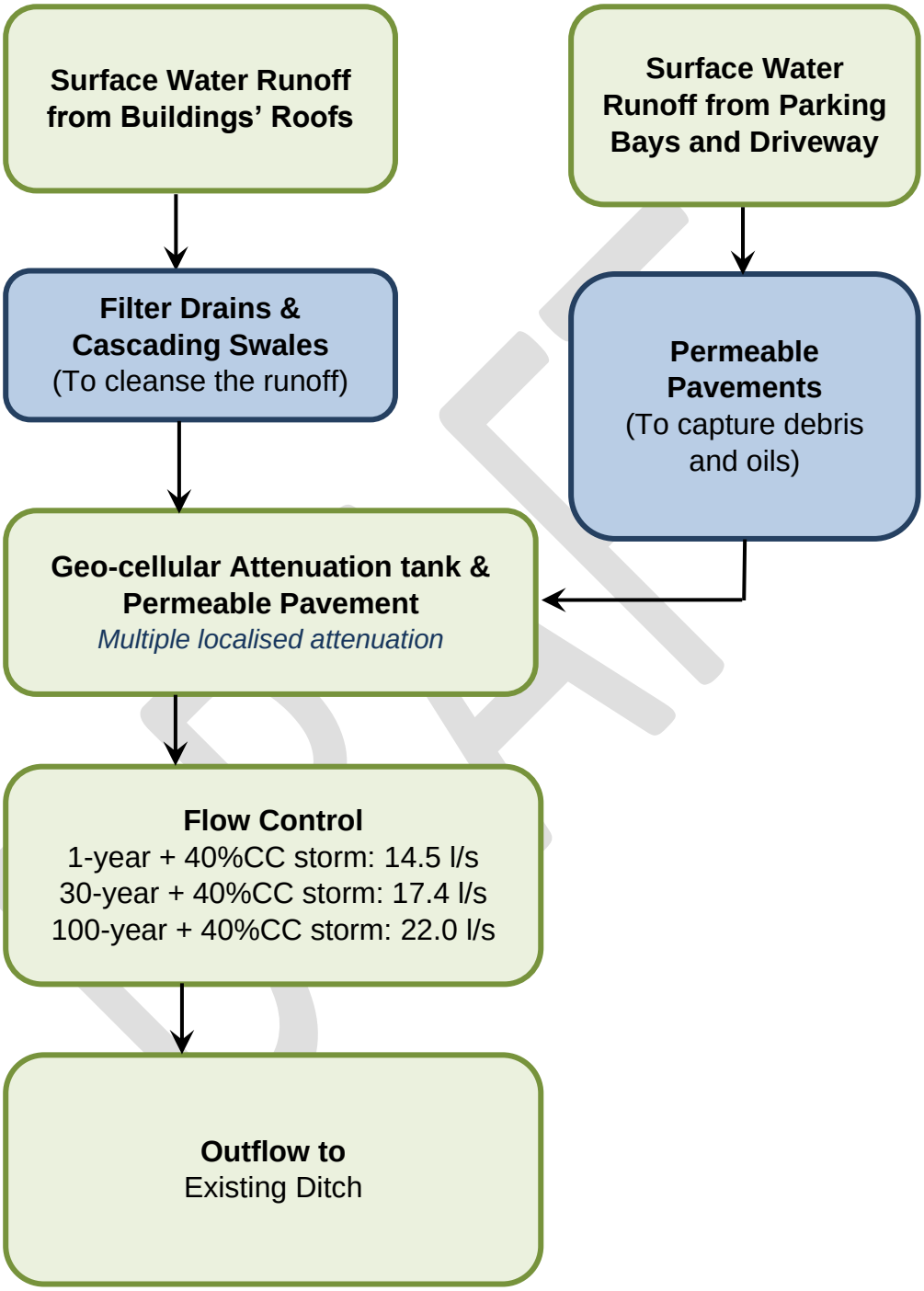

Figure 8: SuDS Drainage Strategy Summary

3.5 Pollution Control and Water Quality

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The following pollution control devices have been proposed:

- ***Permeable pavement:***
  Treat pollutants from the Parking Bays & Access Roads
  Permeable pavement underlaid by a drainage blanket (5-20mm sub-base) wrapped in permeable geotextile will allow runoff to undergo filtration through the sand layer, sub-base and sub-grade before reaching the water table. Permeable Pavement is the primary Pollution Control feature for this SuDS scheme. Any spilled polycyclic aromatic hydrocarbons are filtered through the pavement layers before reaching the sub-grade. Refer to ***Appendix D*** for areas to receive permeable pavement and construction make-up.

- ***Cascading Swales (Bioretention Areas):***
  Treat effluent from the Buildings' Roofs
  The proposed cascading swales receive runoff from buildings' roofs and allow the runoff to seep through filter material to geo-cellular modules underneath the swales thereby undergoing a cleansing process. The flora (planted grass/lawn/reeds) within the cascading swales absorb the pollutants via photosynthesis and reduce the concentrations in the runoff. These areas also provide physical treatment via adsorption of suspended solids to the flora (grass/lawn/reeds). Refer to ***Appendix D*** for the locations of proposed bioretention areas.

- ***Filter Drains:***
  Treat effluent from the roofs
  Situated below swales to collect runoff that seeps through the swale layers. Solid-bound pollutants are removed from the effluent before the runoff reaches the existing ditch. Refer to ***Appendix D*** for the location and the construction of the filter drains.

- ***Catchpit:***
  Capture silt & debris upstream of Attenuation Tanks
  Catchpits have been strategically placed to capture debris and silt before the runoff reaches proposed geo-cellular tanks.

CIRIA report C753, The SuDS Manual, says on page 567 'To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for each contaminant type).'

Table 5 shows Table 26.2 of the SuDS Manual, which gives the pollution hazard indices for various land uses.

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Table 5: Pollution hazard indices for different land use classifications

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Notes

1 Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009).

2 These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help determine the most appropriate approach to the development of a design solution.

Table 6 shows Table 26.3 of the SuDS Manual, which gives indicative SuDS mitigation indices for discharges to surface waters.

Table 6: Indicative SuDS mitigation indices for discharges to surface waters

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TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Notes

1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.

2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.

3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.

4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.

5 See Chapter 14 for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: **http://tinyurl.com/qf7yuj7**

6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Table 7 gives a summary analysis of the adequacy of the proposed SuDS drainage in addressing pollution control and water quality.

Table 7: Mitigation versus hazard indices for proposed layouts

SuDS Drainage Layout	SuDS device/Land Use	TSS	Metals	Hydro-carbons	Remark
Permeable Pavement	Permeable Pavements	0.7	0.6	0.7	

					OK, SuDS element provides sufficient treatment.
	Access Roads & Parking Bays	0.5	0.4	0.4	
Catchpits, Filter Drains, and Cascading Swales	Catchpits, Filter Drains, and Cascading Swales	**0.8**	**0.8**	**0.8**	**OK**, SuDS element provides sufficient treatment.
	Yard + Roof	0.7	0.6	0.45	

5.6 Exceedance Flows

Exceedance flows are those flows generated by flooding of part or all of the drainage scheme due to storm events in excess of the design storm event [100-year + 40% CC storm event]. Proposed Drainage hydraulic calculations (***Appendix F***) show that there shall be ***no flooding on site*** for all storm events up to and including the 100-year + 40% CC storm.

To check the effect of an extreme event and how flooding will be managed on site, a 125-year + 40% CC 600-minute winter storm event was run in Micro-drainage and Flood Flow Analysis carried out using Alternate Direction Implicit and Fine Dynamic Time stepping.

The results of the analysis indicated that flooding will occur at S6 (3.038m3) and S41 (7.576m3). Flood water from S6 will flow along the access road and get collected by strategically placed overflow road gullies, refer to drainage layout in ***Appendix D***. Flood water from S41 will flow to the existing ditch. No proposed industrial units will be affected by these exceedance flows. The flow paths for exceedance flows are shown on the FloodFlow plan layout in ***Appendix F.***

5.7 Foul Drainage

Assuming a Dry Weather Flow of 300litres/100m2/day, peak foul flows were calculated for multiple discharges from proposed private site drainage to the existing (and to be diverted) Welsh Water public combined sewers. Two Welsh Water combined sewers will be diverted through the development (refer to drainage plan layout in ***Appendix D)*** to ensure continuity of service to properties outside site extents and to the north-west of the site.

Proposed foul drainage is shown on drainage plan layout in ***Appendix D,*** and the peak foul flow calculations are in ***Appendix E.***

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Discharge to these existing (and to be diverted) Welsh Water public combined sewers will be subject to S106 Connection consents. This has already been consented by Welsh Water via a Pre-Planning Enquiry, refer to ***Appendix G.***

5.8 Maintenance and Operation

A SuDS Operation and Maintenance Manual has been produced and issued as a separate document from this report. The Manual shall be revised post-construction to suit as-built drainage (which should be in accordance with details approved at planning stage) and added to the Health and Safety File.

Please refer to report ***BCW-BML-ERD-ZZ-RP-C-0501*** SuDS Operation and Maintenance Manual for details of Owner and Maintainer of the assets, and recommended maintenance regime for the drainage assets.

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