Ysgol Bro Morgannwg School

Flood Consequence Assessment

Vale of Glamorgan Council

Project number: 60571314

29 October 2018

Quality information

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Revision History

Revision	Revision date	Details	Approved	Position
1	11th May 2018	Draft Issue	Steve Cook	Associate Director
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1. Introduction

1.1 Commission

AECOM Infrastructure & Environment UK Limited (AECOM) has been commissioned by Vale of Glamorgan Council (VoGC) (hereafter referred to as the 'Client') to undertake a Flood Consequence Assessment (FCA) for submission with a planning application for the development of the existing Ysgol Bro Morgannwg school.

1.2 Policy Context

The Development Advice Map (DAM) presented on the Natural Resources Wales (NRW) website, shows that the entire site is located in DAM Zone A, with the exception of a small area on the southern site boundary which is located within DAM Zone B (Figure 1-1). Areas located in DAM Zone A are classified as being at little or no risk of fluvial or coastal/ tidal flooding. Areas located within DAM Zone B are classified as areas known to have been flooded in the past evidenced by sedimentary deposits. As the risk of flooding from rivers or seas is classified as low, the principal consideration of the FCA is surface water management.

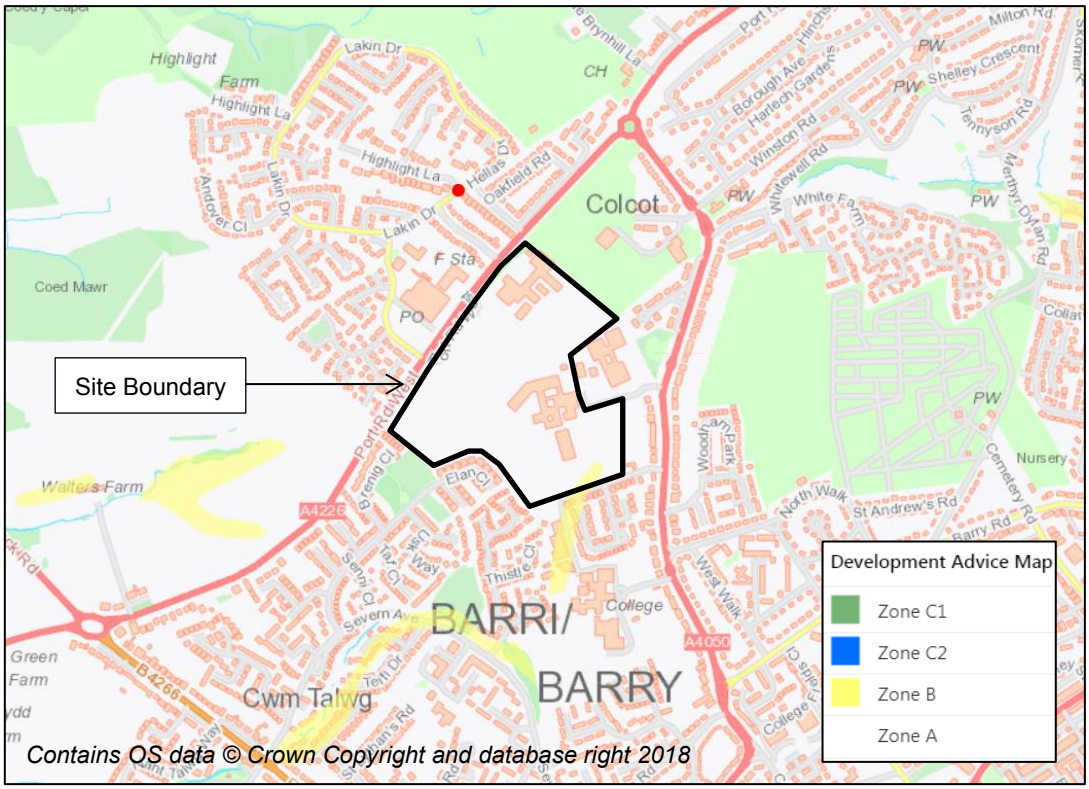


Figure 1-1: Natural Resources Wales Flood Map

(Adapted from NRW flood risk maps. Date Accessed: 23/10/18)

This report has been prepared in accordance with the *Technical Advice Note 15 (TAN15): Development and Flood Risk*[1]. The Welsh Government's accompanying TAN15 DAMs, alongside the NRW flood maps, have also been used to inform this assessment. As the development is situated within DAM Zone A and a small part in Zone B, a justification test is not applicable. However, as the surface water flood risk for the site is high in small localised areas of the Site, an FCA report has been produced to demonstrate requirements for surface water management with potential options.

[1] Technical Advice Note (TAN 15). Available from: https://gov.wales/docs/desh/publications/040701tan15en.pdf. Last Accessed: 09/05/18.

1.3 Aims and Objectives

The aim of this FCA is to consider the flood risk posed to and arising from the Proposed Development. In order to achieve this, the following objectives are required to be met:

- Collect and review existing flood risk data including topographic data, surface water drainage, NRW information, scheme proposals and the VoGC Strategic Flood Consequence Assessment (SFCA);
- Assess and interpret available information to identify potential sources of flood risk including groundwater, surface water and infrastructure failure;
- Complete preliminary runoff calculations to inform potential drainage options; and,
- Produce an FCA report in full accordance with TAN15 to accompany the planning application.

2. Site Description

2.1 Location

The Proposed Development site is located within Colcot, which is approximately 1.5km north of the centre of Barry, in the Vale of Glamorgan. The approximate Ordnance Survey National Grid Reference (OSNGR) centred on the application site is ST 310605 169016. The approximate postcode for the site is CF62 8HZ.

The site is approximately 10ha and is bound to the northwest by Port Road West (A4226), the east by The Barry Hospital and the south and west by a residential estate. This is shown within Figure 2-1 below.

2.2 Environmental Setting

As seen in Figure 1-1, there is negligible flood risk to the site from fluvial or tidal sources. However, there is a small area at the southern boundary of the site which is within DAM Zone B (area known to have been flooded in the past evidenced by sedimentary deposits). It is likely that the historical flood was due to surface water flooding, as discussed further within Section 4.4.

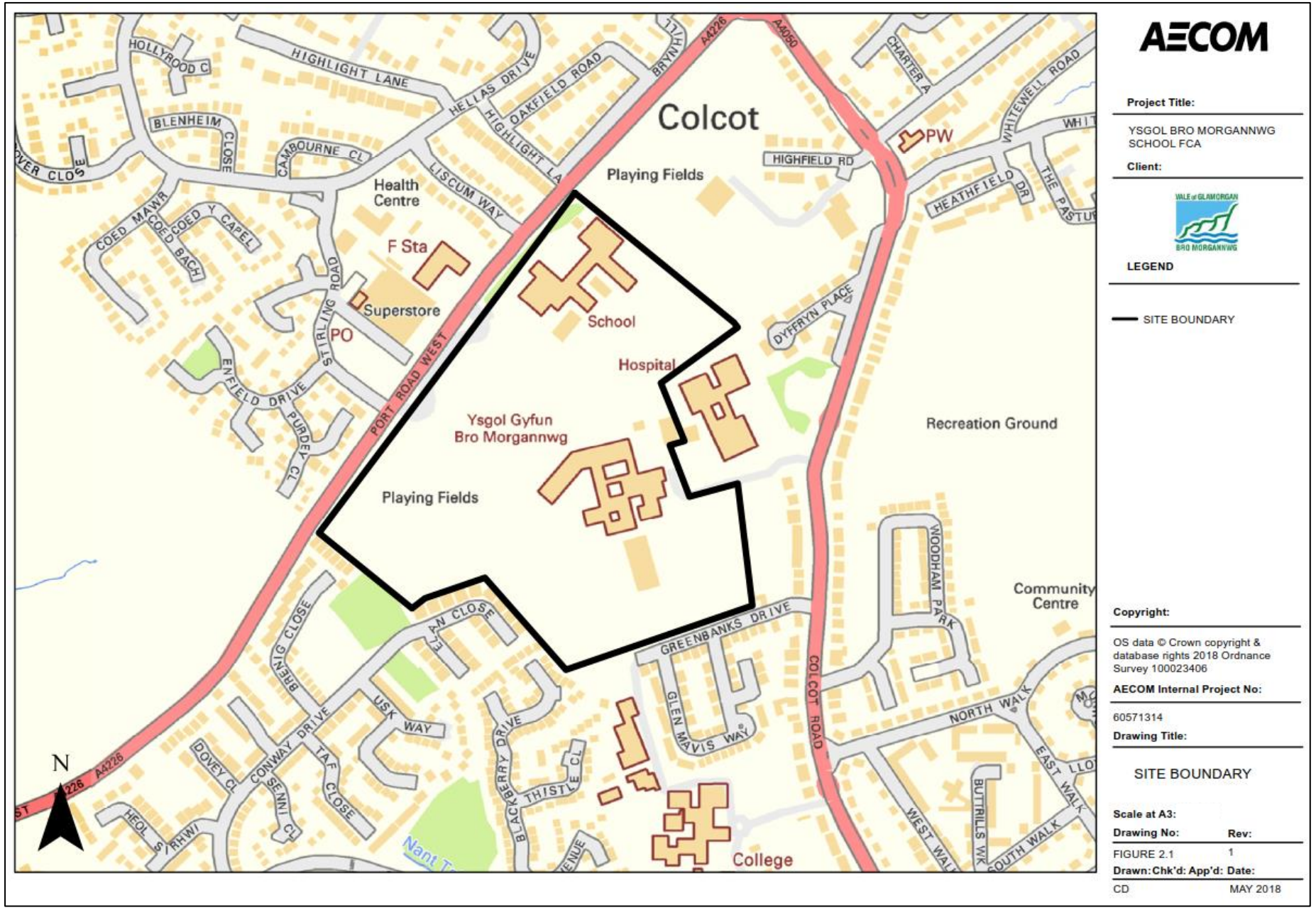
The Coldbrook watercourse is located approximately 480m northeast of the site. Due to the distance from the site and direction of flow (west to east), it is unlikely that this watercourse would have an effect on the site. Located approximately 2.7km south of the development is the Barry Docks. Due to the distance from the Docks no risk of flooding to the site is presented from this area.

According to the GeoIndex Onshore Map[2] the bedrock geology at the site is made up of Porthkerry Member limestone and mudstone, interbedded with a small area to the south of the site, superficial deposits containing alluvium clay, silt, sand and gravel have been recorded.

NRW classifies zones around potable groundwater abstraction points as Groundwater Source Protection Zones (SPZ) and these are designed to limit potential pollution activities. The site is not in a SPZ and there are no SPZ limits within approximately 2km of the site boundary. In addition, DEFRA's Magic Map[3] shows that the site is within a Secondary A Aquifer. These are considered as permeable layers capable of supporting water supplies at a local level, and in some cases, form an important source of base flow to local watercourses.

Two borehole logs located on site (ST16NW105) provide an indication into the geological stratigraphy within this location. From the surface of the borehole to the west of the building to approximately 0.17m below ground level (bgl), turf and topsoil were recorded; dark clay was then recorded from 0.17m bgl to 1.16m bgl; firm yellow clay with occasional flaggy stone was then recorded to a depth of approximately 0.68m bgl; and the final layer recorded to the depth of 1.75m bgl was firm to stiff yellow/grey clay with occasional limestone boulders. The borehole to the east of the building follows an almost identical pattern. There were no records of groundwater within the boreholes.

[2] GeoIndex Onshore Map. British Geological Society. Available from: http://www.bgs.ac.uk/geoindex/. Last Accessed: 09/05/18.
[3] DEFRA Magic Map. Available from: http://www.natureonthemap.naturalengland.org.uk/magicmap.aspx. Last Accessed 10/5/18



AECOM

Project Title:

YSGOL BRO MORGANNWG SCHOOL FCA

Client:

VALE of GLAMORGAN BRO MORGANNWG

LEGEND

SITE BOUNDARY

Copyright:

AECOM Internal Project No:

60571314

Drawing Title:

SITE BOUNDARY

Scale at A3:

Drawing No:	Rev:
FIGURE 2.1	1

Drawn:	Chk'd:	App'd:	Date:
CD			MAY 2018

2.3 Topography

Figure 2-2 displays the contour lines surrounding and within the site boundary. The topography peaks at approximately 90m AOD in between the two schools, then slopes down to approximately 75m AOD towards the south of the site boundary.

The slope is steepest at the Ysgol Bro Morgannwg School to the south of the boundary, where the contour lines are closer together. The flow path to the south of the site, described further in Section 4.4 is likely to be due to the sloping topography of the site.

Further drainage investigation should be carried out in order to check the likelihood of using standard infiltration techniques as a means of surface water disposal for the developed site. The underlying geology is likely to mean that management through attenuation options will be more appropriate for the site.

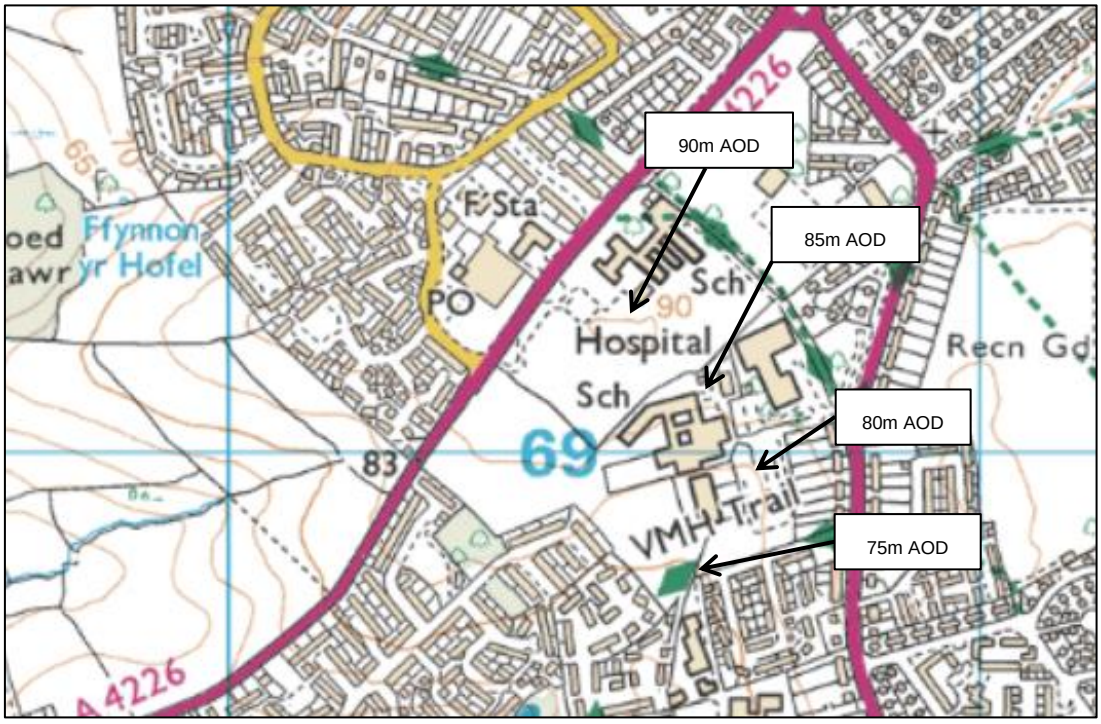


Figure 2-2: OS Contour Map

(Last Accessed 8/5/18)

2.4 Proposed Development

The Proposed Development will include refurbishment of the existing School and an element of new build. Proposed Development drawings and further details on this have not yet been provided.

3. Planning Policy & Guidance

3.1 Technical Advice Note 15

Technical Advice Note 15 (TAN15) provides guidance which supplements the policy set out in Planning Policy Wales[4] (PPW) in relation to development and flooding. A precautionary framework is set out which advises caution in respect of new development in areas at high risk of flooding and this is used as a guide for planning decisions. The overall aim of the precautionary framework is to direct new development away from those areas that have a high risk of flooding; and development will only just be justified in these areas if it meets the criteria and tests specified in this guidance.

The operation of the precautionary framework is governed by DAMs which are made up of three zones (Table 3-1), used to trigger the appropriate planning test and definitions of vulnerable developments. The DAMs are based on the best available information considered adequate to determine when flood risk needs to be taken into consideration with future development.

Table 3-1: Flood Zone designations, their associated flood risk definition and use within the precautionary framework *(source: TAN 15)*

DAM Zone	Definition	Use within the precautionary framework
A	Little or no risk of fluvial/ tidal flooding	Justification test is not applied and do not need to consider further
B	Areas known to have flooded historically evidenced by sedimentary deposits.	Used as part of the precautionary approach to indicate where site levels should be checked against the extreme (0.1% annual probability) flood. No need to consider flood risks further if site levels are greater than the extreme flood level
C	Based on Environment Agency extreme flood outline (0.1% annual probability)	Indicates that flooding issues should be considered as an integral part of the decision making by the application of the justification test, including FCA
C1	Areas of Zone C which are developed and served by significant infrastructure, including flood defences	Indicates that development can take place subject to the application of the justification test, including acceptability of consequences
C2	Areas of Zone C without significant flood defence infrastructure	Indicates that only 'less vulnerable' development should be considered, subject to the application of the justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

The precautionary framework identifies the vulnerability of different land uses to flooding, and classifies proposed uses accordingly as detailed in Table 3-2. This is because certain flooding consequences may not be acceptable for particular development types.

Table 3-2: Development Categories *(source: TAN 15)*

Flood Zone Definition	Use within the precautionary framework
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.
High 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.

[4] Planning Policy Wales. Available from: https://gov.wales/topics/planning/policy/ppw/?lang=en. Last Accessed: 10/5/18.

According to TAN 15, new development should be directed away from Zone C and towards more suitable land in Zone A, otherwise to Zone B, where river or coastal flooding will be less of an issue.

Table 3-2 highlights that public developments such as schools are classified as 'Highly Vulnerable'; the proposed site is located within DAM Zone A (Figure 1-1).

Built development tends to increase the surface area of impermeable ground, thus reducing percolation and increasing rapid surface run-off. This FCA addresses these risks with runoff calculations that can be used to inform surface water management options at the next stage of the development which should help prevent the increase of surface water flood risk to the site and surrounding area.

3.2 Local Development Plan

The Local Development Plan[5] provides the local planning policy framework, which was adopted by VoGC on 28th June 2017. Local Development Plan policies relevant to water and flood risk are summarised below:

- MD1 – Location of new development: this policy seeks to ensure that development will minimise or avoid areas of flood risk. New development will be expected to avoid unnecessary flood risk and to meet the requirements of 'TAN 15: Development and Flood Risk'. No highly vulnerable development will be permitted within DAM Zone C2 and development will only be considered in areas at risk of flooding where it can be demonstrated that the site can comply with the justification and assessment requirements set out in TAN 15.
- MD7 – Environmental protection: this policy seeks to ensure that development does not increase flood risk. In accordance with TAN15: Development and Flood Risk, no highly vulnerable development will be permitted in DAM Zone C2. Development will only be considered in other areas at high risk of flooding where it can be demonstrated that the site can comply with the justification and assessment requirements of TAN 15.

3.3 Strategic Flood Consequence Assessment

No Strategic Flood Consequence Assessment is available from VoGC at the time of writing.

3.4 Preliminary Flood Risk Assessment

VoGC developed a Preliminary Flood Risk Assessment (PFRA)[6] in 2011 which examined the areas within the Vale of Glamorgan that have historically suffered from flooding and potential future floods areas and to identify significant flood risk areas. No indicative Flood Risk Areas have been identified within the Vale of Glamorgan.

3.5 Local Flood Risk Management Strategy

In 2012, VoGC developed a Local Flood Risk Management Strategy (LFRMS)[7]; this document highlights the responsibilities of VoGC as Lead Local Flood Authority (LLFA) with respect to flooding from surface water, ordinary watercourses and groundwater.

The Local Strategy encourages effective flood risk management by enabling people, communities, business and the public sector to work together to:

[5] Vale of Glamorgan Local Development Plan (LDP). Available from: http://www.valeofglamorgan.gov.uk/en/living/planning_and_building_control/Planning/planning_policy/local_development_plan/Local-Development-Plan.aspx. Last Accessed: 09/05/18.
[6] Preliminary Flood Risk Assessment (PFRA) Vale of Glamorgan Council. Available from: http://www.valeofglamorgan.gov.uk/Documents/Living/Highways%20&%20infrastructure/Exec-Summary-ENG.pdf. Last Accessed: 09/05/18.
[7] Local Flood Risk Management Strategy, December 2013. Vale of Glamorgan Council. Available from: http://www.valeofglamorgan.gov.uk/en/living/planning_and_building_control/Planning/planning_policy/local_development_plan/Local-Development-Plan.aspx. Last Accessed: 09/05/18.

- Ensure a clear understanding of the risks of flooding and erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- Set out a clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the residual risk;
- Encourage innovative management of flood and coastal erosion risks, taking account of the needs of communities and the environment;
- Form links between the local flood risk management strategy and local spatial planning;
- Ensure that emergency plans and responses to flood incidents are effective and that communities are able to respond properly to flood warnings; and
- Help communities to recover more quickly and effectively after incidents.

The PFRA refers to two major historic flooding incidents in October 1998 and July 2007, these were classified as 'locally significant harmful consequences'. On 20th July 2007, Barry, together with a number of other locations in the Vale of Glamorgan, was subject to intense rainfall. Significant flooding of properties and roads were reported as watercourses and land drainage systems were unable to cope with the intensity of the event. One of the most significant areas of flooding was along the route of the Coldbrook watercourse which runs from the Colcot area (approximately 480m from the Proposed Development) to the open stream adjacent to the A4231 Barry Docks Link Road (approximately 2.9km from the Proposed Development). Approximately 100 residential properties and four schools were flooded along the route of the watercourse or within its catchment area and local roads were closed.

The locally agreed surface water information dataset combines local information on surface water flooding with the NRW's Flood Map for Surface Water. The analysis was completed on a county wide basis and Barry was not identified as at significant risk from surface water flooding.

In addition, localised groundwater flooding is reported to have occurred in Eqenny Village, St Brides Major, East Monkton, Rhoose and Barry. However, it is shown within Figure 2-4-2 in the LFRMS that the Proposed Development is in an area that is <25% susceptible to groundwater flooding.

3.6 SuDS Guidance

Information with regard to the appropriate mechanisms for considering Sustainable Drainage Systems (SuDS) is contained in the 'Interim Code of Practice for Sustainable Drainage Systems' (2004)[8] and the Non-statutory standards for SuDS in Wales (updated 2017)[9]. Planning authorities may consider imposing a condition requiring developers to examine the SuDS option and provide the planning authority with details and options. If it is demonstrated that SuDS could work on a site, and subject to the appropriate agreements being in place with regard to adoption, then the planning authority would require SuDS to be implemented. Developers will need to give good reason why SuDS could not be implemented. If a conventional drainage system does not improve the status quo or has a negative impact then this can be a valid reason for refusal.

[8] Interim Code of Practice for Sustainable Drainage Systems. National SUDS Working Group, July 2004. Available from: https://www.susdrain.org/files/resources/other-guidance/nswg_icop_for_suds_0704.pdf. Last Accessed: 09/05/18.
[9] Sustainable drainage systems on new developments, Welsh Government. https://gov.wales/topics/environmentcountryside/epq/flooding/drainage/?lang=en. Last Accessed: 09/05/18

4. Flood Risk – To Development

4.1 Overview

TAN15 requires that all potential flood sources that could affect the Proposed Development be considered. This chapter includes flooding from rivers and the sea, directly from rainfall on the ground surface, rising groundwater, overwhelmed sewers and drainage systems. Flooding from reservoirs, canals, lakes and other artificial sources should also be considered. There should be demonstration of how these should be managed so that the development remains safe throughout its lifetime, taking into account climate change.

4.2 Tidal / Fluvial

As discussed in Section 1.2, the majority of the Proposed Development site is located within DAM Zone A, which are areas classified as having little or no risk of tidal/ fluvial flooding. A small area towards the southern boundary of the site is within DAM Zone B, which is an area known to have been flooded in the past evidenced by sedimentary deposits. As discussed in Section 4.4, it is likely that the historic flood in this the DAM Zone B area is caused by surface water flooding. Given the DAM Zone designation (majority within DAM Zone A), the level of the site and distance from the coast, tidal and fluvial flood risk are considered to be low and not considered further in this investigation.

4.3 Groundwater

Groundwater flooding occurs where groundwater levels rise above ground surface levels. The geology has a major influence on where this type of flooding takes place; it is most likely to occur in low-lying areas underlain by permeable rocks.

As outlined in Section 3.5, the LFRMS states that localised groundwater flooding is reported to have occurred in Barry; however no specific flood incidents have been recorded at the site.

The BGS maintains an archive of historical exploratory logs throughout the UK and as part of this project AECOM has searched the database and taken information from log ST16NW105 which was explored in November 1970. This log shows two boreholes, which are located either side of the building furthest east of the Ysgol Bro Morgannwg School. The borehole to the west of that building had a depth of approximately 1.75 bgl; the borehole to the east had a depth of 1.77 bgl. These were both logged as dry with no groundwater recorded.

The heavy clay soils recorded at the site suggest low surface water percolation rates, which reduces the risk of groundwater flooding. In addition according to the LFRMS, the Proposed Development is in an area that is just <25% susceptible to groundwater flooding.

Based on the information derived from the borehole log combined with no site specific flood incidents, the risk from groundwater is considered to be low.

4.4 Surface Water

Overland flow routes can form from rainfall that fails to infiltrate the surface and travels over ground; this is exacerbated where the permeability of the ground is low due to the type of soil/ geology (such as clayey soils) or urban development. Surface water is also promoted in areas of steep topography which can rapidly convey water that has failed to penetrate the surface.

As discussed in Section 2.2, the soil is made up of firm to stiff clay, which would reduce the permeability of the ground leading to an increased likelihood of surface water flood risk.

Figure 4-1 shows NRW's Surface Water Flood Risk Map[10]. The dark orange shading (high risk) shows areas that have a chance of flooding of greater than 3.33% AEP. The light orange shading (medium risk) shows areas have a chance of flooding between 1% AEP and 3.33% AEP. The yellow shading (low risk) shows areas have a chance of flooding between 0.1% AEP and 1% AEP.

[10] Source: Natural Resources Wales Flood Map for Surface Water. Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk. Last accessed 09/05/18.

According to NRW's Surface Water Flood Risk Map (Figure 4-1), the majority of the Site is not considered to be at risk from surface water flooding. There is an area of high/low flood risk near the southeast corner of the site, which appears to resemble a localised low point. This low point is located along the same area as the small area designated as DAM Zone B and it could therefore be possible that surface water flooding caused the historic flood in this location. There is also an area of low risk located in the same area as the superficial deposits of clay, silt, sand and gravel (as mentioned in Section 2.2). There are other smaller areas of low risk nearby the two schools within the site boundary, the majority of which resemble ponding against building footprints.

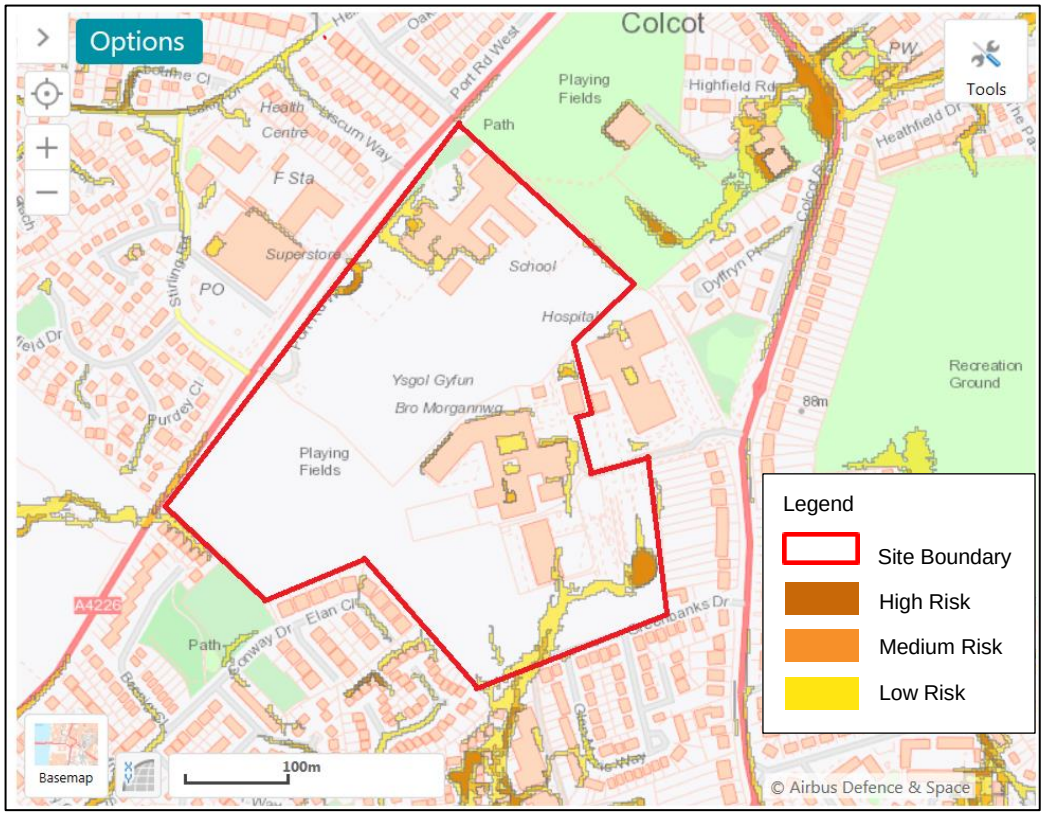


Figure 4-1: Flood Map for Surface Water *(source: NRW)*

(Last Accessed 8/5/18)

Overall it is considered that the flood risk from surface water is low at the Proposed Development site. There are localised areas where the risk from flooding increases (up to high in the southeast corner) and consequently it is recommended that development is steered away from these areas. This is discussed in more detail within Section 5.

4.5 Artificial Sources

Artificial flood sources include raised channels such as canals or storage features such as ponds and reservoirs. The NRW Flood Risk from Reservoirs Map[11] indicates that the nearest reservoir flooding extents at Penarth Cwm Cydfin are approximately 7.6km west of the Proposed Development.

According to the LFRMS, the Warren Mill Pond, which is approximately 8.7km north of the site, has been identified as a large reservoir, but does not exceed the volume criteria set by NRW for potential breach mapping.

Due to the large distance from the flood extent, the risk from artificial sources is considered to be low and not considered further within this assessment.

[11] Natural Resources Wales Flood Map. Available from: https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en. Last Accessed: 09/05/18.

4.6 Sewers

Flooding can occur as a result of infrastructure failure e.g. blocked sewers or failed pumping stations. Sewer flooding can occur when the system surcharges due to the volume or intensity of rainfall exceeding the capacity of the sewer, or if the system becomes blocked by debris or sediment.

Due to the lack of historical flood information on sewer flooding in this area combined with the proposed drainage options (Section 5), flood risk from sewers is considered low and so will not be considered further within this investigation.

5. Flood Risk – From the Development

5.1 Overview

National Policy highlights how built development tends to increase the risk of flooding by increasing surface water runoff. Development often increases the area of impermeable surfaces thereby promoting rapid runoff to surface water sewers or watercourses rather than percolation into the ground. The effect has potential to lead to an increase in both total volume and peak water flows, contributing to flooding.

5.2 Surface Water Management

Due to the small area of higher flood risk (as per DAM Zone B in Figure 1-1 and the Flood Map for Surface Water in Figure 4-1) located towards the southern boundary of the site; it is recommended that all development takes place within DAM Zone A.

In order to comply with national policy, surface water runoff rates up to and including the 1% AEP rainfall event, including climate change (+30%) have been calculated for the Proposed Development site using the mean annual flood flow equation from the Institute of Hydrology Report No. 124 (IH 124) within the WinDES software (Table 5-1 and Appendix A). Although Whitmore School and the Ysgol Bro Morgannwg School occupy the same site, these calculations are based on a 8.8ha area estimated for Ysgol Bro Morgannwg School only.

It should be noted that without any development proposals, runoff rates have been calculated for the entire site area, assuming an overall impermeable area of 40%. These runoff calculations therefore represent a conservative approach, as it is likely that the Proposed Development will involve small extensions and/or minor new builds occupying a much smaller area (<40% impermeable area). Consequently it is likely that runoff rates and required storage volumes for these specific areas are likely to be reduced.

The storage volumes associated with each return period are presented in Table 5-1. In line with national policy, it is the 1% AEP plus 30% climate change which needs to be considered for the Proposed Development.

Table 5-1: WinDES Quick Storage Estimates (FSR Rainfall)

AEP	Climate Change	Discharge Rate (m^3/s)	Storage Volume	
			Minimum (m^3)	Maximum (m^3)
100%	0	1.87	1135	1747
10%	0	3.02	1634	2476
3.33%	0	3.74	1953	2876
1%	30	4.63	3371	4657

As can be seen from Table 5-1, the storage volume ranges between 3,371m^3 and 4,657m^3 for the 1% AEP plus 30% climate change event. As discussed above, it is possible that these volumes will be significantly reduced once more detailed information is known about the exact location and detail of the Proposed Development.

Further assessment will need to be completed at the detailed design stage, once more is known about the final development option. This will include further runoff and storage calculations specific to the areas of the site that are being developed. This in turn will help inform potential SuDS options (i.e. permeable paving, above ground storage features such as ponds or swales, etc.) depending on what is suitable and appropriate for the type and size of the Proposed Option.

It is also recommended that ground investigations are undertaken at the site to assess whether infiltration based SuDS (i.e. soakaways) are possible.

6. Conclusion

6.1 Overview

This FCA has assessed flood sources to and from the Proposed Development in context of the existing and proposed development. The Proposed Development is classified as a highly vulnerable development however the majority of the site is located within DAM Zone A, with the exception of a small area towards the south of the site which is located within DAM Zone B.

6.2 Flood Sources

The following potential sources of flooding which could affect the Proposed Development have been considered and assessed as follows:

- The current risk from fluvial and tidal sources is considered to be low. The majority of the site is located within DAM Zone A, with a small area in DAM Zone B;
- The risk of groundwater flooding is considered to be low;
- The risk of surface water flooding to the majority of the site is considered to be low, with the exception of small localised areas where the risk from surface water flooding is high. It is recommended that development is steered away from these small, high risk areas. Any potential off-site impacts will be addressed through a surface water drainage strategy which will be produced during the next stage of the development process once a more detailed Proposed Option is available;
- The risk of sewer flooding is considered to be low; and
- The risk of flooding from other sources is considered to be low.

6.3 Surface Water Management

Preliminary runoff and storage calculations have been undertaken, however these are considered conservative as they are based on the entire site area, assuming an overall impermeable area of 40%. The Proposed Development is likely to consist of minor extensions/ new builds occupying a smaller area (<40%) therefore runoff and attenuation calculations should be refined once more details regarding the development are available.

7. Appendices

Appendix A – WinDES Calculations

Greenfield Runoff Rate Calculation

Calculation of the mean annual flood of a small catchment is determined using the mean annual flood flow rate equation from the Institute of Hydrology Report No. 124

Catchment

Total Area	8.800	Ha
Developed	40%	

QBAR rural = $0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}$

AREA	0.5	**(km^2)**
SAAR	985	**(mm)**
SOIL	0.15	

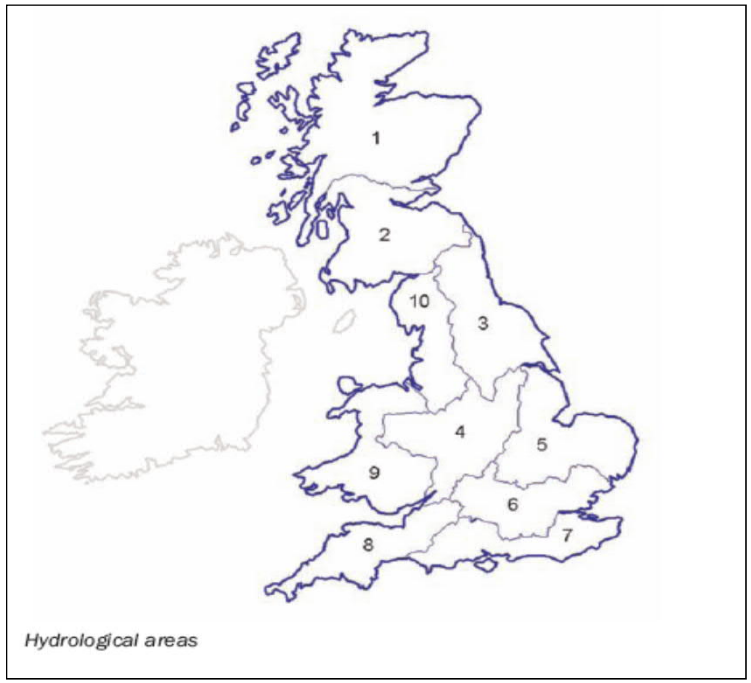
REGION NUMBER 9

QBAR rural = 0.030 m^3/s

Total Proposed Area of Hardstanding (m^2)	**Actual site area (km^2)**	**Scaling factor**
35200	0.0352	0.07

Scaled mean annual flood (m^3/s) = 0.002
Scaled mean annual flood (l/s) = 2.126
Scaled mean annual flood (l/s/Ha) = 0.604

Return Period	Growth Factor	Runoff Rate	Runoff (l/s/Ha)
1	0.88	1.87	0.53
2	0.93	1.98	0.56
5	1.21	2.57	0.73
10	1.42	3.02	0.86
25	1.71	3.64	1.03
30	1.76	3.74	1.06
50	1.94	4.12	1.17
100	2.18	4.63	1.32
200	2.47	5.25	1.49
500	2.86	6.08	1.73



Hydrological areas

For Ireland, use Region Number 11

WinDES Quick Storage Estimates - FSR Rainfall

Return Period	Climate Change	Discharge Rate	Storage Volume Minimum	Storage Volume Maximum
1	0	1.87	1135	1747
10	0	3.02	1634	2476
30	0	3.74	1953	2876
100	30	4.63	3371	4657

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