Harras Moor, Whitehaven, Cumbria

Flood Risk & Drainage Assessment

A090070-410

Revision C: March 2021

Prepared on behalf of

Homes England

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1.0 Introduction

1.1 Purpose of this report

Homes England have commissioned WYG Engineering Ltd to undertake a Flood Risk & Drainage Assessment in respect of a proposed development on a 22.8 ha site, on land within Harras Moor, Whitehaven, CA28 6SQ.

This report has been prepared to accompany the outline planning application for the proposed development as outlined in Section 1.2.

1.2 Proposed Development

An outline planning application is being submitted for approval for the development of up to 370 dwellings.

Appendix A includes an indicative masterplan for the development site.

1.3 Requirement for a Flood Risk Assessment

The application site is located in Flood Zone 1, (i.e. land assessed as having a lower than 1 in 1,000 annual probability of river or sea flooding (>0.1% Annual Exceedance Probability (AEP) in any one year). However, as the site has an area in excess of 1 ha, in accordance with the National Planning Policy Framework (NPPF) and the associated Planning Practice Guide (Flood Risk & Coastal Change) (PPG), a Flood Risk Assessment is required to support the outline planning application.

1.4 Scope of the Flood Risk and Drainage Assessment

The scope of this FRA follows national and local guidance as described below.

The FRA will be undertaken in accordance with the guidelines of the Environment Agency Flood Risk Assessment (FRA) Guidance Note 1 https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas

In line with the PPG requirements, the FRA will consider all potential sources of flood risk, such as pluvial flooding, sewers, overland flow routes, groundwater flooding, reservoir flooding, and ordinary watercourses.

The FRA will also establish a management regime for surface water runoff from the site such that flood risk to adjoining areas is not exacerbated and where possible improved. If not managed properly, surface water runoff from the site could potentially lead to increases in flood risk to other areas or the development itself.

Given that the application seeks outline planning permission, an indicative surface water drainage strategy will be included in which potential measures for draining surface water will be discussed. This will have a specific focus on implementing Sustainable Drainage Systems (SUDs) strategies, where viable.

The report has been revised to address the points raised by Cumbria County Council (CCC or Cumbria CC) as Lead Local Flood Authority (LLFA) in regards to the proposed discharge of surface water runoff into the culverted section of Bedlam Gill to the east of the site. Sections 2.2 and 4.6 have been revised to provide further information in order to satisfy the LLFA. Options to drain through either the existing culverted watercourse or through the woodland at the western extent of the site near the A595 have also been included to provide greater flexibility in the future delivery of the site.

The Foul Drainage Assessment will review the existing foul water drainage systems within and adjacent to the development site and identify the peak flows from the proposed development. A pre-development enquiry was lodged with United Utilities (UU) and the results of this are discussed within the report.

1.5 Limitations of this report

This report has been prepared by WYG Engineering on behalf of Homes England in connection with the scope of the report as described in Section 1.4 above and takes into account the particular instructions and requirements set out in our fee proposal and the acceptance. It is not intended for and should not be relied on by any third party and no responsibility is undertaken to any third party.

WYG Engineering accepts no duty or responsibility (including in negligence) to any party other than the Homes England and disclaims all liability of any nature whatsoever to any such party in respect of this report.

2.0 Site Description

2.1 Existing Site

The application site covers an area of approximately 22.8 ha and is located to the east of Whitehaven, within the Harras Moor area. The nearest postcode is CA28 6SY and the site's grid reference is NX 98631 18123.

The application site is bounded by dwellings on Laurel Bank to the north, by Harras Road and an industrial park to the east, by dwellings and Midgey Wood to the south and dwellings on the A595 to the west and south west.

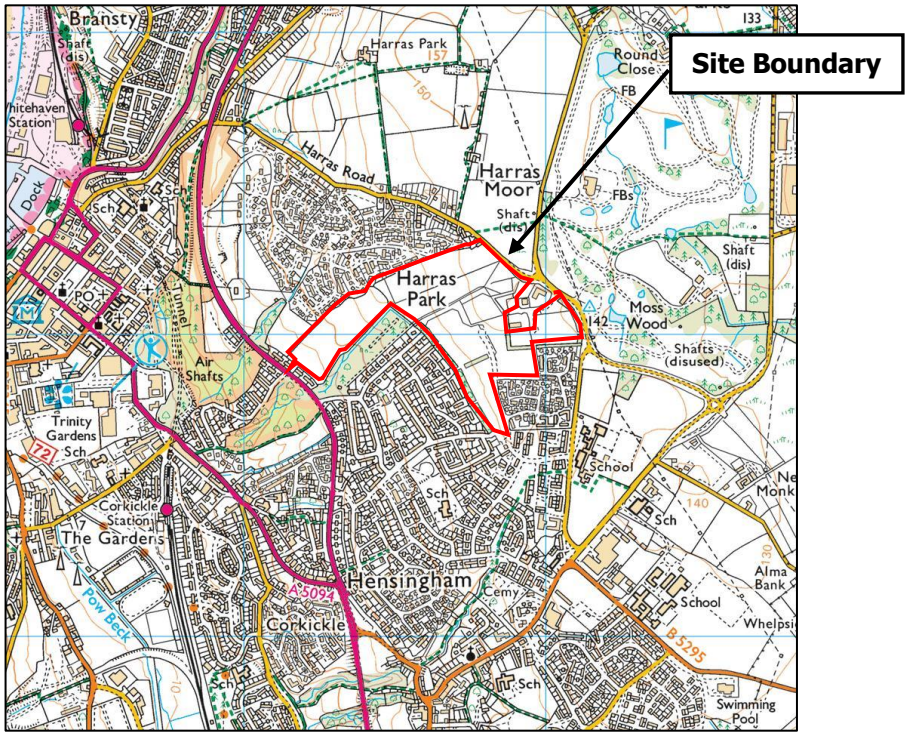

Figure 1 – Site Location Plan[1]

The site is classified as greenfield as it comprises grassland and woodland. LIDAR data was available for the majority of the site. A review of the ground levels within the site indicated that the land falls steeply from north east to south west. The highest level is 145m AOD and is located by Harras Road to the north; whereas the lowest level is 82m AOD at a point adjacent to the A595.

Appendix B includes the topographical survey of the site.

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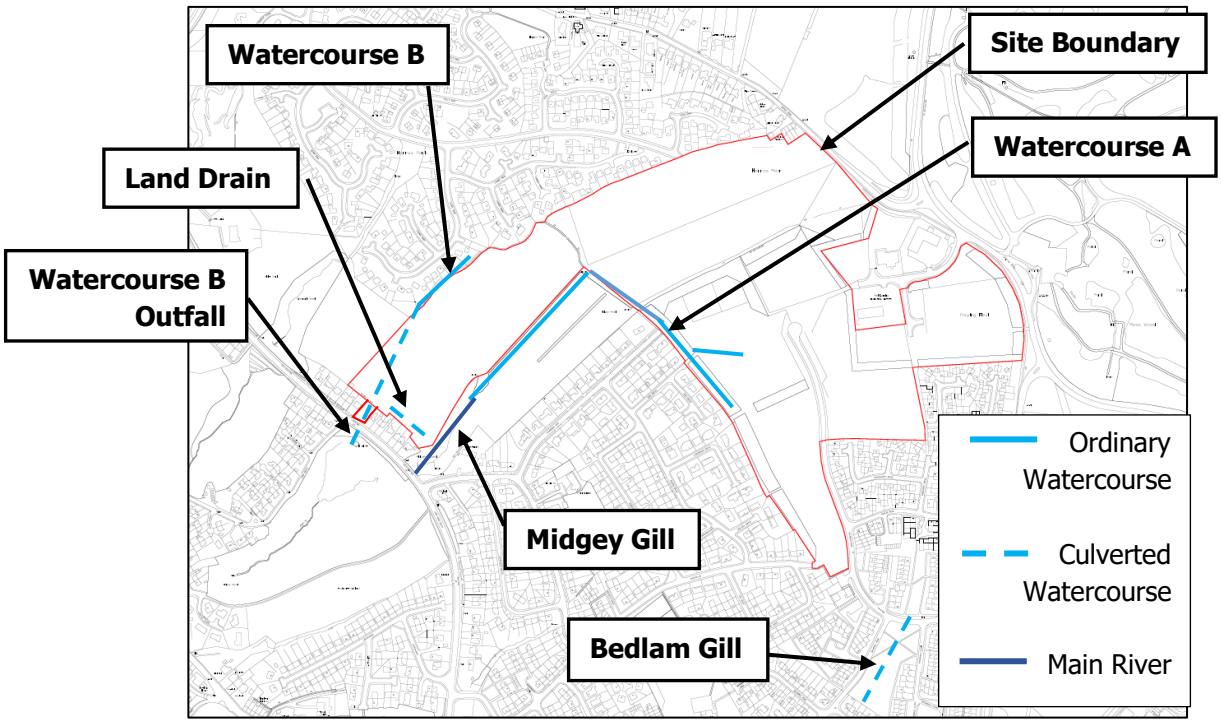

Figure 2 – Site & Watercourse Plan[2]

2.2 Existing Drainage

2.2.1 Main Rivers

The nearest Main River to the application site (as listed on the Environment Agency Flood Map for Planning) is Midgey Gill, which begins in the eastern part of the site. Midgey Gill crosses the A595 as it flows in a steep, deep valley. At this point, Midgey Gill is in a culvert of significant capacity. Midgey Gill then flows in an open channel until it reaches Park Drive where it then becomes culverted and flows north westwards before discharging into the marina which is regulated by a lock structure before draining into the Irish Sea.

Bedlam Gill to the east becomes a Main River to the south of Thornton Road.

2.2.2 Ordinary & Manmade Watercourses

The upper reaches of Midgey Gill are not classified as Main Rivers and therefore they are classified as ordinary watercourses. This is marked as Watercourse A, or the upstream section of Midgey Gill, in Figure 2 above.

Alongside the north western boundary of the site there is an ordinary watercourse (Watercourse B), which becomes a culverted watercourse within a 300mm diameter pipe which

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drains southwards through the site. There is a manhole in the culverted section of Watercourse B and a gully in the area of land between the properties alongside the A595. This manhole receives a connection from a recently upgraded (2020) land drainage system alongside the back of the fences of the properties alongside the A595. This land drainage system captures overland flows from the site before they enter the private gardens, thus mitigating the risk of flooding to the properties. The culverted section of Watercourse B flows from the manhole to the gully by the access gate from the A595. The culvert then continues to the outfall within the woodland to the south. This was confirmed by dye testing. Watercourse B then flows in an open channel through the woodland draining into Midgey Gill.

To the east of the site, the UU sewer records show a 1050mm diameter pipe marked as a 'culverted watercourse' flowing south through the landscaping areas alongside Balmoral Road. Historic Maps show this as a watercourse known as 'Bedlam Gill'. The section of Bedlam Gill north of Thornton Road is classified as an ordinary watercourse.

Appendix D includes the response to a consultation provided by Copeland BC.

2.2.2.1 Watercourse B Culvert Assessment

Watercourse B flows in a small open channel alongside the back gardens of the properties in Laurel Bank as shown in Figure 2 above. Then it becomes culverted as it leaves the last of the properties and turns in the direction of the outfall. The culvert is a 300mm diameter pipe.

The culvert has an approximate gradient of 1 in 7 between the manhole and the outfall. Based on this gradient and assuming a Manning n roughness value of 0.025, the open channel capacity of the culvert (i.e. not surcharged) is 200 l/s.

Watercourse B has a very small catchment of approximately 1.60ha. This is a conservative assessment as part of the catchment is now developed and will drain to the new drainage systems associated with the development in Laurel Bank. In addition to the upstream culvert of the catchment, the culvert receives flows from the recently upgraded land drainage system referenced above, which drains an area of 3.48ha (within the site) and from gullies in the A595 from an area of approximately 0.11ha. Based on a rate of 140 l/s per hectare for the 1 in 30 year return period event, the discharge rate from the road gullies into the culverted watercourse is 15 l/s.

The greenfield runoff associated with the catchment of Watercourse B that may be draining into the culverted section have been calculated using the UK SuDS online tool and are summarised in Table 1 below, which also indicates the greenfield flows that are discharged into the culvert by the land drainage system. It is assumed that the capacity of the gullies in

the A595 will not be much greater than 15 l/s and this has been used to estimate the total flows during the 1 in 100 year return period event.

Table 1 – Watercourse B Greenfield Runoff Assessment (l/s)

Catchment	Area (ha)	Qbar	1 in 1 year	1 in 30 year	1 in 100 year	Culvert Capacity
Open Channel	1.60	13.5	11.8	23.0	28.2	200
Land Drain	3.48	29.7	25.8	50.5	61.8	
A595 Gullies	0.11	-		15.0	15.0	
Total	5.08	43.2	37.6	88.5	105.0	

Therefore, it can be seen that the culvert has sufficient capacity to convey the flows from the upstream greenfield catchment and the section of A595 draining into it.

Appendix L includes the culvert capacity calculations, greenfield rates calculations. The plan included in Appendix F shows the catchment area of the culvert.

2.2.2.2 Bedlam Gill Assessment

The catchment area drained by the watercourse upstream of Caldbeck Road is approximately 16.6 ha and consists mainly of urban areas. It can be seen in SK007 in Appendix K that part of the site is within the catchment of Bedlam Gill. The culvert gradient is approximately 1/30 and at full capacity it can convey a flow of 4.64 m^3/s, assuming a Manning roughness coefficient of 0.015. Based on a figure of 140 l/s/ha, the runoff rate from the upstream urban catchment is 2.33 m^3/s.

An area of 4.4ha within the north eastern part of the site falls naturally within the Bedlam Gill catchment. Table 2 below indicates the greenfield rates generated by the area of the site that is within Bedlam's Gill catchment.

Table 2 – Greenfield Rates to Bedlam Gill (l/s)

Catchment Area (ha)	1 in 1 Year	1 in 30 Year	1 in 100 Year
4.4	34.1	66.7	81.6

Appendix K includes the greenfield runoff calculations for Bedlam Gill and a plan showing the catchment area of Bedlam Gill.

2.2.3 Sewers

Records obtained from UU indicate the presence of the following public sewers near the site:

- Surface Water:
  - 300mm sewer in Highlands to the west of the site.

- Combined Sewers
  - 225mm sewer flowing west in Harras Road;
  - 150/225mm sewer in the A595.

- Foul Sewers:
  - 225mm in Highlands;
  - 150/225mm sewer in the access road to the industrial area

A copy of the sewer records provided by UU is included in Appendix C.

3.0 Flood Risk

3.1 Fluvial Flood Risk

Fluvial flood risk is the risk arising from rivers and watercourses.

A floodplain is the area that would naturally be affected by flooding if a river rises above its banks. In England, floodplains are divided into flood zones (FZ) for planning purposes. These areas show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. They are divided as follows:

- Flood Zone 3 shows the land having a 1 in 100 or greater annual probability of river flooding.
- Flood Zone 2 shows the additional extent of an extreme flood from rivers. It is land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding.
- Flood Zone 1 is the area of land where flooding from rivers and the sea is very unlikely

The application site is located in Flood Zone 1. Hence it is considered that it is at very low risk of flooding from fluvial sources. Figure 3 below includes an extract of the EA's Flood Map for planning.

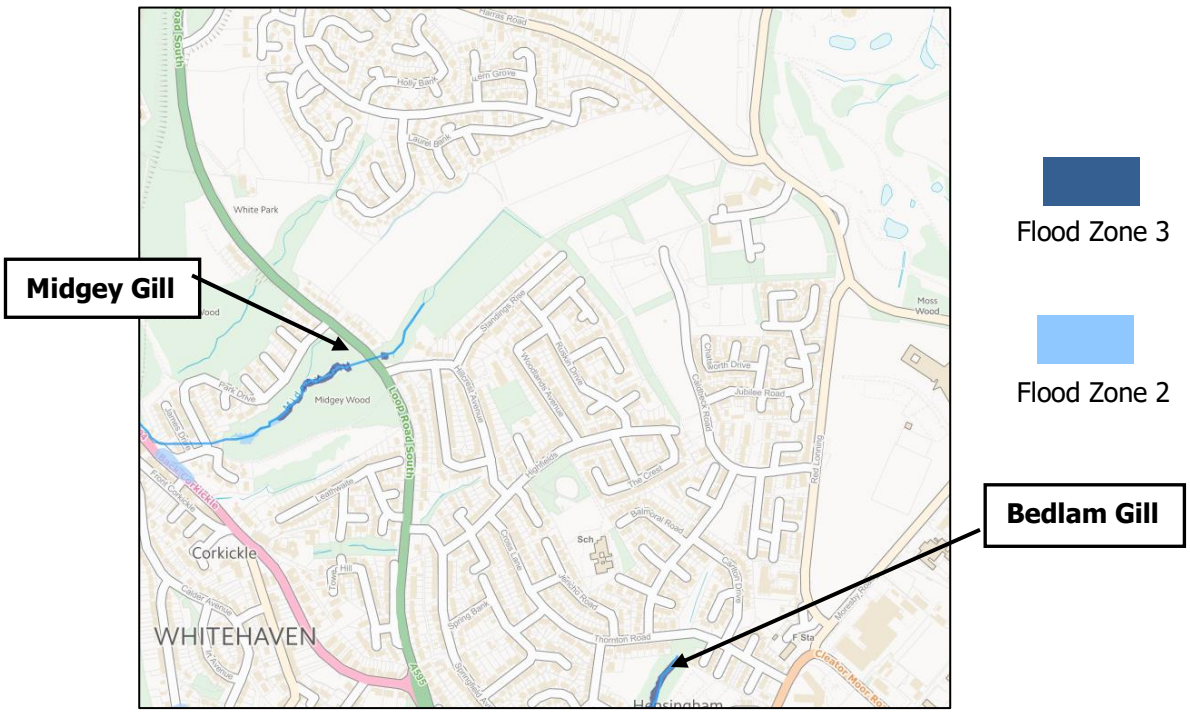

Figure 3 - Extract from EA's Flood Map for Planning (March 2021)

3.2 Surface Water & Overland Flows

Surface water flooding occurs where high rainfall events exceed the drainage capacity in an area (i.e. sewer system and/or watercourse), leading to flooding.

An extract of the Environment Agency's Updated Flood Map of Surface Water is shown in Figure 4, where it can be seen that the site is at very low risk of flooding from surface water and overland flows

3.2.1 Cumbria CC Surface Water Management Plan (SWMP)

The Cumbria County Council draft SWMP dated 2012 was reviewed to inform this report. The site is within a proposed Critical Drainage Area (CDA) within the SWMP, which comprises of most of Whitehaven. However, the area's most at risk within Whitehaven are Mirehouse and Coach Road which are some distance from the application site. The SWMP indicates that disposal of surface water to the combined sewer network should be avoided.

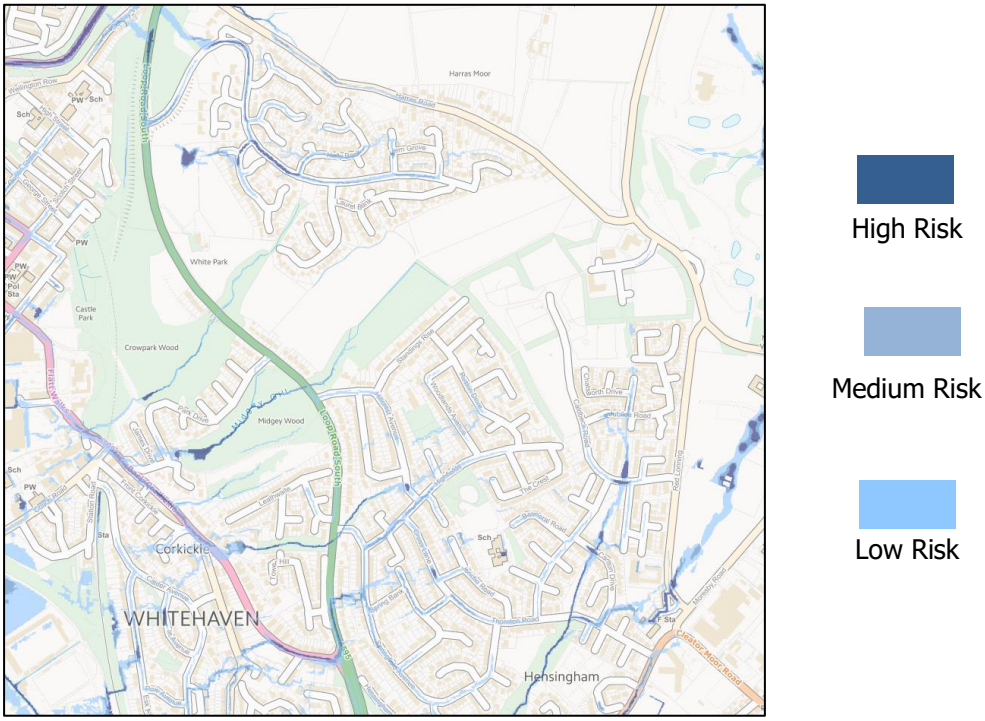

Figure 4 - Extract from Flood Map for Surface Water (March 2021)

3.3 Groundwater Flooding

The Copeland Borough Council Strategic Flood Risk Assessment (SFRA) dated 2007 states that a few areas within the South West Lakes are at risk of flooding from groundwater. Whitehaven

is not within the South West Lakes area and therefore it is concluded that the site is at low risk of flooding from groundwater.

3.4 Reservoir Flooding

Although the probability of a catastrophic dam failure is considered to be extremely low, the consequence of such an event would be severe. A review of the EA online maps of 'Risk of Flooding from Reservoirs' identified that the site is at not risk of flooding as a result of reservoir failure.

3.5 Sewer Flooding

There are no sewers within the site and the nearby sewers are of small diameter and flowing away from the site. Therefore, it is considered that the site is not at risk of flooding from sewers.

3.6 Cumbria County Council Local Flood Risk Management Strategy (CCC LFRMS)

A review of the CCC LFRMS dated 2015 was undertaken to establish any flood risk issues relevant to this application, however no additional issues were identified.

3.7 Summary of Flood Risk

Based on the above, it can be seen that the site is at low risk of flooding from rivers, surface water, overland flows, groundwater, sewers and reservoirs.

It will be essential to ensure that no increase in flood risk occurs downstream of the site or on adjacent areas as a result of the development and this matter is discussed in more detail within Section 4.

4.0 Development Proposals

4.1 Proposed Development

An outline application is being submitted for approval for the development of up to 370 dwellings.

4.2 Sequential & Exception Tests

One of the aims of NPPF is to steer development away from zones of high flood risk towards Flood Zone 1. The proposed development components are classified as 'More Vulnerable' in accordance with Table 2 of the PPG (Flood Risk & Coastal Change). Given that the site is within FZ 1 the proposed development is acceptable on flood risk terms and the sequential and exception tests are not required.

4.3 Local Planning Policies

4.3.1 Copeland Borough Council Local Plan 2013 – 2028

The Local Plan includes policy ENV 1 'Flood Risk and Risk Management'. It also indicates that development should be focused on areas at the least risk of flooding. Policy ENV 1 states the following:

- 'Permitting new build development only on sites located outside areas at risk of flooding, with the exception of some key sites in Whitehaven';
- 'Ensuring that new development does not contribute to increased surface water run-off through measures such as Sustainable Drainage Systems, where these are practical. Where they are not this should be achieved by improvements to drainage capacity'; and
- 'Support for new flood defence measures to protect against both tidal and fluvial flooding in the Borough, including appropriate land management as part of a catchment wide approach'.

4.3.2 Cumbria County Council Local Flood Risk Management Strategy

The CCC LFRMS dated 2015 includes objective P3 'Ensure that flood risk management is integrated within the planning process in Cumbria'. The Council, as LLFA, is a statutory

consultee on major planning applications. Correspondence with the Council to inform this FRA report is included in Appendix D.

4.4 Development & Flood Risk

4.4.1 Flood Risk to the Development

As established in Section 3.9, the site is considered to be at very low risk of fluvial, surface water, sewer, groundwater and reservoir flooding.

Additionally, in accordance with the requirements of the PPG and the NPPF, it is essential and required that the development of the site does not increase the risk of flooding off site.

4.4.2 Flood Risk Arising from the Development

The DEFRA Non-Statutory Technical Standards for Sustainable Drainage requires that the rate of surface water runoff from greenfield sites must not exceed the runoff rate from pre-developed greenfield site. Therefore, on site attenuation will be provided within the application site to make sure that the proposed surface water drainage system does not exacerbate flood risk outside of the extent of the proposed development for all storm events up to and including the 1 in 100 plus 40% allowance for climate change storm event.

4.5 Assessment of Pre and Post Development Areas & Rates

4.5.1 Existing & Proposed Development Areas

The application site covers an area of 22.81 ha and is currently greenfield.

Table 3 below shows the pre and post development permeable and impermeable areas for the application site and is based on the illustrative masterplan contained within Appendix A. Section 4.6.2 below provides further information on the two parts. Figure 5 below shows the catchments boundaries within the site.

Table 3 – Pre and Post Development areas for the application site

Status	Catchment	Impermeable Area (ha)	Permeable Area (ha)
Pre - Development	Whole site	0.0	22.8
Post - Development	Western Part	8.4	6.0
	Eastern Part	5.0	3.4

It should be noted that the above figures are based on the illustrative masterplan and that these will be refined as part of the future reserved matters application.

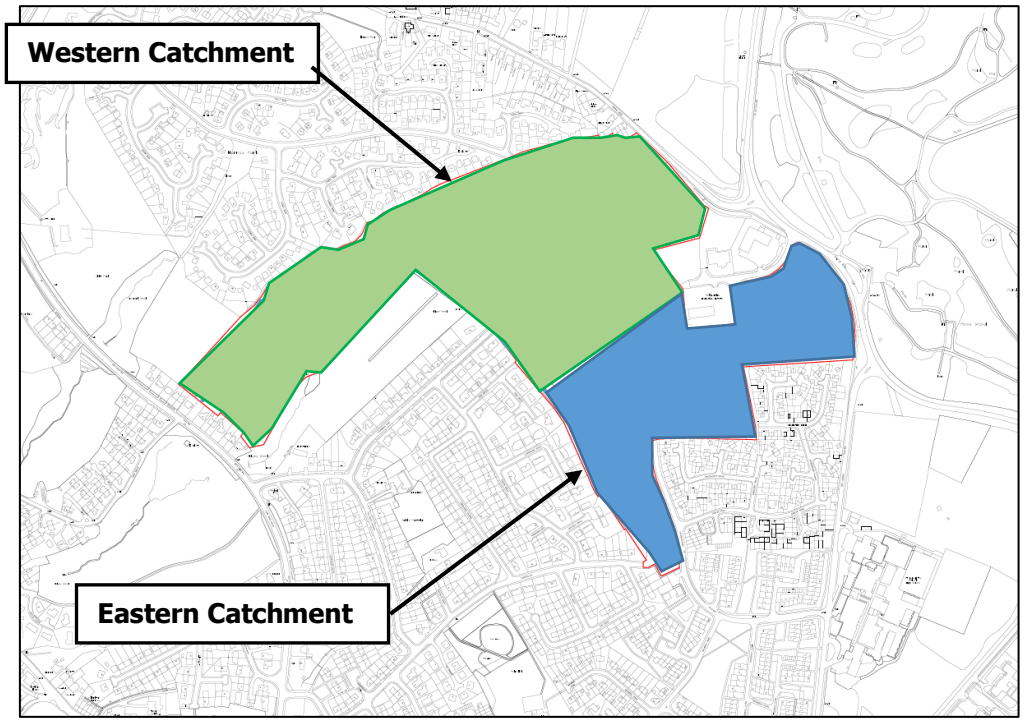

Figure 5 – Surface Water Drainage Catchments Plan

4.5.2 Existing & Proposed Discharge Rates

The site is currently grassland and therefore generates runoff at greenfield rates. Table 4a below shows the greenfield rates from the whole site, and the greenfield rates from the part of the site that falls within the Bedlam Gill catchment (Eastern catchment) and the part of the site that drains into Midgey Gill (Western Catchment).

Table 4a – Greenfield Discharge Rates (l/s)

	Area (ha)	Greenfield Qbar (l/s/ha)	1 in 1 year	1 in 30 year	1 in 100 year
Whole Site	22.8	8.4	111.2	217.2	265.8
Eastern Catchment	4.4		34.1	66.7	81.6
Western Catchment	18.4		77.1	150.5	184.2

Table 4b below shows the proposed discharge rates from each of the drainage catchments. It can be seen that discharge rates from the eastern catchment into Bedlam Gill will be restricted to the greenfield rates of the natural catchment area as shown in Table 2 above. This is in accordance with the requirements set out in the Non-Statutory Technical Standards for

Drainage. Discharge rates from the western part of the site will be restricted to the greenfield Qbar rate.

Table 4b –Proposed Discharge Rates (l/s)

	Impermeable Area (ha)	1 in 1 year	1 in 30 year	1 in 100 year	1 in 100 year + 40% CC
Eastern Catchment	5.0	42.0	66.7	81.6	81.6
Western Catchment	8.4	73.9	73.9	73.9	73.9

Appendix E includes the detailed assessment calculations of the pre-development greenfield rates.

4.5.3 Climate Change

The design of the drainage system is required to consider climate change. Guidance issued by the Environment Agency (July 2020) provides rainfall intensity allowances to be considered in an FRA (Table 2). Assuming that the development lifetime will extend to 2121, the applicable 'central' allowance is 20% and the upper end 40%.

4.6 Proposed Surface Water Mitigation

4.6.1 Surface Water Runoff Mitigation

In order to ensure that surface water runoff from the site does not cause an increase in flood risk the management of runoff has been considered via a sequential approach, in line with Building Regulations. The following options for the disposal of surface water runoff were considered, in order of preference:

i) A soakaway or some other infiltration system;

ii) A watercourse or tidal outfall;

iii) A sewer.

4.6.1.1 Discharge to soakaways

A site visit undertaken in November 2017 identified very clayey soils; and borehole records available in the BGS website indicate the presence of clays.

Given the information provided by the BGS borehole records, the suitability of soakaways is unlikely and therefore this option has been discounted.

4.6.1.2 Discharge to a watercourse

Midgey Gill, Bedlam Gill and other watercourses have been identified in Section 2 above and it is considered that surface water runoff from the site can be discharged to these watercourses.

4.6.1.3 Discharge to a sewer

It is not proposed to discharge surface water runoff into the UU sewer network.

4.6.2 Proposed Surface Water Drainage Catchments

As noted in Section 2 above, an area of 4.4 hectares within the site naturally already falls within the catchment of Bedlam Gill, with the rest of the site being within the Midgey Gill catchment.

However, parts of the proposed development site that would naturally drain into Midgey Gill would not be able to drain by gravity into the western catchment given their location and levels. These areas would be able to drain by gravity into the existing Bedlam Gill culvert and therefore it is proposed that surface water runoff from these areas is drained into the culverted watercourse. Figure 6 below shows the proposed drainage catchments within the site, with the Eastern catchment draining into the culverted section of Bedlam Gill and the Western catchment draining into Midgey Gill.

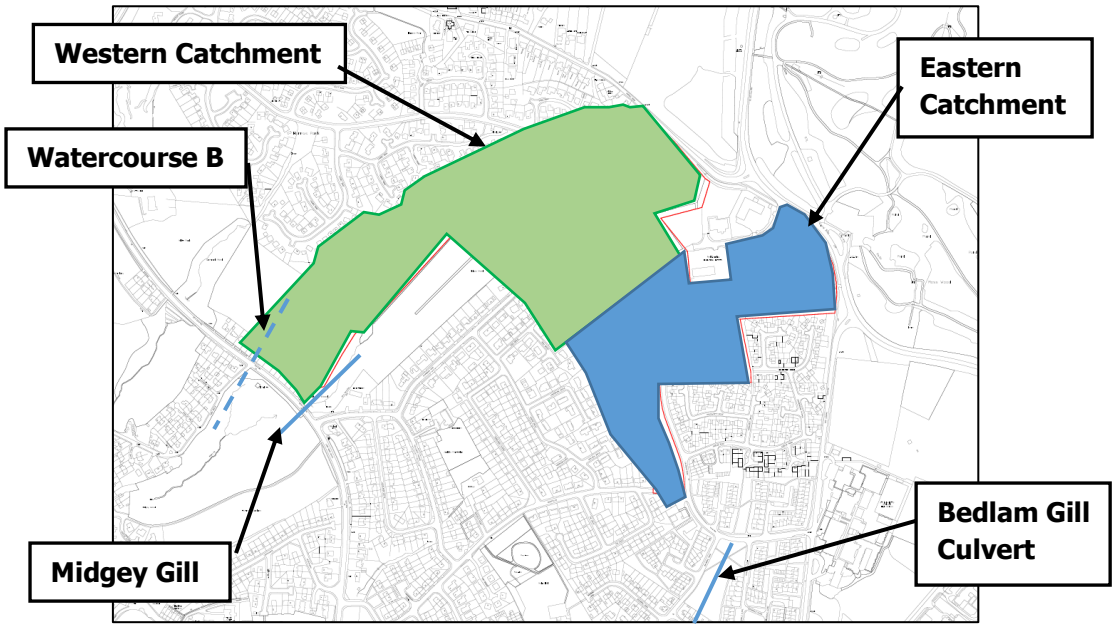

Figure 6 – Surface Water Drainage Catchments and Watercourse Plan

As noted above, discharge rates into the Bedlam Gill culvert will be restricted to the existing greenfield rates of the natural catchment in order to prevent flood risk downstream from increasing as a result of the new development.

4.6.3 Proposed Watercourse Works

One of the primary objectives of the new surface water drainage strategy will be to open up and improve the existing watercourses in order to create new blue corridors within the development. By suitable design and additional planting, it is proposed to enhance the existing ecology and bio-diversity of these watercourses, whilst at the same time managing effectively the surface water run-off generated by the proposed impermeable areas. In addition, localised wetland areas will be created where possible.

It is proposed that as part of the development of the site, the existing culverted section of Watercourse B (as indicated in Section 2.2) is investigated in detail. Once the results of the investigation are available, then the final options for the watercourse will be assessed. As noted above, Watercourse B provides an outfall to the land drainage system that was recently upgraded to prevent overland flows from the site entering the properties alongside the A595. Any future works to Watercourse B will consider the presence of this land drainage system, in order to make sure that the current mitigation against overland flows offered by the current system continues to be provided.

Additionally, it is proposed to enhance the existing watercourses in the north eastern part of the site by opening these up and regrading and improving the channels, as they are currently poorly defined.

It is proposed that Watercourse A will be widened to provide surface water attenuation and a flow control device installed where it discharges into the head of Midgey Gill.

4.6.4 Proposed Surface Water Drainage Strategy

As the application seeks outline planning permission, a strategic drainage scheme is proposed in this section. A detailed drainage design will be provided as part of the future reserved matters application.

It is proposed to divide the site into two surface water drainage catchments, east and west, as shown in Figure 5 above.

a) Eastern Catchment

The eastern catchment will drain to the culverted watercourse under Balmoral Road (Bedlam Gill). Discharge rates into the culvert are to be restricted to the pre-development greenfield rates of the area of the site draining into Bedlam Gill in order to make sure that flood risk elsewhere does not increase as a result of the proposals. Table 4b above shows the proposed discharge rates.

The proposed surface water drainage system within this area will capture runoff on the surface and convey it to a series of swales and detention basins that will provide required attenuation. From the swales and basins, surface water runoff will be discharged into a new surface water sewer in Caldbeck Road, covering the distance between the proposed site access and the connection point into the Bedlam Gill culvert. The specification and design of this new surface water sewer within Caldbeck Road will be explored at reserved matters stage, and will be agreed with both the LLFA and UU under a S104 agreement in addition to a permit by way of Land Drainage Consent to be granted by the LLFA. The estimated length of this sewer is 160m.

Section 4.6.5 below reviews the attenuation volumes required within the site.

4.6.4.1 Impact on Bedlam Gill

As indicated in Section 2 above, an area of 4.4ha within the north eastern part of the site drains naturally into Bedlam Gill. However, it is proposed to drain a total area of 8.4 ha into Bedlam Gill, as it is not possible to enable a gravity connection from this area to the drainage system discharging to Midgey Gill.

Table 4a above indicates the greenfield rates of the site currently draining into the catchment of this watercourse, and Table 4b above indicates that discharge rates from the 'eastern' catchment area will be restricted to greenfield rates as shown in Tables 2 and 4a. Therefore, as the discharge rates from the site into the watercourse will not exceed the existing greenfield rates draining into Bedlam Gill naturally, there will be no increase in flows to the watercourse and no increase in the flood risk associated with this system.

Appendix K includes the greenfield runoff calculations for Bedlam Gill.

b) Western Catchment

Two alternatives are proposed to drain the western catchment. Both of these options eventually drain into Midgey Gill, as shown in Figure 7 below, however they differ as follows:

- Option 1: discharge runoff from the western part of the site to the culverted section of Watercourse B within the southern part of the site; or
- Option 2: discharge runoff from the western part of the site directly into Midgey Gill via a new outfall, through the adjacent woodland to the east of the site.

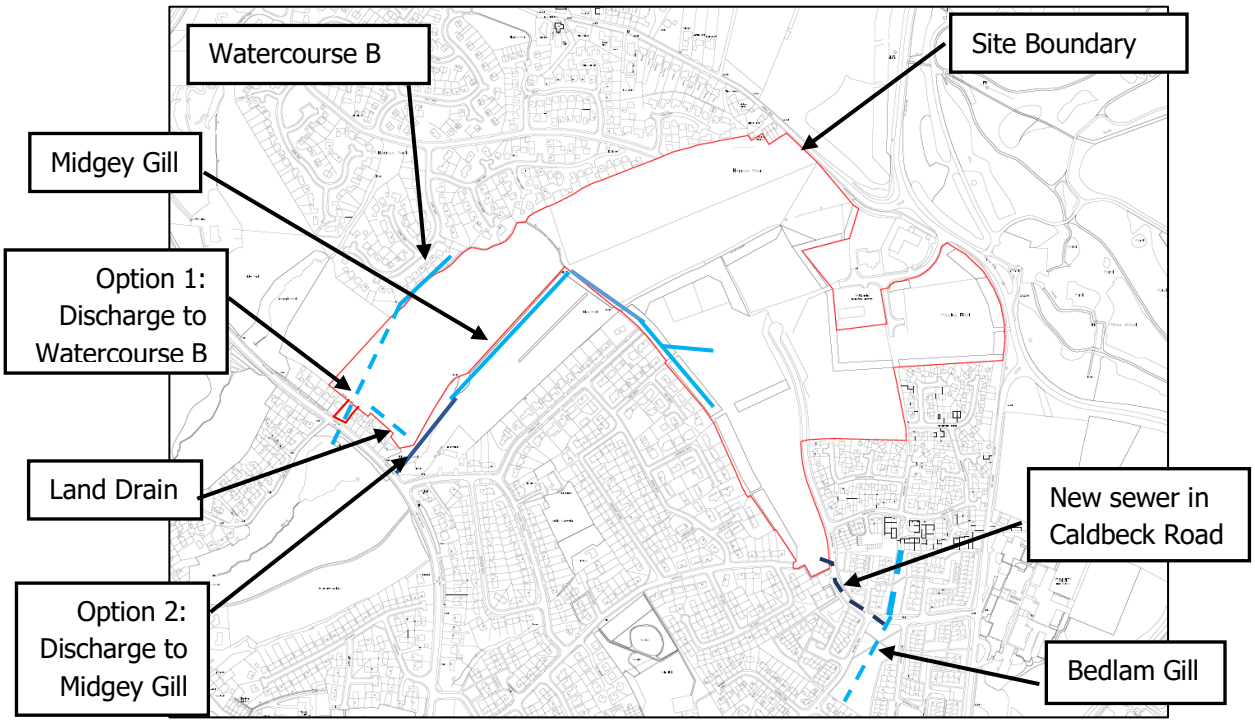

Figure 7 – Site & Watercourse Plan[3]

The proposed alternative will be confirmed at reserved matters stage, however it is important to note that a combination of both options would also be feasible. Discharge rates into these watercourses will be restricted to the greenfield rates of the impermeable areas as shown in Table 4b above. As noted in Section 2 above, the Watercourse B culvert has sufficient capacity to accept additional flows from the site if Option 1 above is pursued.

Given the contours within this part of the site, a number of swales are to be provided throughout the catchment in order to maximise the volume of attenuation provided within each swale. Surface water runoff will go through the system of swales, eventually reaching the southern part of the site, where it will be discharged either into the culverted watercourse or into Midgey Gill.

The above strategy enables the delivery of a phased development as it provides several attenuation features that can be constructed as the phases progress.

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4.6.5 Assessment of Post Development Surface Water Attenuation Volumes

Attenuation storage will be provided in order to retain all rainfall events up to and including the 1 in 100 year event plus an allowance for climate change of 40%. The steep site gradient significantly constraints the volume of exceedance flows in that could be stored within external areas.

Table 5 below indicates the initial attenuation estimates for the site. It is proposed to provide the required attenuation volume in a combination of SuDS measures such as detention basins and swales; however the details of the proposed drainage system are to be determined at the reserved matters stage.

Table 5 – Post Development Discharge Rates and Estimated Attenuation Volumes

Catchment	Impermeable Area (ha)	Allowable discharge rate (l/s)	1 in 30 year storage (m^3)	1 in 100 year + 40% CC Volume (m^3)
Eastern	5.0	See Table 4b	1280	2810
Western	8.8	73.9	2840	6450

Section 5 below reviews the applicability to the site of various SuDS systems. Appendix G includes the quick storage estimates for the required attenuation. Appendix F includes a preliminary surface water drainage layout.

4.7 Finished Floor Levels & Overland Flow Routes

Finished floor levels (FFL) should be raised 150mm above finished ground levels in order to provide mitigation above events that exceed the design capacity of the system. Given that the site is at low risk of flooding from all sources, raising the FFL higher is not expected to be required.

In addition to raising FFLs, in the unlikely event that that surface water flows in exceedance of the 1 in 100 years plus 40% allowance for climate change storm event occur or a failure of the site surface water drainage system occurs, roads will provide overland flow routes for surface water runoff.

4.8 Residual Risk

If the above mitigation measures are provided as part of the development, it is considered that the primary residual risk would be as a result of some type of failure of the site drainage system during the life of the development. The residual risk is considered to be very low, subject to regular, ongoing maintenance of the proposed drainage system.

In addition, as discussed above there remains a residual risk of a storm event that exceeds the capacity of the drainage system, as events beyond the 1 in 100 year plus 40% allowance for climate change storm event will not be catered for explicitly.

4.9 Future Maintenance

It is anticipated that the surface water drainage system within the application site will be adopted under a Section 104 agreement with United Utilities and therefore the maintenance of these elements will be undertaken by United Utilities. The latest Code for Adoption and Sewerage Sector Guidance enacted in April 2020 enables water utilities to adopt SuDS such as swales and basins.

Further discussion regarding the long-term maintenance of the new drainage system is discussed in more detail within Section 5.5.

5.0 Sustainable Drainage

5.1 Review of SuDS options

In order to comply with the national guidelines and policies set by the Environment Agency and Copeland Borough Council and the Non-Statutory Technical Standards for Sustainable Drainage, the design of the surface water drainage system should seek to maximise the use of SuDS techniques.

This section reviews the suitability of the different SuDS elements available for the application site.

As stated previously, where it is possible, it is proposed to incorporate a fully compliant SuDS drainage system to manage the discharge of surface water from the proposed development.

5.2 The SuDS Management Train

The overarching principles of a SuDS system are to minimise the impacts arising from the development on the quantity and quality of the development surface water run-off, whilst at the same time replicating the natural drainage from the site before development.

SuDS key objectives are to minimise the impacts from the development on the quantity and quality of run-off and to maximise amenity and biodiversity opportunities.

The accepted SuDS management train consists of three elements

- Source Control: Water butts, green roofs, filter drains, pervious surfaces, swales.
- Site Control: Swales, ponds, wetlands, infiltration devices.
- Regional Control: Basins, ponds, wetlands and reservoirs.

The following is an illustration of the SuDS principles and how they may be applied to a development via a SuDS Management Train.

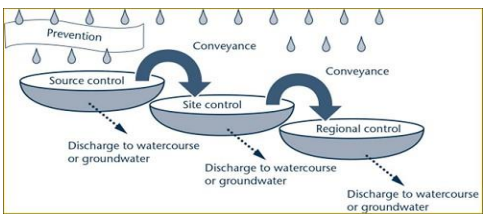

Table 6 below includes a review of the different SuDS systems and their potential applicability to the site. The SuDS elements to be incorporated into the proposed drainage system are to be confirmed at reserved matters stage.

Table 6 - Review of SuDS Options

Type of SuDS		Description	Applicability to the Site
Source Control	Water butts	Small storage tanks on each individual housing plot	This is appropriate for the site.
	Rain water harvesting	Recycling of water from roofs and impermeable areas.	This might be appropriate for the site.
	Green roofs	Vegetated roofs that reduce runoff and remove pollutants.	These are not appropriate for the site.
	Pervious surfaces	Hardstanding that allow surface water inflow into underlying surfaces.	This might be appropriate for the site.
	Rain Gardens	Shallow depressions with free draining soil and planted with vegetation that withstands occasional flooding	These could be appropriate for the site.
Site & Regional Control	Filter drains	Linear drains or trenches filled with granular material that allow infiltration to the surrounding ground.	
	Swales	Vegetated channels to convey store and treat runoff.	These are appropriate for the site and are included in the outline strategy.
	Basins and ponds	Shallow areas of open space that temporarily hold water and collect silt.	
	Infiltration basin	Shallow depression that stores runoff before it infiltrates into the subsoil.	This is not appropriate for the site.
	Infiltration devices	Generally granular trenches or soakaways that store water and allow infiltration to the surrounding ground.	

5.3 Proposed SuDS Principles

Within the site a variety of SuDS techniques such as swales, detention and rainwater

harvesting can be included in the proposed drainage strategy where viable[4] to ensure that discharge rates are limited to the rates shown in Table 3 above.

Due to the steep nature of the site, attenuation storage will have to be provided in a combination of swales and detention basins where possible; a regional attenuation feature is not considered practical. The new Code for Adoption enables water utilities to adopt SuDS more widely and it is anticipated that proposed swales will be adopted by United Utilities, if designed in accordance with the requirements set out in CIRIA C753 The SuDS Manual.

Should infiltration prove viable, then an alternative drainage design still incorporating SuDS elements will be provided and it may be that a combination of the two drainage design criteria could be provided.

The individual elements of the surface water drainage systems potentially suitable for the site are discussed in more detail below:

5.3.1 House Drainage

Initially, if the ground conditions permit, then conventional infiltration techniques (i.e. soakaways) will be adopted to drain the roof and external hardstanding areas. However, due to the expected ground conditions the use of soakaways is not anticipated to be viable.

House drainage (i.e. run off from roofs and parking areas) could be drained to edge of carriageway swales, discharging into collector swales located within the green spaces, which would then discharge into the local detention ponds. Alternatively, conventional below ground drainage systems could be utilised to discharge into the collector swales.

5.3.2 Water Butts & Rainwater Harvesting

The use of rainwater butts and rainwater recycling could be promoted in order to reduce runoff and to minimise water consumption and demand.

5.3.3 Permeable Pavements

Parking areas could utilise permeable paving. There are several benefits to permeable paving, if ground conditions are found to be conducive to infiltration, permeable paving may allow an element of infiltration through its sub base into the underlying ground. In the event that

4

Reasonable and "what is reasonably practical" is as set out within paragraphs 082,083,084 and 085 of the PPG (Flood Risk & Coastal Change) and compliance with the Technical Standards (i.e. DEFRA Non Statutory Technical Standards for Sustainable Drainage) will be regarded as not

practical, if the cost of compliance exceeds the cost of compliance with Building Regulations (unless compliance is necessary where there is a risk of flooding requiring the development to be safe and to avoid flood risk elsewhere

infiltration is not viable, then the run off can be drained to a lined basal stone layer with the surface water run off being drained direct to the on site surface water drainage system.

5.3.4 Highways

Detailed design of internal roads will take place at the reserved matters stage. At that stage, highways and footways could be designed by eliminating edge kerbing to allow surface water run off to discharge direct to an edge swale and as this will be a departure from current highway adoption standards further negotiations should be held with the Highway Authority (CCC). Alternatively, edge filter strips could be utilised to receive the run off.

In the event that such a design was not acceptable to the Highway Authority, then conventional gulleys could be utilised which would discharge into the edge swale, however this option would result in the swales becoming deeper and their appearance more like a ditch which would create possible maintenance and safety issues. Alternatively, a conventional below ground piped highway drainage system could be considered discharging to either swales or a downstream surface water sewer system.

5.3.5 Swales

Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration (where ground conditions permit) and they allow low flow velocities to allow much of the suspended particulate load in the surface water run off to settle out, thus providing effective pollutant removal.

The swales would be shallow (i.e.1m deep) depressions with a grass finish and where ground conditions permit an element of infiltration incorporate a base filter trench. The route of the swale would either, follow the main highway within each zone and where necessary to cross sections of highway or footway incorporate short sections of culverts, or be located within the open space zones.

The swales will eventually discharge into the local detention ponds.

Alternatively, it may be necessary in certain situations in order to facilitate adoption of the highways, to utilise conventional piped drainage systems to convey the surface water to the detention ponds.

Any proposed swales are to be designed in accordance with the requirements set out in CIRIA C753 The SuDS Manual and any additional requirements that UU may have.

5.3.6 Detention Basins and Ponds

Detention ponds (also known as detention basins) are dry basins that attenuate storm water run of by providing temporary storage and controlled release of detained run off. They are normally vegetated depressions (i.e. grass) that remain mainly dry, except during and immediately after storm events. The detention ponds may also incorporate a small permanent pool of water at the outlet to prevent re suspension of sediment particles by high intensity storms and to provide enhanced water quality treatment for frequent storm events.

The detention ponds will consist of shallow depressions located within the proposed green space for each zone and will be approximately 1.5m deep. The sides of the ponds will be approximately 1 in 3 and subject to the final design may incorporate shallow ledges.

The ponds will be designed to incorporate a shallow dished section within the central part to allow low flows to drain to the outfall which will incorporate a below ground flow control device rated to the required green field run off rate. At times of high rainfall the pond will fill up to provide the required attenuation and then drain down to maintain a grassed area for general amenity use. Where ground conditions permit an element of infiltration will be allowed through the base of the pond by utilising a series of below ground filter trenches or drains.

As the areas served will be residential and will incorporate swales to initially remove pollutants, then it is not considered necessary to incorporate a separate sediment fore bay.

In order to provide access for maintenance to the ponds inlet and outlet structures vehicular access will be provided around the perimeter of the ponds utilising a grass grid or similar pavement system.

Any proposed basins are to be designed in accordance with the requirements set out in CIRIA C753 The SuDS Manual and any additional requirements that UU may have.

5.3.7 Hydraulic Considerations

Any conveyance system, be it swale or sewer, would be required to cater for the flows resulting from a 1 in 30 year storm event and where the ground conditions permit infiltration then the storage capacity should take this into consideration.

The detention ponds will be designed to provide adequate storage for storm events up to and including the 1 in 100 year plus 40% allowance for climate change. The required attenuation estimates are shown in Section 4.6.5 above.

5.4 Examples of SuDS Systems

Typical details showing how the proposed SuDS techniques can be incorporated into the surface water design for the development are contained within Appendix J.

Subject to the publication of the approved National Standards these details may be subject to review and will need to be incorporated into the final detailed design proposals.

5.5 Water Quality

The SuDS design should seek to provide an appropriate management train of SuDS components to effectively mitigate the pollution risks associated with the different site users.

Within this development, there are two key drivers in respect of pollutant risks to the receiving downstream sewer systems, these being pollution from vehicle parking areas and pollution from highways.

In accordance with Table 26.2 of The SuDS Manual CIRIA C753, the pollution hazard level is considered to be 'Medium' for the proposed land use. Therefore, the requirements for discharge to surface waters state that the 'Simple index approach' should be used. Step 1 of the simple index approach is to identify the pollution hazard indices for the proposed land use as set out in Table 7 below, which is an extract of Table 26.2.

Step 1 of the simple index approach is to identify the pollution hazard indices for the proposed land use. Table 26.2 of The SuDS Manual states the following:

Table 7 – Pollution Hazard Indices

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Individual property driveways, low traffic roads.	Low	0.5	0.4	0.4
Most roads.	Medium	0.7	0.6	0.7

Step 2 of the simple index approach is to select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index. Up to four levels of treatment may be possible with these potentially being provided by the following systems:

- Permeable Paving;
- Bioretention systems;

- Swales; and
- Detention Basins.

Table 26.3 of The SuDS Manual states the various mitigation indices for discharges to surface waters. The mitigation indices for the potential SuDS systems are shown below in Table 8.

Table 8 – SuDS Mitigation Indices (Discharge to Surface Water)

Type of SuDS component	TSS	Metals	Hydrocarbons
Swale	0.5	0.6	0.6
Detention basin	0.5	0.5	0.6

The total SuDS mitigation index for each pollutant is a combination of the mitigation indices of each element. The first SuDS element of the train will always be more effective than the subsequent elements, given that the concentration of pollutants in the runoff entering these is lower.

Based on the above, given that runoff is expected to go through various SuDS elements before being discharged, it can be seen that the required mitigation indices can be achieved.

Although possible options have been stated, alternative SuDS options may also be considered during the detailed design stage which achieves or exceeds the water quality objective.

Provided that the mitigation indices of the treatment techniques are greater than or equal to the hazard indices for the proposed development then there should be no reduction in the overall water quality within the receiving system.

5.6 Future SuDS maintenance

It is anticipated that United Utilities will adopt and maintain the surface water drainage system, including SuDS such as swales and basins. Table 9 below shows the maintenance requirements of each of the proposed SuDS elements for the scheme.

Table 9 - Maintenance tasks and frequency required

SuDS element	Maintenance Task	Recommended Frequency
Swale	- Remove litter and debris - Cut grass & vegetation management - Inspect inlets, outlets and structures - Remove sediments from inlet and outlet - Remove sediments from main basin - Repair erosion and other damages - Relevel surfaces	- Monthly - Monthly in Spring and Summer or as required - Every 12 months - As required
Detention Basin	- Remove litter and debris - Cut grass & vegetation management - Inspect inlets, outlets and structures - Remove sediments from inlet and outlet - Prune and trim trees - Remove sediments from main basin - Repair erosion and other damages - Relevel surfaces	- Monthly - Monthly in Spring and Summer or as required - Every 12 months - Every 5 years - As required

6.0 Foul Drainage Assessment

6.1 Existing Foul Sewers

As explained in section 2.2.3, there are a number of foul and combined sewers near the site boundaries. The nearest sewer to the eastern part of the site is a 225mm diameter foul sewer flowing south in Balmoral Road; and the nearest foul sewer to the south western part of the site is a 150mm public foul sewer in the A595 northern footpath.

6.2 Proposed Foul Drainage Strategy

In order to provide gravity connections to the public sewers from the proposed development, it is proposed to divide the site into two foul water catchments, east and west, that will drain to the existing UU sewer network. These two catchments are to be similar to the proposed surface water drainage catchments shown in Figures 5 and 6 above.

The eastern catchment is the area that is able to drain by gravity into the public sewers in Balmoral Road and Calbeck Road to the east of the site. The western catchment is the area that can drain by gravity to the sewer in the A595.

Table 10 below indicates the estimated number of houses within each catchment and the peak foul flow associated with it. The peak flows are calculated based on the figure of 0.05 l/s per dwelling in line with the requirements of the new Codes for Adoption and UU confirmed that the existing foul drainage network can accept the proposed additional flows.

Table 10 - Foul Water Discharge Points

Catchment	No. of Dwellings	Estimated Peak Flow (l/s)	Discharge Points
East	170	8.5	225mm sewer in Balmoral Rd / New offsite sewer in Caldbeck Road to existing foul sewer in Balmoral Road
West	200	10.0	Combined Sewer A595

The above catchments are indicative only and the total number of dwellings draining into each foul sewer will be confirmed at reserved matters stage as it will depend on the site phasing. An indicative foul drainage plan is included in Appendix H. The response to the consultation to UU is included in Appendix I.

7.0 Consents Required

7.1 Water Industry Act 1991

7.1.1 Section 106

Any new connection to the United Utilities public sewer system will require a Section 106 application under the Water Industry Act 1991.

7.1.2 Section 104

It is anticipated that the on and off-site sewers will be put forward for adoption under Section 104 of the Water Industry Act 1991 and technical approval will be required for these sewers.

7.1.3 Section 185

There are a number of public sewers within the site that will need to be diverted as a result of the proposed development. Section 185 of the Water Industry Act 1991 regulates the diversion of public sewers and an agreement with UU will be required.

7.2 Watercourse Consents

The proposed new connections to the existing watercourses will need to be consented by Cumbria CC as LLFA under section 23 of the Land Drainage Act 1991. The proposals are acceptable in principle to the LLFA, a consent will be required before the site is developed once the reserved matters applications are approved.

8.0 Conclusions & Recommendations

This report has identified the following conclusions:

1. This report has identified that there are no significant flood risk issues that may prevent the development of the site.
2. The development site is shown on the EA Statutory Flood Maps for Planning as being entirely within Flood Zone 1.
3. The proposed development is to consist of up to 370 new residential units on the 22.8ha site.
4. The site is classified as greenfield as it comprises farmland.
5. The proposed development is classified as 'More Vulnerable' according to Table 2 of the PPG (Flood Risk & Coastal Change).
6. 'More Vulnerable' development is acceptable in Flood Zone 1 and the Sequential and Exception Tests are not required.
7. The land falls from north to south and east to west.
8. The nearest main river to the application site (as listed on the EA Flood Map for Planning) is Midgey Gill that runs through Midgey Wood to the east of the site.
9. There is a culverted watercourse to the east of the site known as Bedlam Gill. The culverted watercourse has a capacity at full bore of approximately 4.64 m^3/s.
10. There is a culverted watercourse through the south western part of the site. The culvert crosses the A595 and becomes an open channel in the woodland to the south, prior to discharging to Midgey Gill.
11. There are no historical records of any flooding within the application site. Recent improvements to field drains within the site undertaken by the applicant in 2020 are considered to have improved the existing surface water runoff management within the site, especially along the western boundary near to the A595
12. The existing Qbar rate of discharge per hectare is estimated to be 8.4 l/s.
13. It is proposed to divide the site into two surface water drainage catchments, eastern and western.

14. The eastern catchment will discharge to the Bedlam Gill culverted watercourse under Balmoral Road via a new sewer in Caldbeck Road.

15. The western catchment will discharge indirectly to Midgey Gill through either the culverted watercourse in the southern part of the site that crosses under the A595 or via a new outfall through the adjacent land (or a combination of both).

16. Both the Bedlam Gill culvert and the culverted Watercourse B have sufficient capacity to accommodate the proposed discharge from the site.

17. Discharge rates into both Bedlam Gill and Midgey Gill are to be restricted to pre-development greenfield rates.

18. The proposed drainage systems within each catchment is to comprise a network of basins and swales in order to provide the required attenuation. It is proposed to provide attenuation storage for rainfall events up to and including the 1 in 100 year plus 40% climate change event.

19. Where possible it is proposed to widen and vegetate the existing watercourses to provide improved access and biodiversity elements.

20. It is proposed to divide the site into two foul drainage catchments, east and west, to enable gravity connections to the UU foul sewer network. The eastern parts of the site will drain into the existing sewer in Balmoral Road, directly and through a new foul sewer in Caldbeck Road; and the western catchment will drain into the existing sewer in the A595.

Based on the above, the following recommendations are made:

1. Finished Floor Levels of the new buildings are to be set at 150mm above the proposed surrounding ground level to ensure that in the event of exceedance events causing overland flows within the development, no flooding of the properties will occur.

2. The final site layout and drainage design shall seek to maximise the use of SUDs techniques.

3. On completion, a regular inspection & maintenance regime is to be provided together with details of who will be responsible for the inspection and maintenance of the proposed SUDs components.