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Flood Risk Assessment & Drainage Strategy

Harras Road, Whitehaven

John Swift Homes

Ref: K39108.FRA/001

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6. GLOSSARY OF TERMS

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Society
CC	Climate Change
CCC	Cumbria County Council
DSM	Digital Surface Model
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FRA	Flood Risk Assessment
GIS	Geographical Information System
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
OS	Ordnance Survey
RGP	RG Parkins & Partners Ltd
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System
UU	United Utilities

7. INTRODUCTION

7.1 BACKGROUND

This report has been prepared by R. G. Parkins & Partners Ltd (RGP) for John Swift Homes in support of their proposals for a new residential development comprising 23 no. properties at Harras Road, Whitehaven.

RGP has been appointed to undertake a Flood Risk Assessment and Surface and Foul Water Drainage Strategy in accordance with the National Planning Policy Framework (NPPF) to support a planning application that fulfils the requirements of the Local Planning Authority, Environment Agency, Lead Local Flood Authority and the Sewerage Undertaker.

The following study assesses flood risk to the site and proposed development and demonstrates the proposed development will not adversely affect flood risk elsewhere.

7.2 PLANNING POLICY

The NPPF [1] and its Planning Practice Guidance [2] states “a site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in the future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.”

7.3 THE DEVELOPMENT IN THE CONTEXT OF PLANNING POLICY

Owing to the size of the development in terms of number of properties (23no.), it is classed as major development (over 10 dwellings) in accordance with The Town and Country Planning Order 2015 [3].

The area covered by the application is 1.6 ha (hectares) and by reference to the Environment Agency Flood Map, the site lies in Flood Zone 1.

Table 2 of the NPPF’s Planning Practice Guidance [2] classifies each development into a vulnerability class, depending on the type of development, as outlined in Table 7.1. The site is to be developed for a housing development; and is classified as ‘More vulnerable’. ‘More Vulnerable’ development classes are deemed acceptable in terms of flood risk within Flood Zones 1, 2 and 3a but are not generally considered acceptable within Flood Zone 3b.

Table 7.1 Vulnerability Classification

Vulnerability Classification	Development
Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure, which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. Wind turbines.
Highly Vulnerable	Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operation during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes, and park homes intended for permanent residential use. Installations requiring hazardous substances consent.
More Vulnerable	Hospitals. Residential institutions such as residential care homes, children's homes, prisons and hostels. Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs, and hotels. Non-residential uses for health services, nurseries, and education establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short let caravans and camping, subject to a specific warning and evacuation plan
Less Vulnerable	Police, ambulance, and fire stations which are NOT required to be operational during flooding. Buildings used for shops; financial, professional, and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distributions; non-residential institutions not included in the 'more vulnerable' class; and assemble and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill & hazardous waste facilities). Minerals working & processing (except for sand & gravel working). Water treatment works which do not need to remain operational during times of flood. Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water-Compatible Development	Flood control infrastructure. Water transmission infrastructure & pumping stations. Sewage transmission infrastructure & pumping stations. Sand & gravel working. Docks, marinas, and wharves. Navigation facilities. Ministry of Defence installations. Ship building, repairing & dismantling, dockside fish processing & refrigeration & compatible activities requiring a waterside location. Water based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation & biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category subject to a specific warning & evacuation plan.

8. SITE CHARACTERISATION

8.1 SITE LOCATION

The site is accessible directly from Harras Road and is situated approx. 1 km northwest of Whitehaven town centre, at National Grid Co-ordinates 298300E 518545N. The site location is shown in Figure 8.1.

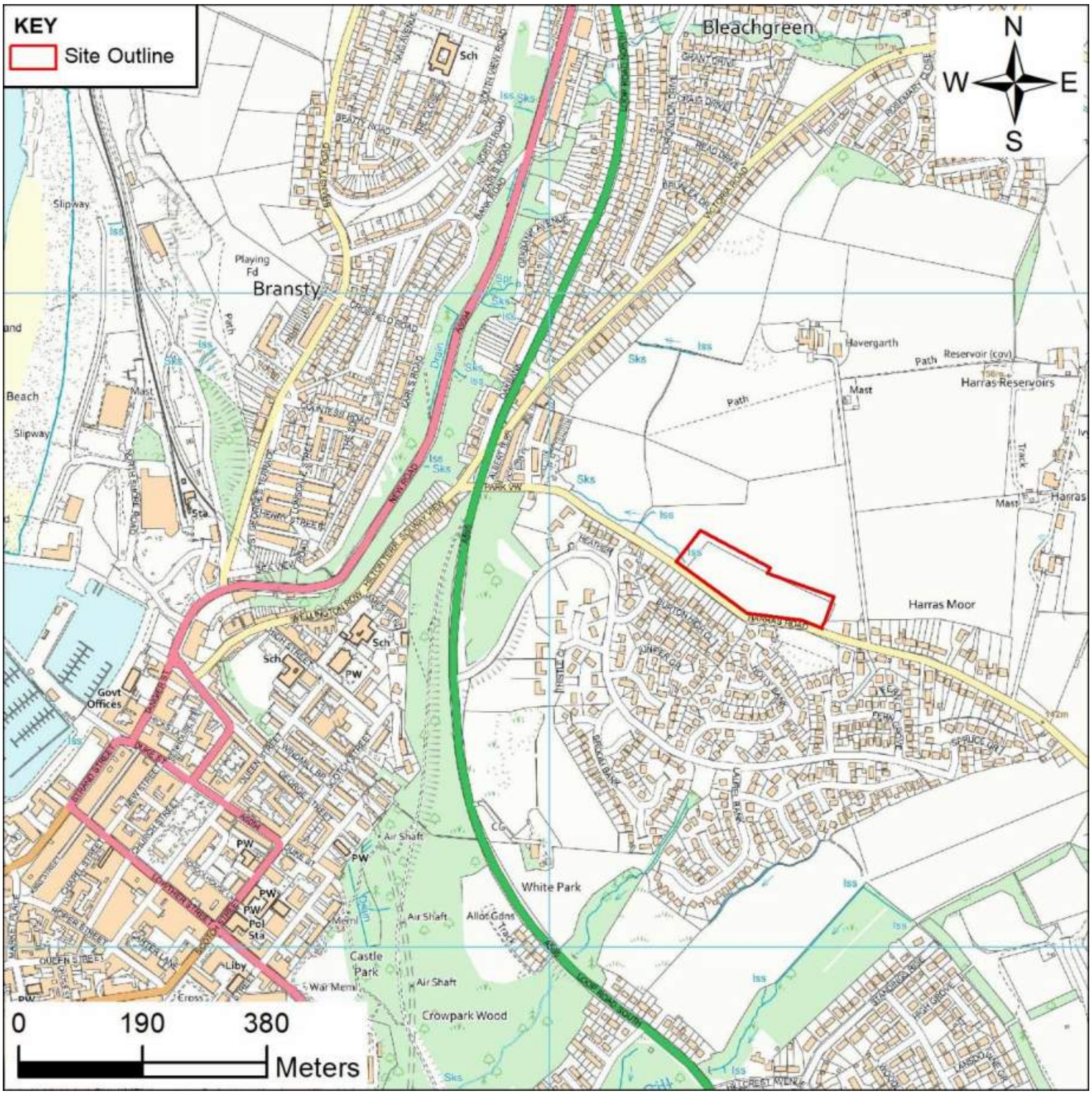

Figure 8.1 Site Location

8.2 SITE DESCRIPTION

The area of the site proposed for development covers approximately 1.6 ha. And is currently used as agricultural pasture and can be classed as Greenfield.

The site is bound by agricultural land to the north and west, Harras Road to the south and a cluster of residential houses aligned with the road in front of Harras Moor to the east.

Topographically levels vary significantly across the site, with the survey indicating the site is located on a steeply sloping hill with levels typically falling from east to west.

Levels in the developable area range from approximately 130.00 mAOD at the north-eastern extent to around 100.00 mAOD at the southwestern boundary where a natural open watercourse issues. The levels then continue to drop off steeply beyond the site boundary to the west.

8.3 GEOLOGY & HYDROGEOLOGY

British Geological Survey (BGS) [4] and Land Information Systems (LandIS) [5] mapping indicates the site is underlain by the geological sequences outlined in Table 8.1. The EA Groundwater Vulnerability Map [6] indicates the nearest Groundwater Source Protection Zone is a Zone 3 which is situated approximately 6 km south of the site. The development site overlies a secondary aquifer with 'High' vulnerability.

Table 8.1 Site Geological Summary

Geological Unit	Classification	Description	Aquifer Classification
Soil	Soilscape 6	Freely draining slightly acid loamy soils	N/A
Drift	None recorded	N/A	N/A
Solid	Pennine Middle Coal Measures Formation (West) Whitehaven Sandstone Formation (East)	Mudstone, Siltstone, Sandstone Sandstone	Secondary A

8.4 HYDROLOGY

The closest surface water feature is the unnamed Ordinary Watercourse emanating from the southwestern corner of the site, which is clearly identifiable on ordnance survey maps and marked as issues at its origin and sinks downstream, where it appears to be culverted through the nearby residential estates located downhill of the development site.

The localised topography would suggest that this watercourse acts as a natural drainage route for the existing site.

8.5 EXISTING SEWERS

Reference to United Utilities Sewer Records indicate the presence of a 300mm diameter public combined sewer located in Harras Road. Road gullies and manhole covers are also visible along the road indicating the presence of surface water Highways drains, it is assumed these drains discharge to the combined sewer.

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8.6 GROUND INVESTIGATION

The site has been subject to several potential development enquiries over the years and therefore a series of ground investigations have been undertaken for previous planning applications. RGP have been provided with the most recent Ground Investigation Reports carried out by Geo-Environmental Engineering for the site dating back to 2019 for a previous development layout comprising of 9 dwellings.

Collapse features and voids were encountered during the initial phase of investigations and as the area is synonymous with historic coal mining activity, for safety reasons a staged approach to the investigations were subsequently undertaken in 2019 by Geo-Environmental Engineering which included geophysical surveys followed by a further round of intrusive ground investigations comprising 17 No. mechanically excavated trial pits, 5 No. in-situ dynamic cone penetrometer (DCP) tests and laboratory based geotechnical testing.

No evidence of bell pits or mine shafts was subsequently encountered as part of the investigations. Topsoil was encountered across the site to depths of between 0.15m & 0.39m, with some made ground encountered up to a depth of 2.5m bgl in an area around a possible collapsed shallow mine working.

Natural drift deposits across the majority of the site were typically found to be firm to stiff brown sandy very gravelly clay with occasional cobbles of sandstone, with the exception of the far western part of the site where a layer of soft, locally very soft grey silty sandy gravelly clay overlying firm to stiff gravelly clay at 1.8m bgl was found, most likely associated with the watercourse channel in this area.

Weathered bedrock was encountered at depths of between 0.7m and 1.9m bgl. The bedrock was found to change in formation in different areas of the site, with weathered sandstone found in both the east and west areas of the site, with a change in strata through the central site area where coal measures was encountered.

The report includes reference to the relevant coal authority records for the area and presented recommendations to excavate all made ground encountered in the vicinity of the historic collapse features and infill any voids with suitable compacted material. RGP understand that this remediation has already been undertaken by the Client in 2021.

More recently percolation testing has been undertaken, to determine the suitability of an infiltration-based drainage strategy. Testing was carried out on the site in March 2021, which comprised BRE365 Soakaway testing in 8 No. Mechanically excavated trial pits.

Variable ground conditions were found across the site with grass and topsoil overlying layers of sandy gravelly clay, sand and gravel and possible shallow sandstone bedrock.

The infiltration testing provided inconclusive results, with only 3 of the 8 pits returning favourable results indicating a medium permeability classification. The percolation tests in the remaining 5 trial pits failed to drain a sufficient depth to determine an infiltration rate.

No significant groundwater ingress was encountered during any of the trial pitting; only slight ingress was noted within 2 of the trial holes at 2.1m and 2.0m respectively, which was thought to be perched groundwater above the clay subsoils.

For further information and fu refer to the following Geo Environmental Engineering Ground investigation reports:

- GEO2019-3797 – Preliminary Draft - Ground investigation Report (Issued 2019)

- GEO2021-4705 – Ground Investigation Report – Soil Infiltration Test Results (Issued April 2021)

9. ASSESSMENT OF FLOOD RISK

9.1 BACKGROUND

The following risk assessment has been carried out in accordance with the National Planning Policy Framework [1] and its Planning Practice Guidance [2] on Flood Risk. The broad aim of the guidance is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is properly assessed during the initial planning stages.

Responsibility for this assessment lies with the developers and they must demonstrate:

- Whether the proposed development is likely to be affected by flooding.
- Whether the proposed development will increase flood risk in other parts of the hydrological catchment.
- That the measures proposed to deal with any flood risk are sustainable.

The developer must prove to the Local Planning Authority and the Environment Agency that the existing flood risk or the flood risk associated with the proposed development can be satisfactorily managed.

9.2 FLOOD RISK TERMINOLOGY

Flood risk considers both the probability and consequence of flooding.

Flood events are often described in terms of their probability of recurrence or probability of occurring in any one year. The threshold between a medium flood and a large flood is often regarded as the 1 in 100-year event. This is an event which statistical analysis suggests will occur on average once every hundred years. However, this does not mean that such an event will not occur more than once every hundred years. Table 9.1 shows the event return periods expressed in years and annual exceedance probabilities as a fraction and a percentage. For example, a 1 in 100-year event has a 1% probability of occurring in any one year, i.e. a 1 in 100 probability. A 1000-year event has a 0.1% probability of occurring in any one year, i.e. a 1 in 1000 probability.

Table 9.1 Flood Return Periods & Exceedance Probabilities

Return Period (years)	Annual Exceedance Probability (AEP)	
	Fraction	Percentage
2	0.5	50%
10	0.1	10%
25	0.04	4%
50	0.02	2%
100	0.01	1%
200	0.005	0.5%
500	0.002	0.2%
1000	0.001	0.1%

9.3 DATA COLLECTION

The following information was referred to for the Flood Risk Assessment:

- Environment Agency Flood Map for Planning covering the site and adjacent area.
- Environment Agency Surface Water Flood Risk Map
- Environment Agency Reservoir Flood Risk Map
- Environment Agency Historic Flood Map
- United Utilities sewer records
- British Geological Survey Groundwater Flooding Susceptibility Map
- Copeland Borough Council Strategic Flood Risk Assessment
- Development layout plan
- Topographic survey

9.4 STRATEGIC FLOOD RISK ASSESSMENT

Copeland Borough Council commissioned JBA Consulting to produce a Level 1 Strategic Flood Risk Assessment (SFRA) Report [7] finalised in 2021 which refers to the Environment Agency Flood Maps to determine flood risk.

It states there are several historic flooding incidents in Whitehaven, but these are generally attributed to tidal flooding due to the proximity of the town centre to the coastline. Some properties are at risk from the main watercourse, Pow Beck which bisects the town and during extreme events, flooding can be exacerbated in certain areas by insufficient sewer capacities. This site however is located away from the historically affected areas and is not shown to be at risk of flooding.

Since the original SFRA's were undertaken, the understanding of flood mechanisms and risks has developed, and the EA has carried out new modelling to define flood risks. The SFRA maps are therefore regarded as superseded by the new EA Flood Maps for Planning in any case which have been used to determine the sites flood risk for the basis of this report.

9.5 ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING

Figure 9.1 is an extract from the EA's Flood Map for Planning [6]. This has been reviewed to assess the level of flood risk to the area. The flood map shows areas that may be at risk of fluvial flooding in a 1% (1 in 100 year, dark blue) or 0.1% (1 in 1000 year, light blue) Annual Exceedance Probability (AEP) event. Alternatively, if the flood risk is tidal the flood map will show areas predicted to be at risk of flooding from the sea in a 0.5% AEP event (1 in 200 year, dark blue) or a 0.1% AEP event (1 in 1000 year, light blue).

The Flood Map shows the current best information on the extent of the extreme flooding from rivers or the sea that would occur without the presence of flood defences. The potential impact of climate change is not considered by the mapping.

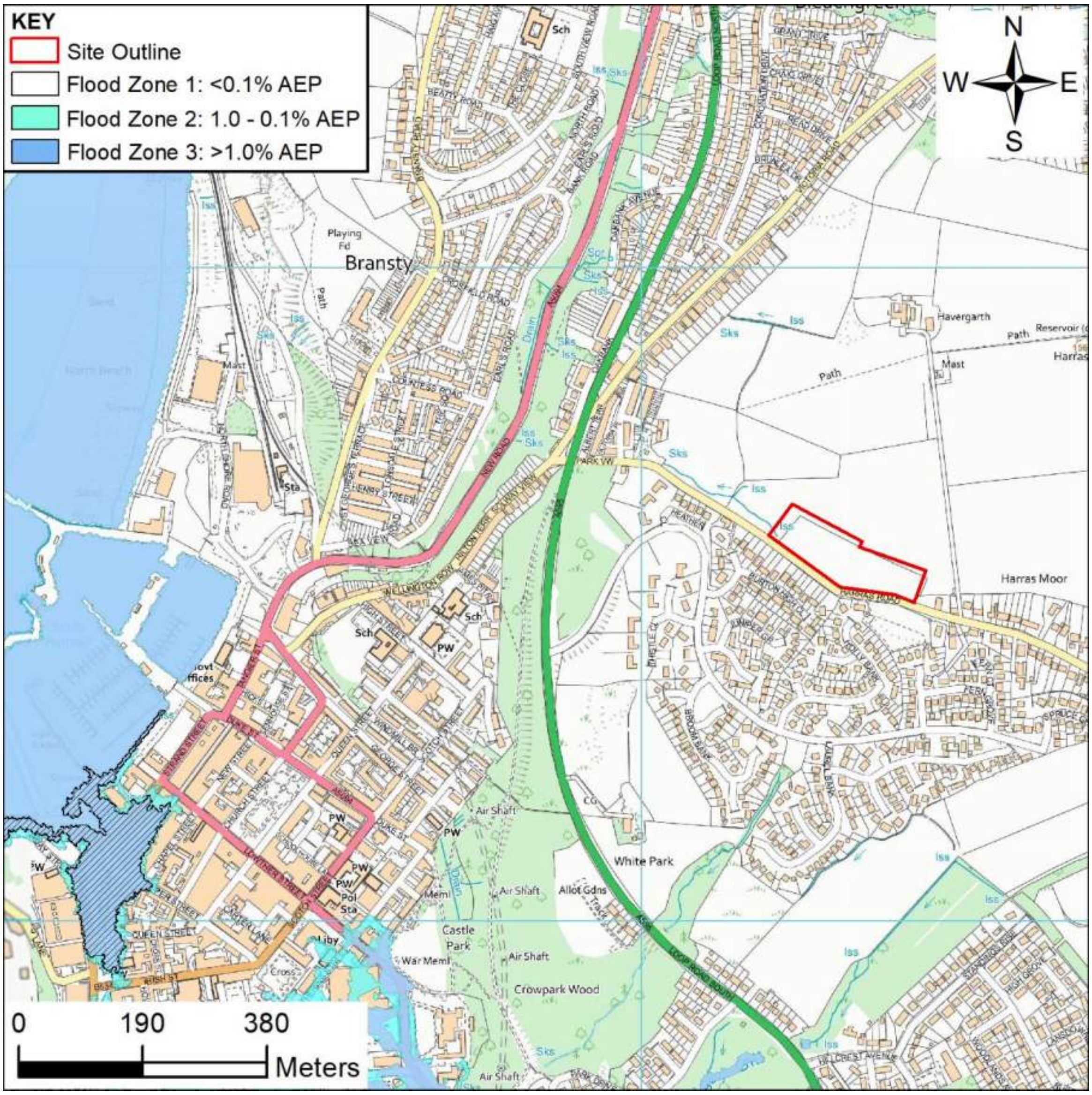

Figure 9.1 Environment Agency Flood Map for Planning

Reference to Figure 9.1 indicates the site lies within Flood Zone 1 “Low Probability”, land assessed as having a less than 0.1% annual probability of flooding (i.e. rivers, lake or sea) in any year by reference to the NPPF and is therefore not considered to be at risk of fluvial flooding.

9.6 SURFACE WATER FLOOD RISK

Surface water flooding is that which results from extreme rainfall rather than overflowing rivers. This type of flooding typically occurs when extreme rainfall causes water to run down slopes and collect in depressions in the landscape or where runoff is focussed into an area where drainage is insufficient. It can also cause erosion resulting in the partial or complete blockage of drains or culverts.

Figure 9.2 shows an extract from the EA Surface Water Flood Risk Map [6]. This has four risk classifications from very low probability (<0.1% AEP) to high probability (>3.3% AEP).
The EA surface water flood map indicates that the entire site area proposed for development is at 'Very Low' risk of surface water flooding with the risk of flooding being less than 0.1% AEP (1 in 1000 year).

This is likely due to the steep sloping topography of the site whereby levels fall consistently towards the western boundary and towards the ordinary watercourse emanating from within the site boundary.

Outside the site boundary an area of 'High Probability' flooding is shown on the line of this unnamed watercourse to the west with 'low' and 'medium' probability areas shown further downstream. There are also some 'Low' and 'Medium' risk areas shown on Harras Road.

These areas of surface water flooding could be partly attributable to run-off from the steep sloping topography of the site and surrounding fields over an area of relatively impervious soil.

As surface water run-off from the site is currently directed towards the watercourse due to the sloping topography, any development resulting in an increase in impermeable areas could cause additional run-off if not properly managed. It is therefore proposed to incorporate sufficient SuDS measures and attenuation storage to mitigate this as part of the overall Drainage Strategy. This is discussed in further detail in Section 10.0.

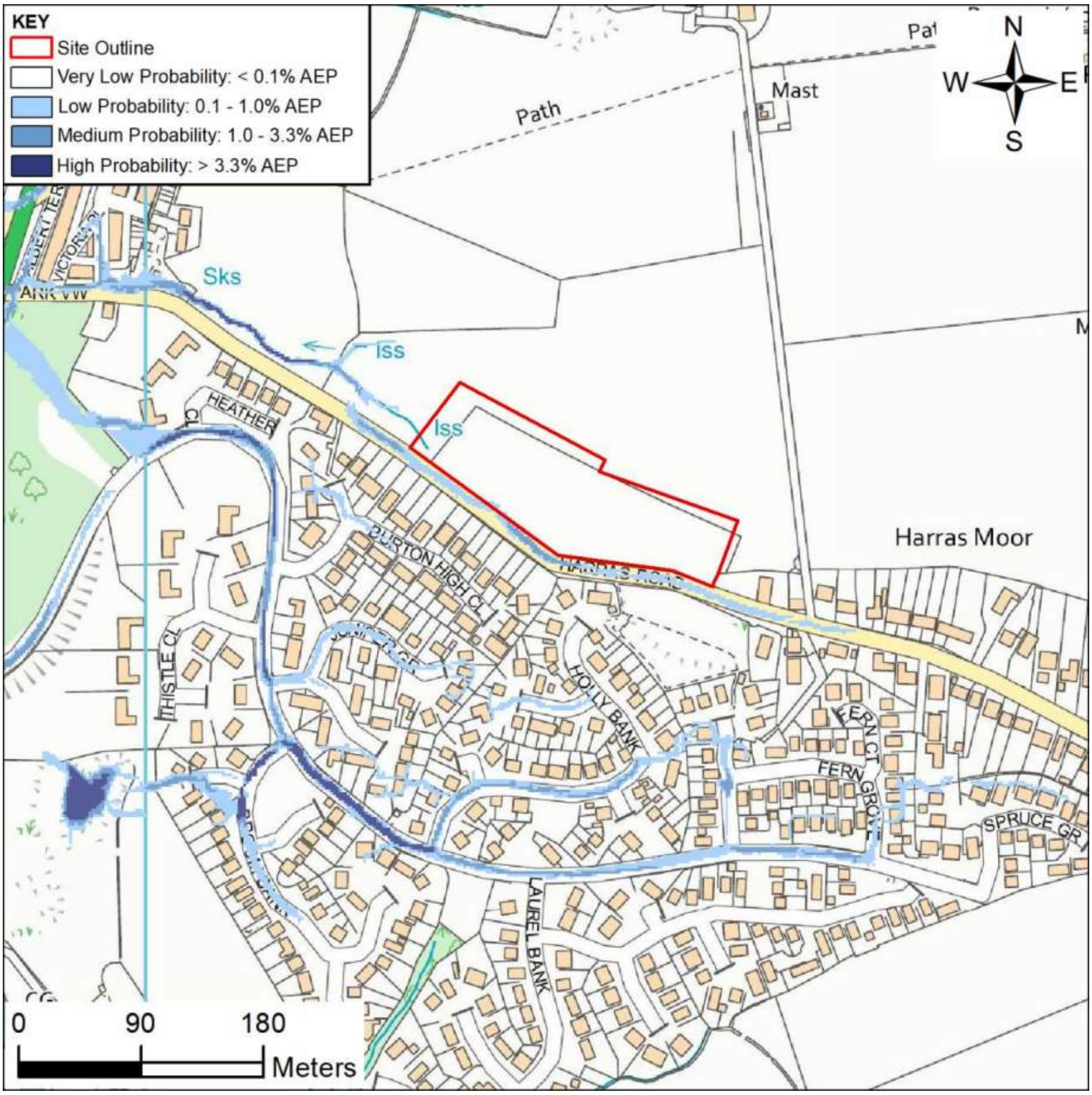

Figure 9.2 Environment Agency Surface Water Flood Map

9.7 GROUNDWATER FLOOD RISK

Groundwater flooding occurs when water levels in the ground rise above the ground surface. It is most likely to occur in low lying areas underlain by permeable drift and rocks.

No significant groundwater ingress was encountered during any of the trial pits conducted as part of the ground investigations (Section 8.6); only slight ingress was noted within 2 of the trial holes at 2.1m and 2.0m respectively, which was thought to be perched groundwater above the clay subsoils.

It is likely that groundwater levels will fluctuate throughout the year but given the steep topography and elevation this site is unlikely to be significantly affected by groundwater flooding.

9.8 FLOODING FROM RESERVOIRS, CANALS OR OTHER ARTIFICIAL SOURCES

The likelihood of reservoir flooding is considered to be much lower than other forms of flooding. Current reservoir regulation, which has been further enhanced by the Flood and Water Management Act, aims to make sure that all reservoirs are properly maintained and monitored to detect and repair any problem.

The Ordnance Survey map indicates that there are no reservoirs, canals or artificial structures in the close proximity of the proposed development site.

9.9 FLOODING FROM SEWERS

United Utilities (UU) do not provide information on flood risk from their assets and there have been no reports within the SFRA in this locality. The existing combined sewer is located in Harras Road at elevations lower than the adjacent site levels and any surcharging of the sewer would result in flood flows following the steep gradient of the highway downhill. It is therefore concluded that the site is not at risk of flooding from these sources.

10. SURFACE WATER DRAINAGE STRATEGY

10.1 INTRODUCTION

The principal aim of the following drainage strategy is to design the development to avoid, reduce and delay the discharge of rainfall to public sewers and watercourses in order to protect watercourses and reduce the risk of localised flooding, pollution and other environmental damage.

In order to satisfy these criteria this surface water runoff assessment and drainage design has been undertaken in accordance with the following reports and guidance documents:

- SuDS Manual, CIRIA Report C753, 2015 [8]
- Code of Practice for Surface Water Management, BS8582:2013, November 2013[9]
- Rainfall Runoff Management for Developments, Defra/EA, SC030219, October 2013[10]
- Designing for Exceedance in Urban Drainage – Good Practice, CIRIA Report C635, 2006[11]
- Flood Estimation Handbook (FEH)[12]
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993[13]
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983[14]
- Flood Estimation for Small Catchments, Marshall & Bayliss, Institute of Hydrology, Report No. 124 (IoH 124), 1994 [15]
- Non-Statutory technical Standards for Sustainable Drainage Systems, Defra, March 2015[16]
- Water UK, Design and Construction Guidance for Foul & Surface Water Sewers March 2020[17]
- Defra, Recommendations to Update Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS), February 2021[18]
- HR Wallingford: Tools for the design and evaluation of Sustainable Drainage Systems (SuDS) [19]

The following assessment and drainage strategy are based on the latest site layout plan. Any alterations to the site plan resulting in changes to impermeable areas will require the drainage strategy to be revisited.

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10.2 SITE AREAS

To support the exploration of options for site drainage, the spatial extent of different types of proposed land cover on the site have been measured. Table 10.1 shows the measured proposed land cover areas. The highest percentage is garden and landscaped areas at 43% of the total site area. Roof areas cover 19%, road area 10% and parking and paved areas 20%.

Table 10.1 Land Cover Areas

Land Cover	Area		Percentage of total site area
	m^2	Ha	
Total Housing Roof Area	2976.9	0.298	19%
Total Parking & Paved Areas	3176.2	0.318	20%
Total Road Area	1638.2	0.164	10%
Garden & Landscaped Areas	6815.7	0.682	43%
Open space	1393.0	0.139	9%

Based on the steeply sloping topography of the existing Greenfield site it can be concluded that the entirety of the site area drains downslope towards the southwestern boundary and into the existing open watercourse located downslope. As such the pre-development Greenfield runoff rates will be calculated based on the total site area with a reduction accounted for by the small area of open space (which is assumed to be permeable and would drain naturally towards the watercourse).

Table 10.2 therefore gives the total area of land cover proposed to be positively drained.

Table 10.2 Area of Positively Drained Land Cover

Land Cover	Area		Percentage of total site area (excluding open space)
	m^2	Ha	
Total Positively Drained Area	14607	1.461	100%

10.3 PRE-DEVELOPMENT GREENFIELD RUNOFF ASSESSMENT

With reference to Table 10.2 the pre-development greenfield runoff assessment has been calculated for an area of 14,607m2.

As the site covers an area of less than 200 ha, (1.6 ha) the Greenfield calculations have been undertaken in accordance with methodology described in IoH 124 [15]. For catchments of less than 50 ha the Greenfield runoff rate is scaled according to the size of the catchment in relation to a 50-hectare site.

Full details of the calculations and the methodology for deriving the Greenfield Runoff Rate are in included in Appendix B. A summary of the results is included in Table 10.3.

Table 10.3 Pre-Development Peak Runoff Rates

Rate of Runoff (l/s)	
Event	Greenfield
Q1	10.3
QBAR	11.8
Q10	16.3
Q30	20.1
Q100	24.6
Q100 + 40% CC	34.4

Without attenuation, the proposed development would significantly increase the rate of Runoff from the developed areas of the site.

To mitigate against the potential increase in runoff, it is proposed to contain and attenuate runoff within the development site before being released at a controlled rate to the existing watercourse, at the pre-development Greenfield QBAR rate of 11.8 l/s.

10.4 SURFACE WATER DRAINAGE DESIGN PARAMETERS

The surface water drainage system has been designed on the following basis using the modified rational method and a generated rainfall profile:

10.4.1 CLIMATE CHANGE

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall are likely to occur over the next few decades in the UK. These future changes will have implications for river flooding and for local flash flooding. These factors will lead to increased and new risks of flooding within the lifetime of planned developments.

Climate change guidance is issued by the Environment Agency and outlines the anticipated changes to extreme rainfall intensity. Table 10.4 shows anticipated changes in extreme rainfall intensity in small and urban catchments. Guidance states that for site-specific flood risk assessments and strategic flood risk assessments, the upper end allowance should be assessed. A climate change allowance of 40% has been selected for the purpose of drainage design based on the 100-year anticipated design life of the proposed development.

Table 10.4 Peak Rainfall Intensity Allowance in Small and Urban Catchments

(use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

10.4.2 URBAN CREEP

BS 8582:2013 [9] outlines best practice with regard to Urban Creep. Although not a statutory requirement, future increase in impermeable area due to extensions and introduction of impervious positively drained areas has been considered. An uplift of 10% on impermeable areas associated with plots only (excluding roads) has been applied to the contributing area.

The inclusion of 10% is highly conservative due to the provision of adequate parking on the site and considering the limited extension potential of the dwellings due to site topography.

10.4.3 PERCENTAGE IMPERMEABILITY (PIMP)

The percentage impermeability (PIMP) for all impermeable areas is modelled as 100%. The entirety of the impermeable areas is to be positively drained.

10.4.4 VOLUMETRIC RUNOFF COEFFICIENT (CV)

The volumetric runoff coefficient describes the volume of rainfall which runs off an impermeable surface following losses due to infiltration, depression storage, initial wetting and evaporation. The coefficient is dimensionless. Default industry standard volumetric runoff coefficients are typically 0.75 for summer and 0.84 for winter. However, for this design a more conservative Cv value of 1.0 has been used for all impermeable areas, as described in Section 10.6.

10.4.5 RAINFALL MODEL

The calculations use the REFH2 unit hydrograph methodology in line with best practice as outlined in the SuDS Manual [8]. The calculations use the most up to date available catchment descriptors (2013) provided by the Centre for Ecology and Hydrology Flood Estimation Handbook web service.

10.5 SURFACE WATER DISPOSAL

Surface water disposal has been considered in line with the hierarchy outlined in the SuDS Manual [8]. The approach considers infiltration drainage in preference to disposal to watercourse, in preference to discharge to sewer.

Cumbria County Council as Lead Local Flood Authority prefer design in accordance with the Cumbria Design Guide which identifies the following hierarchy of techniques to be used:

- **Prevention**: Prevention of runoff by good site design and the reduction of impermeable areas.

- **Source Control**: Dealing with water where and when it falls
- **Site Control**: Management of water in the local area
- **Regional Control**: Management of runoff from sites

10.5.1 INFILTRATION

The infiltration testing returned some favourable results in localised positions across the site that were deemed acceptable for a much smaller scale development (i.e. previous 9no. dwelling planning application). With the increase in scale of the development to 23no. dwellings, subsequent alterations to the site layout resulting in less available open space, combined with the significant variability in infiltration rates across the site (as discussed in Section 8.6) it is considered that disposal of surface water using a full infiltration-based SuDS is no longer a practical or suitable solution for this proposed development.

Furthermore, pre-development consultation with the Flood and Coastal Defence Engineer at Copeland Borough Council has confirmed that an infiltration-based drainage strategy would not be supported for this scale of development at this site and an attenuation-based strategy would be preferred to help mitigate existing flooding issues encountered downstream of the development.

10.5.2 POSITIVE DRAINAGE – WATERCOURSE

It is therefore proposed that the development site will require a positive drainage solution. Runoff will be stored and attenuated to the pre-development Greenfield QBAR rate, with controlled discharge to the existing open watercourse located within the site boundary at the southwest of the site.

10.5.3 CONSIDERATION OF SUDS COMPONENTS

A full range of SuDS components and techniques have been considered for the development of the site and their applicability to the site is discussed below.

- **Green roofs –** Discounted due to cost and limits of water volume retention.
- **Soakaways –** inconclusive infiltration rates, steep topography and limited available space in rule out infiltration as a viable drainage strategy.
- **Water butts –** These are suitable for the site, but their effectiveness would depend on them being empty prior to a period of significant rainfall. This could occur during the summer when occupiers are likely to use the water but unlikely during the autumn and winter Irrelevant for drainage design due to their inability to provide reliable stormwater storage.
- **Permeable paving –** Unsuitable road and driveway gradients and inconsistent soil permeability across the site for permeable block paving solutions to work efficiently.

- **Swales –** Would require large areas within the site that are not available.

- **Filter drains, Infiltration trenches, and basins** – Variable levels of soil permeability across the site rule out a full infiltration as a viable drainage strategy. Inclusion of perforated land drainage pipes is considered suitable as a means to drain gardens and landscaped areas.

- **Detention basins** – This has been explored as an option and discounted. Detention basins would require large areas within the site that are not available. The steeply sloping topography in the open space is not suitable for this type of SuDS structure and would not provide sufficient storage capacity

- **Ponds / wetland –** As explained above.

- **Rain gardens –** discounted due to high capital and maintenance costs. Maintenance cannot practically be enforced.

- **Geocellular attenuation tank systems –** Preferred option for surface water storage due to site restrictions and the requirements to locate storage underneath garden, driveway and road areas. These tanks would be wrapped and sealed with an impermeable geomembrane to provide a water-tight structure. Offsite flows would then be controlled via an HydroBrake flow control device to Greenfield QBAR rate. The required size of the proposed storage structures has been calculated and is detailed in Section 10.6.

10.6 SURFACE WATER DRAINAGE DESIGN

The proposed surface water network serving the entire developable area of the site has been modelled using Causeway Flow (results included in Appendix B). The site layout has been divided into the 3 No. separate sub-catchments as detailed in Table 10.5 with Area A covering Plots 1-8, Area B covering Plots 9-15 and Area C accounting for the remaining Plots 16-23. Within each Area the associated roads, driveways and all other impermeable areas are included.

The drainage design has been sized to store a future 1% AEP event of critical duration without any flooding. Future climate change (40%) and urban creep (10% to housing roof areas only) is accounted for within the calculations.

In line with the latest design guidance a Cv Value of 1.0 has been used for all impermeable areas and a factored contribution (0.3) of the sites pervious areas has been included for conservative design.

In February 2021 DEFRA published a paper listing recommendations to update the non-statutory technical standards for SuDS [18] and in cases such as this where it is proposed that 100% of the development site including green/garden areas will be positively drained, it is recommended that it would be more appropriate to assume 100% runoff from impermeable areas and 30% runoff from pervious surfaces.

The advocated approach cannot be applied using current industry software which is based on the modified rational method and uses a global Cv value. Contributing area from garden and landscaped areas of the site can instead be factored by a value of 0.3, therefore, for conservative design a Cv value of 1.0 has been used and an additional contribution for the pervious areas of the catchment has been included in the model, factored by a value of 0.3. This is the same methodology adopted by HR Wallingford for storage assessment as detailed on their website [19].

This approach therefore results in the modified contributing catchment areas detailed in Table 10.5 being utilised to model the surface water attenuation requirements for this site.

Table 10.5 Modified Contributing Catchment Areas

Site Area	Impermeable Area (+10% urban creep) m^2	Factored Pervious Area Contribution (30%) m^2	Total Contributing Area Modelled	
			m^2	Ha
Area A	2357.8	609.96	2967.8	0.297
Area B	2581.03	640.79	3221.8	0.322
Area C	3110.85	716.45	3827.3	0.382

It is proposed that all roof and driveway areas will drain into shared private geocellular crate attenuation systems, located within private drive areas.

Roof water, driveway and road runoff will connect directly into the surface water pipe network upstream of the crate systems, with inspection chambers utilised to route the new pipework and allow for future inspection and maintenance. Proposed ground and floor levels will be fall consistently both north to south and east to west in order to enable gravity connections to the drainage system.

In addition, all gardens and landscaped areas will benefit from infiltration trenches and perforated pipes to allow these areas to drain effectively towards the nearest attenuation systems. This will mitigate the risk of uncontrolled overland flow from garden to garden as the site falls from east to west.

Silt traps will be located upstream of each attenuation tank, which will provide surface water treatment and access for maintenance. Silt traps isolate silt and other particles by encouraging settlement into sumps, preventing ingress into the tank.

The attenuation tanks will be founded at a suitable level providing a minimum depth of suitable cover. These tanks will be wrapped and sealed with an impermeable membrane to provide a water-tight structure.

Hydrobrake flow control chambers will restrict discharge from each shared geocellular crate system. With the cumulative discharge from the site culminating in a total discharge rate of 11.8l/s from the new plots equalling the pre-development greenfield runoff QBAR rate for the site area.

A storage assessment has been undertaken for the Q100+40% CC storm event and has been designed with sufficient capacity to convey flows without causing flooding, the results are provided in Table 10.6.

Table 10.6 Attenuation Storage Volumes

Site Area	Tank Plan Area (m^2)	Tank Dimensions (m)	Volume to TWL (m^3)	Discharge Rate (l/s)
Area A	182	28 x 6.5 x 1.2	203	3.6
Area B	200	20 x 10 x 1.2	223	3.8
Area C	240	20 x 12 x 1.2	264	4.4
			TOTAL	**11.8**

Note: TWL - Top Water Level for the Q100 + 40%CC event

For further detail refer to the Outline Drainage Layout Plan included in Appendix A.

10.7 EXISITNG RUNOFF FROM UPLAND AREAS

To mitigate the potential risk of overland flow entering the site from upland areas it is proposed to incorporate a land drainage system along the northern and eastern boundaries of the site. The filter drains will intercept and route upland runoff towards the watercourse to replicate the existing natural drainage characteristics of the wider catchment, whilst protecting the new dwellings from inundation.

10.8 OTHER BENEFITS OF DEVELOPMENT

The development site in its current agricultural form as sparse grazing pasture on steeply sloping land, underlain by relatively impermeable soil, provides little in the way of natural flood defence or attenuation to overland flows and stormwater runoff. In all likelihood, the extent and severity of the downstream flooding is probably a direct result of uncontrolled run-off from this site and the surrounding steeply sloping catchment areas. The land in its current form lacks any meaningful biodiversity or amenity value and provides limited benefits to the surrounding community.

The proposed development site will be terraced to tie into the existing topography via the careful application of engineered slopes and retaining walls. Slopes, gardens and open space areas will be carefully landscaped using a variety of plants, shrubs and trees with clean imported granular topsoil, providing a net gain in biodiversity and enhanced storage/protection against overland flows. Retaining walls will be positively drained using heel drains with discharge into the main surface water system. As such the existing hydraulic regime of the site will be modified whereby overland and subsurface flows will be intercepted, attenuated, and re-directed by below ground structures, positive drainage, infiltration trenches and service trenches. Hydraulic gradients and velocities will be reduced, and the risk of downstream flooding would not be increased. Surface emergence of any groundwater on-site will be intercepted by land drainage systems and directed into the various SuDS attenuation systems.

In addition, the proposed below ground volumetric storage and controlled discharge to match QBAR for the development will greatly improve on the existing situation by reducing the rate and volume of water for more extreme storm events i.e. Greenfield Q100 flows are 24.6 l/s in comparison.

10.9 DESIGNING FOR LOCAL DRAINAGE SYSTEM FAILURE

In accordance with the general principles discussed in CIRIA Report C635 – Designing for Exceedance in Urban Drainage [13] the proposed surface water drainage, where practical, should be designed to ensure there is no increased risk of flooding on the site or elsewhere as a result of extreme rainfall, lack of maintenance, blockages or other causes. These measures are discussed below.

Surface Storage & External Levels – where possible driveway/car parking areas will be designed to offer additional surface water storage volume and conveyance of flood water should the SuDS and drainage system fail, flood or exceed capacity. Where appropriate, the kerb lines will be raised to channel surface water runoff back into the drainage system or onto the existing highway.

Drainage Contingency – the sustainable drainage systems have been conservatively designed to attenuate a 100-year design storm including a 40% allowance for climate change, using a Cv value of 1.0 and a factored percentage of all pervious areas. The drainage system will also provide capacity for lower probability (greater design storm events) which are not critical duration.

Building Layout & Detail – the dwellings will be designed and situated to ensure that they are not at risk of flooding from overland flow. The finished floor and threshold levels of the proposed new dwellings will be set above the external levels, and external footpaths will fall away from the dwellings, ensuring that any flood water runs away from, rather than towards the properties.

Blockage and exceedance – In the unlikely case of exceedance or blockage of the geocellular systems, associated silt traps and/or flow control chambers, spills would occur from the lowest access cover around the properties. Exceedance flows shall be retained on site within the drainage system as far as practical and in the case of extreme events site levels will be set to divert any exceedance flows to fall towards and disperse into the more permeable green space areas where they would be contained and intercepted by positive land drainage which will discharge exceedance flows back into the attenuation tanks, once the water level has subsided. A high-level overflow on the flow control chambers should prevent any spills from these manhole covers during exceedance events, however in the unlikely event it was to overtop, exceedance flows would be directed towards the existing highway where they would be contained and intercepted by gullies.

10.10 SURFACE WATER QUALITY

The treatment of surface water is not a statutory requirement. Water quality remains a material consideration but there are no prescriptive standards to be imposed in terms of treatment train management. In the absence of a design standard, the SuDS manual has been used which outlines best practice.

Pollutants such as suspended solids, heavy metals and organic pollutants may be present in surface water runoff, the quantity and composition of the runoff is highly dependent upon site use. For housing developments, the pollutant load is very low.

The SuDS Manual[9] outlines best practice with regards to treatment of surface water by SuDS components prior to discharge to the environment. SuDS components can be effective in reducing the amount of pollutants within the surface water discharged and therefore environmental impact of the development. SuDS components may be installed in series to form a treatment train to treat the runoff.

The simple index approach as outlined in the SuDS manual has been used to assess the pollution hazard indices and proposed treatment components, the calculations are included in Appendix B.

For the three categories of runoff areas served by the drainage system, Roof areas, residential parking and residential roads, treatment is proposed by use of a hydrodynamic vortex separator (or similar device) which removes sediments, oils and floatables from the site stormwater runoff. Tables 10.7 – 10.9 summarise the pollution hazard and mitigation indices for this type of runoff.

Table 10.7 Pollution Hazard & Mitigation Indices - Roof Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	**ADEQUATE**	**ADEQUATE**	**ADEQUATE**

Table 10.8 Pollution Hazard & Mitigation Indices - Residential Parking

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	**ADEQUATE**	**ADEQUATE**	**ADEQUATE**

Table 10.9 Pollution Hazard & Mitigation Indices - Residential Roads

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	**ADEQUATE**	**ADEQUATE**	**ADEQUATE**

10.11 OPERATIONS & MAINTENANCE RESPONSIBILITY

All access roads and below ground drainage is to remain private and will be maintained by a third-party management company established by John Swift Homes.

A SuDS 'Operations & Maintenance Plan' has been prepared by RGP detailing the requirements for future maintenance of the drainage system.

11. FOUL WATER DRAINAGE STRATEGY

It is proposed that foul water from the new dwellings shall be drained via gravity within the site before being discharging to the existing 300mm diameter combined sewer located in Harras Road.

Due to the new development being subdivided into three distinct residential areas with separate shared access roads, it is anticipated each area will require an individual connection to the existing sewer and it is therefore anticipated that 3 No. new connections in total will be required to service the new development.

A pre-development enquiry has been submitted to United Utilities to confirm acceptability of the foul water drainage proposals and their response provides approval in principle for connection to the existing combined sewer in Harras Road. Correspondence is included in Appendix C.

Under Section 106 of The Water Industry Act 1991, 'the owner / occupier of any premises shall be entitled to have his drain or sewer communicate with the public sewer of any sewerage undertaker and thereby to discharge foul water and surface water from those premises or that private sewer.' Unless 'the making of the communication would be prejudicial to the undertaker's sewerage system'.

Preliminary foul water discharge calculations have been undertaken for the new dwellings in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers [17], as shown in Table 11.1 below.

Table 11.1 Peak Foul Flow Rates

Sewerage Sector Design and Construction Guidance Clause B3.1	
Peak Load Based on Number of Dwellings – 23 No. @ 4000 L/day	92,000
Peak Foul Flow Rate from Site (l/s)	1.07

The estimated predicted peak foul flow rate from the new development is 1.07 l/s.

The outline foul water drainage pipe routes are inductively shown on drawing K39108-100, included in Appendix A.

12. CONCLUSIONS AND RECOMMENDATIONS

In consideration of the Flood Risk Assessment and Drainage Strategy for the new development the following conclusions and recommendations are made:

- The site is located in Flood Zone 1 with a predicted annual probability of flooding from rivers or the sea of less than 0.1% AEP (1 in 1000).
- The site is not considered to be at significant risk of flooding from surface water, groundwater, reservoirs, canals, or any artificial structures.
- Ground investigations have shown that the underlying ground conditions across the site have variable levels of permeability and are not deemed suitable for an infiltration-based SuDS solution for a development of this scale. The steep topography is more suited to an interception and attenuation-based surface water drainage strategy.
- It is proposed that surface water drainage shall be positively drainage and attenuated, using 3 no. geocellular tank systems, with individual flow control devices restricting cumulative discharge to the pre-development Greenfield QBAR rate of 11.8 l/s prior to the existing open watercourse located at the southwestern corner of the site development boundary.
- Enhanced treatment of surface water will be provided by a hydrodynamic vortex separator which removes sediments, oils and floatables from the site stormwater runoff.
- In addition to these measures, a SuDS Operations and Maintenance Plan has been prepared by RGP detailing future maintenance requirements of all sustainable drainage systems.
- Foul flows from the site shall discharge by gravity to the existing 300mm diameter public combined sewer located in Harras Road. A pre-development enquiry has provided an agreement in principle for connection from UU.

13. REFERENCES

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APPENDIX A

DRAWINGS

LANDSCAPE ARCHITECT'S SITE PLAN

OUTLINE DRAINAGE LAYOUT

Hardworks

Main Entrance Drive and Communal Drive Areas
Bitmac apron to tie in with existing road surface. Exposed agregate drive surface e.g. SuperColour® Exposed in 'Gravel' or similar to be approved. Reclaimed gritstone sett kerbs, 70mm upstand, joints to be as narrow as possible - no mortar visible.

Private Driveways and Parking Areas
Proposed Tegula by Tobermore in 'Cedar' or 'Slate' sett infill with matching trims/banding, or similar to be approved. Kerbs to match.

Sett Threshold
Bands of reclaimed gritstone setts, laid flush with adjacent surfacing. Mortar joints to be as narrow as possible.

Proposed Paths, Patios and Steps
All to be surfaced with buff, natural stone flags and edged with matching natural stone setts where appropriate. Inset panels of square flags (in same material) within patios laid to add interest. Stepping stones if used in same material.

Proposed Garden Walls
Brick walls and piers with stone copings. Brick to be specified by the architect. Stone cope 75mm depth to match building sills. Piers to be 2 brick courses above wall height. Retaining walls to be 150mm above upper soil level, walls to be fronted with hedging or shrub planting where possible.

Proposed Walls and Piers along Roadside
Red sandstone wall of local vernacular with piers to match, max 2m high, retaining walls to be 150mm above upper soil level

High Timber Fence
1.8m high timber fence to form property divides. Vertical feather edge, close boarded with capping rail. Fence to slope with natural ground gradients - no stepping. Fence to be stained very dark brown. Timber gates to match. Fences to steps down to 1.1m high where possible, e.g.when on top of retaining wall and towards to the rear of rear gardens

Timber Post and Stock Proof Fence
1.1m high round tanalised timber posts with stock proof wire netting.

Softworks

Proposed Trees
Trees selected for seasonal variety, interest and form and tolerant of local conditions, trees to be selected from the palette below. Nearby trees have been viewed to assess which species and varieties are most likely to tolerate the hillside location. All trees to be double staked and of local provenance.
AC - Acer campestre 'Elegant', 16-18cm girth, RB
AP - Acer platanoides, 16-18cm girth, RB
AL - Amelanchier Lamarkii (multi- stem), 2.5m high, CG
BF - Betula 'Fascination', 16-18cm girth, RB
BP - Betula pendula, 16-18cm girth, RB
CP - Crataegus prunifolia, 16-18cm girth, RB
GS - Gleditsia triacanthus 'Sunburst', 16-18cm girth, RB
MF - Malus floribunda, 16-18cm girth, RB
PP - Prunus padus, 16-18cm girth, RB
PS - Pinus sylvestris, 2-2.25m high, RB
QP - Quercus palustris, 20-25cm girth, RB
QR - Quercus robur, 16-18cm girth, RB
SE - Sorbus aria, 16-18cm girth, RB
SA - Sorbus aucuparia, 16-18cm girth, RB

Proposed Hedges
All hedges to be Griselinia littoralis (unless annotated at Native Species Hedge) due to the exposed, coastal location.
1m high, 3 per linear metre planted in a single line. CG

Proposed Low Hedging
Ilex crenata 'Green Glory', 30-40cm high, planted at a rate of 5 per lin metre in a single row, clipped after planting to form an instant hedge.

Proposed Shrub Planting
Range of plants selected for seasonal variety, colour and form. See schedule for typical species, sizes and densities.

Proposed Lawn

P120.00 — Proposed Levels
E121.00 — Existing Levels

Visibility splays

Metres
05 10 15 20 25 30 35 40 50
SCALE 1:500

PLANTING NOTES

This landscaping plan shall be implemented in full accordance with the approved scheme within the first planting season following the occupation of the buildings or completion of the approved development, whichever is the sooner, or in accordance with a programme first agreed in writing with the Local Planning Authority. Any trees, shrubs or hedges planted in accordance with this condition which are removed, die, become severely damaged or become seriously diseased within five years of planting shall be replaced within the next planting season by trees, shrubs or hedging plants of similar size and species to those originally required to be planted.

Do not substitute species, variety and form or reduce the specified size and number of plants without prior agreement. Note sizes shown are minimum.

Topsoil to be premium grade topsoil to BS 3882 (most recent).Topsoil depth to be minimum of 450mm in shrub borders + 150mm in lawned areas.

All planting to be water as required immediately after planting. We advise all evergreen hedges and semi-mature trees are linked to a leaky pipe watering system.

All plants to be free from pests and disease. All plants to be good specimens and characteristic of the species. Do not plant anything in the rain shadow under a roof overhang.

Allow for the preparation of tree pits for new trees. Pits to be adequate in size to take tree rootballs. Pits to be backfilled with 20% clean stone as drainage layer and 80% clean topsoil.

Semi mature and Extra Heavy Standard trees to be secured by underground guying. Selected Standards to be secured with a single timber round stake with appropriate rubber tie. All trees and hedges to be checked periodically to check stakes are sufficient to keep plants and trees upright.

At completion carefully spread PAS100 composted green waste to an even and uniform depth of 50mm to all planted areas, including hedges.

All trees, hedging, shrubs and plants to comply with BS 3936 (most recent) specification for nursery stock.

All site preparation, planting and maintenance to comply with BS 4429 (most recent).

All new trees to be positioned in accordance with requirements of table 2 BS 5837 (most recent)

All new turf to be fine quality from Lindum or equivalent and laid in accordance with BS 3969 (most recent).

Ongoing management of the site

LEAF COLLECTION IN YEAR 1 AND 2
It will be important to ensure that the bulk of leaf litter is collected during the first two Autumn periods after ground flora establishment as the grass will not be strong enough to resist the smothering effect of leaf cover.

WATERING AND MAINTENANCE
All the newly planted stock shall be watered during dry spells.

GRASS CARE
Grass shall be treated with 2 no spring and summer feeds and one autumn feed.

TREE INSPECTIONS
The trees should be inspected for disease and decay by a qualified arboriculturalist every 5 years.

Schedule of Typical Shrub Species: Plant in single species groups of 2,3 and 5

Shrub Species	Code	Size in cm	C Size	Density/Spacing
Azalea deciduous	AZA DEC	40-60	C10	2No per m²
Azalea japonica	AZA JAP	30-40	C10	3No per m²
Choisya 1ernate 'Sundance'	CHO SUN	40-60	C10	3No per m²
Cornus 'Elegantissima'	COR ELE	80-100	C10	2No per m²
Euonymus 'Silver Queen'	EUO SIL	30-40	C10	3No per m²
Hebe 'Marjorie'	HEB MAR	40-60	C10	3No per m²
Hydrangea macrophylla 'Lanarth White'	HYD WHI	60-80	C10	2No per m²
Lavandula 'Hidcote'	LAV HID	30-40	C10	3No per m²
Lonicera pileata 'May Green'	LON MAY	40-60	C10	3No per m²
Phlomis fruticosa	PHL FRU	40-60	C10	3No per m²
Photinia 'Red Robin'	PHO RED	40-60	C10	2No per m²
Rhododendron 'Yakushimanum'	RHO HYB	40-60	C10	3No per m²
Skimmia japonica rubella	SKI RUB	40-60	C10	3No per m²
Skimmia reevesiana 'Ruby King'	SKI REV	40-60	C10	3No per m²
Skimmia x confuse 'Kew Green	SKI KEW	40-60	C10	3No per m²
Skimmia japonica 'Goldflame'	SKI GOL	40-60	C10	3No per m²
Viburnum davidii	VIB DAV	40-60	C10	3No per m²

Specimen Shrub Species	Code	Size in cm	C Size	Density/Spacing
Choisya ternata	Ct	40-50	C10	1No per m²
Cotinus 'Royal Purple'	Cr	100-125	C10	1No per m²
Hydrangea 'White Wave'	Hw	40-50	C10	1No per m²
Magnolia stellata	Ms	125-150	C20	1No per m²
Photinia 'Red Robin'	Pr	125-150	C20	1No per m²
Pieris 'Forest Flame'	Pf	40-50	C10	1No per m²
Prunus lusitanica	Pl	100-125	C10	1No per m²
Viburnum tinus	Vt	100-125	C35	1No per m²

Herbaceous Species	Code		C Size	Density/Spacing
Acorus gramineus 'Ogon'	ACO OGO		C5	5No per m²
Euphorbia wulfenii	EUP WUL		C5	5No per m²
Euphorbia robbiae	EUP ROB		C5	5No per m²
Geranium 'Johnson's Blue'	GER JOH		C5	5No per m²
Hesperis matronalis	HES MAT		C5	5No per m²
Heuchera Marmalade'	HEU PAL		C5	5No per m²
Iris ensata 'Variegata'	IRI VAR		C5	5No per m²
Nepeta 'Six Hills Giant'	NEP SIX		C5	5No per m²
Persicaria affinis	PER AFF		C5	5No per m²
Saxifraga x urbium	SAX URB		C5	5No per m²
Climbers	**Code**	**Size in cm**	**C Size**	**Density/Spacing**
Cotoneaster horizontalis	COT HOR	60-80	C10	1m centres
Hedera hibernica	HED HIB	60-80	C5	4No per m²
Hydrangea petiolaris	HYD PET	60-80	C5	
Parthenocissus tricuspidata	PAR TRI	80-100	C5	
Ground Cover	**Code**	**Size in cm**	**C Size**	**Density/Spacing**
Hedera hibernica	HED HIB	60-80	C5	4No per m²
Hypericum x moserianum	HYP MOS		C5	4No per m²

Shrub Species to be Planted against Walls and Fences (no windows): Plant in single species groups of no less than 2, 3, 5No.

Shrub Species	Code	Size in cm	Size	Density/Spacing
Cotoneaster horizontalis	COT HOR	60-80	10L	3/m2
Eleagnus ebbingei 'Limelight'	ELE EBB	60-80	10L	3/m2
Euonymus 'Emerald and Gold'	EUO GOL	30-40	10L	3/m2
Hydrangea macrophyllum 'Blue Wave'	HYD BLU	60-80	10L	2/m2
Hydrangea macrophyllum 'Lanarth White'	HYD WHI	60-80	10L	2/m2
Euonymus 'Silver Queen'	EUO SIL	30-40	10L	3/m2
Euonymus japonicas 'Aureomarginatus'	EUO AUR	60-80	10L	3/m2
Griselinia littorais	GRI LIT	60-80	10L	3/m2
Ilex aquifoliu	ILE AQU	60-80	10L	3/m2
Photinia 'Red Robin'	PHO RED	60-80	10L	3/m2
Pyracantha 'Orange Glow'	PYR ORA	80-100	10L	3/m2
Viburnum tinus 'Eve Price'	VIB EVE	40-60	10L	3/m2

Communal Areas Shrub Mix: Plant in single species groups of 3, 5 and 7

Shrub Species	Code	Size in cm	C Size	Density/Spacing
Amelanchier lamarckii	AME CAN	80-100	10L	1/m2
Aucuba japonica	AUC JAP	40-60	10L	1/m2
Cornus alba 'Elegantissima'	COR ELE	80-100	10L	1/m2
Cornus sericea 'Flaviramea'	COR SER	80-100	10L	1/m2
Cotinus coggygria	COT COG	40-60	10L	1/m2
Elaeagnus ebbingei 'Limelight'	ELE EBB	60-80	10L	1/m2
Griselinia littoralis	GRI LIT	60-80	10L	1/m2
Hydrangea 'Annabelle'	HYD ANA	60-80	10L	1/m2
Hydrangea Paniculata 'Vanille Fraise'	HYD PAN	60-80	10L	1/m2
Hypericum Hidcote	HYP HID	60-80	10L	3/m2
Ligustrum ovalifolium 'Aureum'	LIG AUR	60-80	10L	1/m2
Philadelphus 'Belle Etoile'	PHI BEL	60-80	10L	1/m2
Photinia 'Red Robin'	PHO RED	60-80	10L	1/m2
Prunus laurocerasus 'Rotundifolia'	PRU LAU	100-125	10L	1/m2
Prunus lusitanica	PRU LUS	60-80	10L	1/m2
Viburnum plicatum 'Mariesii'	VIB PLI	60-80	10L	1/m2
Viburnum tinus	VIB TIN	40-60	10L	1/m2
Viburnum x carlcephalum	VIB CAR	60-80	10L	1/m2

Evergreen Shrub Mix to be Planted on Sloped Ground: Plant in single species groups of no less than 5No.

Shrub Species	Code	Size in cm	Size	Density/Spacing
Azalea Japonica	AZA JAP	30-40	7.5L	3/m2
Azalea mollis	AZA MOL	40-50	10L	1/m2
Camellia japonica in variety	CAM JAP	40-50	10L	1/m2
Eucryphia glutinosa	EUC GLU	30-40	7.5L	3/m2
Ilex aquifolium	ILE AQU	60-80	10L	3/m2
Pieris japonica	PIE JAP	40-50	10L	1/m2
RIbes sanguineum	RIB SAN	30-40	7.5L	3/m2
Rhododendron hybrids	RHO HYB	60-80	10L	1/m2
Viburnum tinus 'Eve price'	VIB EVE	40-60	10L	3/m2

Rev V04: Semi-detached house type included, plots re-numbered. (01.02.22) RC
Rev V03: Minor amends to boundary treatments (06.01.21) RC
Rev V02: Boundary treatment adjacent to Plot 7 moved back to wholly outside the visibility splay (04.01.22) RC

north

DWG NO. M3450-PA-01-V04
DWG TITLE. LANDSCAPE LAYOUT
CLIENT. JOHN SWIFT HOMES
PROJECT TITLE. LAND TO THE NORTH OF HARRAS ROAD, WHITEHAVEN
WORK STAGE. PLANNING
SCALE. 1:500@A1
DATE. 12.2021
DRAWN BY. RC
CHECKED BY. RC

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Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: First Issue

Do not scale from this drawing

Client: John Swift Homes

Project: Harras Road, Whitehaven

Drawing Title: Outline Drainage

Scale @ A1: 1:500	First Issue: 21/02/2022	Office of Origin: Kendal
Drawn by: CA	Checked by: TM	Approved: TM
Project No: K39108	Drawing No: 100	Rev:
BIM No:		

APPENDIX B

CALCULATIONS

PRE-DEVELOPMENT RUNOFF

CAUSEWAY FLOW MODEL

SURFACE WATER TREATMENT

R G PARKINS 97 King Street | Lancaster | LA1 1RH Tel:01524 32548 Email: office@rgparkinslancaster.co.uk	**Greenfield Runoff Estimation**	Job Number K39108	Page Number
		Calc by CA	Check by RH
	Harras Road Whitehaven	Date 08/02/2022	Revised

DESIGN BASIS MEMORANDUM - PEAK RATE OF RUN-OFF CALCULATION

Design Brief

The following peak rate of run-off calculations have been undertaken to determine changes in peak flow resulting from the development of a greenfield or brownfield site. These calculations are for the **Peak Rate of Run-Off** requirements only.

Background Information & References

The site area **is less than** 200ha and the Greenfield (pre-development) calculation has been undertaken in accordance with methodology described by Marshall & Bayliss, Institute of Hydrology, Report No. 124, Flood Estimation for Small Catchments, 1994 (IoH 124).

In addition, the following references have been used in the preparation of these calculations:

- Interim Code of Practice for Sustainable Drainage Systems (SUDS), CIRIA, 2004
- CIRIA, The SUDS Manual, Report C753, 2015
- Designing for Exceedance in Urban Drainage - good practice, CIRIA Report C635, 2006
- Flood Estimation Handbook (FEH)
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993
- Flood Studies Supplementary Report No 2 (FSSR2), The Estimation of Low Return Period Floods
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983
- Planning Practice guidance of the National Planning Policy Framework, Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Results Summary

Rate of Run-Off (l/s)			
Event	**Greenfield**	[redacted]	**Post-Development**
Q1	10.3		10.3
QBAR	11.8		11.8
Q10	16.3		11.8
Q30	20.1		11.8
Q100	24.6		11.8
Q100 + 40% CC	34.4		11.8

SITE AREAS (LAND COVER AREAS)

Existing Impermeable & Permeable Land Cover

Total Site Area: **1.6** ha **16000** m²

Existing Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	0.0	0.000	0%
Remaining permeable area	16000.0	1.600	100%

Proposed Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	ha	
Total housing roof area	2976.9	0.298	19%
Total parking and paved area	3176.2	0.318	20%
Total road area	1638.2	0.164	10%
Garden & landscaped areas	6815.7	0.682	43%
Public open space	1393.0	0.139	9%

Proposed Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	7791.3	0.779	49%
Remaining permeable area	8208.7	0.821	51%

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ESTIMATION OF QBAR (RURAL) (GREENFIELD RUNOFF RATE)

IoH 124 based on research on small catchments < 25 km2

Method is based on regression analysis of response times
using catchments from 0.9 to 22.9 km^2

$QBAR_{rural}$ is mean annual flood on rural catchment
$QBAR_{rural}$ depends on SOIL, SAAR and AREA most significantly

$QBAR_{rural}$ = $\boxed{0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}}$

For SOIL refer to FSR Vol 1, Section 4.2.3 and 4.2.6 and IoH 124

Contributing watershed area

Area, A	=	500000	m^2	insert 50 ha for EA
	=	0.500	km^2	small catchment method
	=	50.000	ha	
SAAR	=	**1088**	mm	From FEH Web Service (point data)

Soil index based on soil type, SOIL = $\dfrac{(0.1S1+0.3S2+0.37S3+0.47S4+0.53S5)}{(S1+S2+S3+S4+S5)}$

Where:	S1	=		%
	S2	=		%
	S3	=		%
	S4	=	**100**	%
	S5	=		%
			100	%
So,	SOIL	=	**0.47**	

UK Suds website provides a value of 4 based on the equivalent Host value. This seems reasonable based on ground investigation.

Note: for very small catchments it is far better to rely on local site investigation information.

$QBAR_{rural}$	=	0.404	m^3/s
	=	404.4	l/s

Small rural catchments less than 50 ha
The Environment Agency recommends that this method should be used for development sizes from
0 to 50 ha and should linearly interpolate the formula to 50 ha.

So, catchment size	=	**14607**	m^2	Excluding significant open space which would remain disconnected from the positive drainage system during flood events.
	=	0.015	km^2	
	=	1.461	ha	
$QBAR_{rural\ site}$	=	0.01181	m^3/s	
	=	**11.81**	l/s	

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
MH1	0.297	5.00	122.750	1200	298358.340	518537.967	3.250
TIA			122.750		298357.401	518535.150	4.347
TOA		5.00	121.000		298348.535	518508.558	2.600
MH2			120.600	1500	298347.651	518505.691	2.251
MH6	0.322	5.00	117.000	1200	298316.922	518538.390	2.700
TIB			116.750		298315.593	518535.702	3.548
TOB		5.00	115.320		298307.013	518517.557	2.120
MH7			115.170	1500	298305.366	518515.014	2.020
MH3			115.000	1200	298304.472	518513.111	2.000
MH4			106.940	1200	298239.764	518557.760	2.115
MH5			104.100	1500	298209.779	518578.772	1.300
OUTFALL 1			103.500		298209.267	518587.520	1.000
MH8	0.382	5.00	108.400	1200	298252.373	518584.050	2.100
TIC			108.200		298250.759	518581.520	3.098
TOC		5.00	107.200		298242.950	518562.772	2.100
MH9			107.000	1500	298241.375	518560.291	2.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	MH1	TIA	2.969	0.600	119.500	119.350	0.150	19.8	225	5.02	50.0
1.001	TOA	MH2	3.000	0.600	118.400	118.349	0.051	58.8	150	5.04	50.0
1.002	MH2	MH3	43.812	0.600	118.349	113.000	5.349	8.2	150	5.24	50.0
2.000	MH6	TIB	2.999	0.600	114.300	114.150	0.150	20.0	225	5.02	50.0
2.001	TOB	MH7	3.030	0.600	113.200	113.150	0.050	60.6	150	5.04	50.0
2.002	MH7	MH3	2.103	0.600	113.150	113.000	0.150	14.0	150	5.05	50.0
1.003	MH3	MH4	78.617	0.600	113.000	104.900	8.100	9.7	150	5.65	50.0
1.004	MH4	MH5	36.614	0.600	104.825	102.800	2.025	18.1	225	5.84	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	2.954	117.5	75.1	3.025	3.175	0.297	0.0	131	3.131
1.001	1.314	23.2	0.0	2.450	2.101	0.000	0.0	0	0.000
1.002	3.542	62.6	0.0	2.101	1.850	0.000	0.0	0	0.000
2.000	2.939	116.9	81.5	2.475	2.375	0.322	0.0	138	3.168
2.001	1.294	22.9	0.0	1.970	1.870	0.000	0.0	0	0.000
2.002	2.705	47.8	0.0	1.870	1.850	0.000	0.0	0	0.000
1.003	3.253	57.5	0.0	1.850	1.890	0.000	0.0	0	0.000
1.004	3.091	122.9	0.0	1.890	1.075	0.000	0.0	0	0.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.005	MH5	OUTFALL 1	8.763	0.600	102.800	102.500	0.300	29.2	225	5.90	50.0
3.000	MH8	TIC	3.001	0.600	106.300	106.000	0.300	10.0	225	5.01	50.0
3.001	TOC	MH9	2.939	0.600	105.100	105.000	0.100	29.4	150	5.03	50.0
3.002	MH9	MH4	3.000	0.600	105.000	104.900	0.100	30.0	150	5.05	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.005	2.429	96.6	0.0	1.075	0.775	0.000	0.0	0	0.000
3.000	4.161	165.4	96.6	1.875	1.975	0.382	0.0	123	4.314
3.001	1.864	32.9	0.0	1.950	1.850	0.000	0.0	0	0.000
3.002	1.844	32.6	0.0	1.850	1.890	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	2.969	19.8	225	Circular	122.750	119.500	3.025	122.750	119.350	3.175
1.001	3.000	58.8	150	Circular	121.000	118.400	2.450	120.600	118.349	2.101
1.002	43.812	8.2	150	Circular	120.600	118.349	2.101	115.000	113.000	1.850
2.000	2.999	20.0	225	Circular	117.000	114.300	2.475	116.750	114.150	2.375
2.001	3.030	60.6	150	Circular	115.320	113.200	1.970	115.170	113.150	1.870
2.002	2.103	14.0	150	Circular	115.170	113.150	1.870	115.000	113.000	1.850
1.003	78.617	9.7	150	Circular	115.000	113.000	1.850	106.940	104.900	1.890
1.004	36.614	18.1	225	Circular	106.940	104.825	1.890	104.100	102.800	1.075
1.005	8.763	29.2	225	Circular	104.100	102.800	1.075	103.500	102.500	0.775
3.000	3.001	10.0	225	Circular	108.400	106.300	1.875	108.200	106.000	1.975
3.001	2.939	29.4	150	Circular	107.200	105.100	1.950	107.000	105.000	1.850
3.002	3.000	30.0	150	Circular	107.000	105.000	1.850	106.940	104.900	1.890

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	MH1	1200	Manhole	Adoptable	TIA		Junction	
1.001	TOA		Junction		MH2	1500	Manhole	Adoptable
1.002	MH2	1500	Manhole	Adoptable	MH3	1200	Manhole	Adoptable
2.000	MH6	1200	Manhole	Adoptable	TIB		Junction	
2.001	TOB		Junction		MH7	1500	Manhole	Adoptable
2.002	MH7	1500	Manhole	Adoptable	MH3	1200	Manhole	Adoptable
1.003	MH3	1200	Manhole	Adoptable	MH4	1200	Manhole	Adoptable
1.004	MH4	1200	Manhole	Adoptable	MH5	1500	Manhole	Adoptable
1.005	MH5	1500	Manhole	Adoptable	OUTFALL 1		Junction	
3.000	MH8	1200	Manhole	Adoptable	TIC		Junction	
3.001	TOC		Junction		MH9	1500	Manhole	Adoptable
3.002	MH9	1500	Manhole	Adoptable	MH4	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
MH1	298358.340	518537.967	122.750	3.250	1200	0	1.000	119.500	225
TIA	298357.401	518535.150	122.750	4.347		1	1.000	119.350	225
TOA	298348.535	518508.558	121.000	2.600		0	1.001	118.400	150
MH2	298347.651	518505.691	120.600	2.251	1500	1	1.001	118.349	150
						0	1.002	118.349	150
MH6	298316.922	518538.390	117.000	2.700	1200	0	2.000	114.300	225
TIB	298315.593	518535.702	116.750	3.548		1	2.000	114.150	225
TOB	298307.013	518517.557	115.320	2.120		0	2.001	113.200	150
MH7	298305.366	518515.014	115.170	2.020	1500	1	2.001	113.150	150
						0	2.002	113.150	150
MH3	298304.472	518513.111	115.000	2.000	1200	1	2.002	113.000	150
						2	1.002	113.000	150
						0	1.003	113.000	150
MH4	298239.764	518557.760	106.940	2.115	1200	1	3.002	104.900	150
						2	1.003	104.900	150
						0	1.004	104.825	225
MH5	298209.779	518578.772	104.100	1.300	1500	1	1.004	102.800	225
						0	1.005	102.800	225
OUTFALL 1	298209.267	518587.520	103.500	1.000		1	1.005	102.500	225
MH8	298252.373	518584.050	108.400	2.100	1200	0	3.000	106.300	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
TIC	298250.759	518581.520	108.200	3.098		1	3.000	106.000	225
TOC	298242.950	518562.772	107.200	2.100		0	3.001	105.100	150
MH9	298241.375	518560.291	107.000	2.000	1500	1	3.001	105.000	150
						0	3.002	105.000	150

Node MH2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	118.349	Product Number	CTL-SHE-0087-3600-1225-3600
Design Depth (m)	1.225	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.6	Min Node Diameter (mm)	1200

Node MH7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	113.150	Product Number	CTL-SHE-0089-3800-1222-3800
Design Depth (m)	1.222	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	3.8	Min Node Diameter (mm)	1200

Node MH9 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	105.000	Product Number	CTL-SHE-0096-4400-1258-4400
Design Depth (m)	1.258	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.4	Min Node Diameter (mm)	1200

Node TOA Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Main Channel Length (m)	28.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	118.400	Main Channel Slope (1:X)	10000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.020

Inlets

TIA

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	182.0	0.0	1.200	182.0	0.0	1.201	0.0	0.0

Node TOB Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Main Channel Length (m)	20.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	113.200	Main Channel Slope (1:X)	10000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.020

Inlets
TIB

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	200.0	0.0	1.200	200.0	0.0	1.201	0.0	0.0

Node TOC Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Main Channel Length (m)	20.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	105.100	Main Channel Slope (1:X)	10000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.020

Inlets
TIC

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	240.0	0.0	1.200	240.0	0.0	1.201	0.0	0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.33%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
15 minute winter	MH1	10	119.703	0.203	101.2	0.6013	0.0000	OK
240 minute winter	TIA	232	118.932	0.529	23.5	0.0000	0.0000	OK
240 minute winter	TOA	232	118.932	0.532	13.7	0.0000	0.0000	SURCHARGED
240 minute winter	MH2	232	118.930	0.581	7.3	1.0272	0.0000	SURCHARGED
15 minute winter	MH6	10	114.544	0.244	109.7	0.8563	0.0000	SURCHARGED
240 minute winter	TIB	232	113.732	0.530	25.5	0.0000	0.0000	OK
240 minute winter	TOB	232	113.732	0.532	14.7	0.0000	0.0000	SURCHARGED
240 minute winter	MH7	232	113.730	0.580	7.0	1.0254	0.0000	SURCHARGED
30 minute winter	MH3	47	113.037	0.037	7.4	0.0415	0.0000	OK
1440 minute winter	MH4	870	104.872	0.047	11.8	0.0531	0.0000	OK
1440 minute winter	MH5	870	102.855	0.055	11.8	0.0967	0.0000	OK
1440 minute winter	OUTFALL 1	870	102.553	0.053	11.8	0.0000	0.0000	OK
15 minute winter	MH8	10	106.494	0.194	130.2	0.9269	0.0000	OK
240 minute winter	TIC	232	105.625	0.523	30.2	0.0000	0.0000	OK
240 minute winter	TOC	232	105.625	0.525	17.4	0.0000	0.0000	SURCHARGED
240 minute winter	MH9	232	105.623	0.623	7.9	1.1000	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)
15 minute winter	MH1	1.000	TIA	100.4	2.934	0.855	0.1005
240 minute winter	TIA	Flow through pond	TOA	13.7	0.043	0.007	91.7122
240 minute winter	TOA	1.001	MH2	7.3	0.610	0.315	0.0528
240 minute winter	MH2	Hydro-Brake®	MH3	3.6			
15 minute winter	MH6	2.000	TIB	106.2	2.917	0.908	0.1069
240 minute winter	TIB	Flow through pond	TOB	14.7	0.035	0.004	100.9334
240 minute winter	TOB	2.001	MH7	7.0	0.572	0.306	0.0533
240 minute winter	MH7	Hydro-Brake®	MH3	3.8			
30 minute winter	MH3	1.003	MH4	7.4	2.236	0.129	0.2604
1440 minute winter	MH4	1.004	MH5	11.8	1.762	0.096	0.2458
1440 minute winter	MH5	1.005	OUTFALL 1	11.8	1.624	0.122	0.0637
15 minute winter	MH8	3.000	TIC	129.1	3.980	0.780	0.0964
240 minute winter	TIC	Flow through pond	TOC	17.4	0.035	0.004	119.4883
240 minute winter	TOC	3.001	MH9	7.9	0.578	0.239	0.0517
240 minute winter	MH9	Hydro-Brake®	MH4	4.4			

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.33%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	MH1	10	119.907	0.407	132.4	1.2030	0.0000	SURCHARGED
360 minute winter	TIA	344	119.168	0.765	22.8	0.0000	0.0000	OK
360 minute winter	TOA	344	119.168	0.768	13.3	0.0000	0.0000	SURCHARGED
360 minute winter	MH2	344	119.167	0.818	4.3	1.4454	0.0000	SURCHARGED
15 minute winter	MH6	10	114.766	0.466	143.5	1.6394	0.0000	SURCHARGED
360 minute winter	TIB	344	113.968	0.766	24.7	0.0000	0.0000	OK
360 minute winter	TOB	344	113.968	0.768	14.3	0.0000	0.0000	SURCHARGED
360 minute winter	MH7	344	113.967	0.817	4.3	1.4428	0.0000	SURCHARGED
15 minute winter	MH3	23	113.037	0.037	7.4	0.0415	0.0000	OK
960 minute summer	MH4	510	104.872	0.047	11.8	0.0531	0.0000	OK
1440 minute winter	MH5	750	102.855	0.055	11.8	0.0967	0.0000	OK
1440 minute winter	OUTFALL 1	750	102.553	0.053	11.8	0.0000	0.0000	OK
15 minute winter	MH8	10	106.712	0.412	170.2	1.9635	0.0000	SURCHARGED
360 minute winter	TIC	344	105.857	0.755	29.3	0.0000	0.0000	OK
360 minute winter	TOC	344	105.857	0.757	16.9	0.0000	0.0000	SURCHARGED
360 minute winter	MH9	344	105.855	0.855	9.8	1.5101	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
15 minute winter	MH1	1.000	TIA	130.2	3.273	1.108	0.1181
360 minute winter	TIA	Flow through pond	TOA	13.3	0.039	0.007	132.5534
360 minute winter	TOA	1.001	MH2	4.3	0.561	0.186	0.0528
360 minute winter	MH2	Hydro-Brake®	MH3	3.6			
15 minute winter	MH6	2.000	TIB	140.7	3.538	1.204	0.1193
360 minute winter	TIB	Flow through pond	TOB	14.3	0.024	0.004	145.7306
360 minute winter	TOB	2.001	MH7	4.3	0.560	0.190	0.0533
360 minute winter	MH7	Hydro-Brake®	MH3	3.8			
15 minute winter	MH3	1.003	MH4	7.4	2.236	0.129	0.2604
960 minute summer	MH4	1.004	MH5	11.8	1.762	0.096	0.2458
1440 minute winter	MH5	1.005	OUTFALL 1	11.8	1.624	0.122	0.0637
15 minute winter	MH8	3.000	TIC	166.5	4.192	1.006	0.1142
360 minute winter	TIC	Flow through pond	TOC	16.9	0.024	0.004	172.2986
360 minute winter	TOC	3.001	MH9	9.8	0.652	0.296	0.0517
360 minute winter	MH9	Hydro-Brake®	MH4	4.4			

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.33%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
15 minute winter	MH1	10	120.230	0.730	185.5	2.1606	0.0000	SURCHARGED
480 minute winter	TIA	456	119.576	1.173	25.7	0.0000	0.0000	OK
480 minute winter	TOA	456	119.577	1.176	14.6	0.0000	0.0000	SURCHARGED
480 minute winter	MH2	456	119.576	1.227	5.8	2.1683	0.0000	SURCHARGED
15 minute winter	MH6	10	115.139	0.839	201.1	2.9490	0.0000	SURCHARGED
480 minute winter	TIB	464	114.374	1.172	27.9	0.0000	0.0000	OK
480 minute winter	TOB	464	114.374	1.173	15.8	0.0000	0.0000	SURCHARGED
480 minute winter	MH7	464	114.372	1.222	7.3	2.1590	0.0000	SURCHARGED
15 minute summer	MH3	37	113.037	0.037	7.4	0.0415	0.0000	OK
480 minute winter	MH4	464	104.872	0.047	11.8	0.0531	0.0000	OK
480 minute winter	MH5	464	102.855	0.055	11.8	0.0967	0.0000	OK
480 minute winter	OUTFALL 1	464	102.553	0.053	11.8	0.0000	0.0000	OK
15 minute winter	MH8	11	107.278	0.978	238.6	4.6651	0.0000	SURCHARGED
480 minute winter	TIC	464	106.263	1.161	33.1	0.0000	0.0000	OK
480 minute winter	TOC	464	106.263	1.163	18.7	0.0000	0.0000	SURCHARGED
480 minute winter	MH9	464	106.260	1.260	11.3	2.2267	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)
15 minute winter	MH1	1.000	TIA	181.6	4.566	1.546	0.1181
480 minute winter	TIA	Flow through pond	TOA	14.6	0.039	0.008	203.0666
480 minute winter	TOA	1.001	MH2	5.8	0.558	0.250	0.0528
480 minute winter	MH2	Hydro-Brake®	MH3	3.6			
15 minute winter	MH6	2.000	TIB	195.3	4.910	1.671	0.1181
480 minute winter	TIB	Flow through pond	TOB	15.8	0.026	0.005	222.7948
480 minute winter	TOB	2.001	MH7	7.3	0.582	0.320	0.0533
480 minute winter	MH7	Hydro-Brake®	MH3	3.8			
15 minute summer	MH3	1.003	MH4	7.4	2.236	0.129	0.2604
480 minute winter	MH4	1.004	MH5	11.8	1.762	0.096	0.2459
480 minute winter	MH5	1.005	OUTFALL 1	11.8	1.625	0.122	0.0637
15 minute winter	MH8	3.000	TIC	229.2	5.764	1.386	0.1193
480 minute winter	TIC	Flow through pond	TOC	18.7	0.027	0.004	264.9697
480 minute winter	TOC	3.001	MH9	11.3	0.725	0.344	0.0517
480 minute winter	MH9	Hydro-Brake®	MH4	4.4			

DESIGN BASIS MEMORANDUM - SUSTAINABLE DRAINAGE TREATMENT OF SURFACE WATER

Design Brief

The following calculations outline the recommended treatment requirements for a sustaionable drainage system as outlined in the SuDS Manual 2015. The method used is the simple index approach outlined in section 26. The requirement for oil interceptors has been assessed in line with the now withdrawn Pollution Prevention Guidance document PPG3, produced by the Environment Agency. An oil interceptor is not required for the proposed development.

Treatment within SuDS components is affected by the flow rate and volume of water which passes through the component. It is not reasonable or practical to treat the entirety of the runoff for infrequent greater intensity design storms. In any case the majority of the pollutants are removed from surfaces by the more frequent rainfall events and in the first flush resulting from the initial runoff from the larger events.
and to a certain capacity.

The following references have been used in the preparation of these calculations:

- SUDS Manual, CIRIA Report C753, 2015
- Pollution Mitigation Indicies provided by Hydro International

Results Summary

Roof Area:

Treatment component 1 Hydo International Downstream Defender

Treatment component 2 None

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	Adequate	Adequate	Adequate

Residential Parking:

Treatment component 1 Hydo International Downstream Defender

Treatment component 2 None

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	Adequate	Adequate	Adequate

Residential Roads

Treatment component 1 Hydo International Downstream Defender

Treatment component 2 None

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	Adequate	Adequate	Adequate

POLLUTION HAZARD INDEX

Source of Runoff	Pollution Hazard	Pollution Hazard Indices: Suspended Solids	Metals	Hydro-carbons
Residential roofing	Very low	0.2	0.2	0.05

POLLUTION MITIGATION INDEX

The receiving water body shall be: Surface Water

Suds Component		Pollution Mitigation Indices: Suspended Solids	Metals	Hydro-carbons
1	Hydo International Downstream Defender	0.5	0.4	0.8
2	None	0	0	0
3	None	0	0	0
4	None	0	0	0
Total Pollution Mitigation Index		**0.5**	**0.4**	**0.8**

ASSESSMENT OF TREATMENT PROPOSAL

Indices	Suspended Solids	Metals	Hydro-carbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.4	0.8
	Adequate	**Adequate**	**Adequate**

R G PARKINS Kendal | 01539 729393 Lancaster | 01524 32548	CALCULATION		Job No.	K39108	Page	3 of 4
	Job	Harras Road	Drg no.		Date	17/02/2022
		Whitehaven	Revision		Initial	CA
	Title	Sustainable Drainage - Treatment			Checked	RH

POLLUTION HAZARD INDEX

Source of Runoff	Pollution Hazard	Pollution Hazard Indices: Suspended Solids	Metals	Hydro-carbons
Residential parking	Low	0.5	0.4	0.4

POLLUTION MITIGATION INDEX

The receiving water body shall be: Surface Water

Suds Component		Pollution Mitigation Indices: Suspended Solids	Metals	Hydro-carbons
1	Hydo International Downstream Defender	0.5	0.4	0.8
2	None	0	0	0
3	None	0	0	0
4	None	0	0	0
	Total Pollution Mitigation Index	**0.5**	**0.4**	**0.8**

ASSESSMENT OF TREATMENT PROPOSAL

Indices	Suspended Solids	Metals	Hydro-carbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
	Adequate	Adequate	Adequate

	CALCULATION		Job No.	K39108	Page	4 of 4
R G PARKINS Kendal | 01539 729393 Lancaster | 01524 32548	Job	Harras Road	Drg no.		Date	17/02/2022
		Whitehaven	Revision		Initial	CA
	Title	Sustainable Drainage - Treatment			Checked	RH

POLLUTION HAZARD INDEX

		Pollution Hazard Indices		
Source of Runoff	**Pollution Hazard**	**Suspended Solids**	**Metals**	**Hydro-carbons**
Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)	Low	0.5	0.4	0.4

POLLUTION MITIGATION INDEX

The receiving water body shall be: Surface Water

		Pollution Mitigation Indices		
	Suds Component	**Suspended Solids**	**Metals**	**Hydro-carbons**
1	Hydo International Downstream Defender	0.5	0.4	0.8
2	None	0	0	0
3	None	0	0	0
4	None	0	0	0
	Total Pollution Mitigation Index	**0.5**	**0.4**	**0.8**

ASSESSMENT OF TREATMENT PROPOSAL

Indices	**Suspended Solids**	**Metals**	**Hydro-carbons**
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
	Adequate	**Adequate**	**Adequate**

APPENDIX C

UU CORRESPONDENCE

PRE-DEVELOPMENT ENQUIRY RESPONSE EMAIL

Chris Abram

From:	Perry, Graham
Sent:	24 February 2022 17:25
To:	Chris Abram
Cc:	Wastewater Developer Services
Subject:	Pre Development Enquiry for : Harras Road, Whitehaven CA28 6SG UU reference Number : 4200047309

Pre Development Enquiry for: Harras Road, Whitehaven CA28 6SG UU reference Number : 4200047309

We have carried out an assessment of your application which is based on the information provided. This pre-development advice on your drainage strategy will be valid for 12 months. Your drainage strategy will need to be reviewed by other competent authorities as part of the planning process, and we advise that you carry out the necessary site investigations to confirm the viability of your proposals.

If your investigations require access to our public sewer network, we ask that you contact our network engineers with a request for an access certificate via our main contact telephone number 0345 3723223 or refer to the link below:

https://www.unitedutilities.com/builders-developers/working-near-our-assets/

Foul Water

Foul flow from this site will be allowed to drain into the public foul water/combined sewer system.

Our preferred point of discharge would be to the 300mm diameter public combined sewer within Harras Rd located to the south of your proposed development at an unrestricted rate. We have no issue with you making 3 separate connections to serve the 3 cul de sacs

If you are able to identify an alternative, more suitable point of discharge, we request that you contact us at your earliest convenience so that we can assess suitability.

Surface Water

All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80, (Reference ID: 7-080-20150323), of the National Planning Practice Guidance. We also recommend you prioritise the use of multi-functional sustainable drainage systems for the management of surface water in accordance with national planning policy.

Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable.

This is outlined as follows, in order of priority:

1. **into the ground (infiltration);**
2. **to a surface waterbody;**
3. **to a surface water sewer or highway drain;**
4. **to a combined sewer.**

For guidance, The **North West SuDS Pro-Forma** provides information on the appropriate evidence required at each stage of the hierarchy, to demonstrate how each level has been discounted.

The Lead Local Flood Authority has responsibility for all surface water drainage concerns and their input to your proposal is critical. You should also consider whether it is necessary to discuss your proposal with the Environment Agency, or Internal Drainage Board (if operating in your area).

The Local Planning Authority are the determining authority for any application for planning permission and the appropriate authority for determining cost viability of a proposed drainage scheme, such assessments are outside of the jurisdiction of United Utilities.

Infiltration

Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible.

A detailed evidence based feasibility assessment must be carried out in line with Chapter 25 of the CIRIA SuDS Manual 2015 to determine whether infiltration is a suitable method of surface water disposal.

Particular attention must be paid to Ground Water Source Protection Zones to ensure that the risk of pollution to these valuable resources is not compromised. Details can be obtained from the government website:

https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs#find-groundwater-spzs

If your site is in a Groundwater Source Protection Zone, you should have regard to the Environment Agency's approach to Groundwater Protection. Information on this is available via the link below:

https://www.gov.uk/government/publications/groundwater-protection-position-statements

Please note that such a location could have implications for the principle of your development and the need for additional mitigating measures to protect the groundwater environment and public water supply in the detailed design of your site.

Waterbody

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you contact the Lead Local Flood Authority and/or Environment Agency to discuss a point of discharge to the watercourse located to the west of the site boundary

We would encourage you to identify and engage with any third party landowner and riparian owner to agree access and discharge rights to the water body if this is not in your ownership.

Highway Drainage

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you investigate the possibility of draining surface water to the highway drain where this ultimately discharges to a watercourse, by contacting the relevant Highway Authority.

Public Sewer

In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, both discharge to ground via infiltration and discharge to a waterbody should be discounted prior to consideration of discharging surface water to the public sewer system. Evidence should be provided to demonstrate how these have been discounted, as outlined in the North West SuDS pro-forma.

Once evidence is provided as outlined above, United Utilities will consider a connection to the 300mm diameter public combined sewer within Harras Rd located south of the proposed site at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5 l/s.

As a Water Company, we have no obligation to accept highway drainage into our public sewer network. However, should your proposals include runoff from highways, we would request that consideration is given to SuDS components that deliver source control are incorporated within the design of the scheme to reduce the volume and frequency of discharges of these flows to the public sewer.

Levels

For low-lying sites, (where the ground level of the site or the level of a basement is below the ground level at the point where the drainage connects to the public sewer), care should be taken to ensure that the property is not at increased risk of flooding. If these circumstances exist, we recommend that you contact us to discuss further. It could affect the detailed design of your site and result in the need to incorporate appropriate mitigating measures in your drainage scheme.

Land drainage / Overland flows / track drainage

United Utilities have no obligation, and furthermore we do not accept land drainage, overland flows or track drainage into the pubic sewerage network under any circumstances

Sewer Adoptions

You have indicated on your application form that you intend to put the sewers forward for adoption (including any SuDS components that can come within the meaning of a sewer).

United Utilities assess adoption applications based on the current Design & Construction Guidance and local practices which have now replaced 'Sewers For Adoption 6th Edition'.

We recommend that you submit a pre design assessment to the sewer adoption mailbox (SewerAdoptions@uuplc.co.uk) stating pre design assessment in the title

Please refer to links below to obtain further guidance:

https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-adoptions/

Site drainage must be designed in accordance with Building Regulations, National Planning Policy, and local flood authority guidelines, we would recommend that you speak and make suitable agreements with the relevant statutory bodies.

If you intend to put forward your wastewater assets for adoption by United Utilities, the proposed detail design will be subject to a technical appraisal by an Adoption Engineer as we need to be sure that the proposals meets the requirements set out in the Design & Construction Guidance. The proposed design should give consideration to long term operability and give United Utilities a safe and cost effective proposal for the lifetime of the assets. In these cases, we strongly recommend that no construction commences until the detailed drainage design, submitted as part of the Section 104 application, has been assessed and accepted in writing by United Utilities. Any work carried out prior to the technical assessment being approved is done entirely at the developer’s own risk and could be subject to change.

SuDS

If your development proposal incorporates any SuDS component(s) which interact with a sewer network you plan on offering for adoption to United Utilities; contact should be made with our technical team at your earliest convenience, please complete the 'Section 104 pre-application form : ' and include as much relevant detail as you can. These discussions can help prevent delays later in the development process.

Section 104 Pre application form (1b)

As per the sewerage sector guidance, all SuDS should be designed in accordance with the standards within the Design & construction guidance & the CIRIA SuDS manual (C753)

Codes For Adoption

The new Codes for Adoption are outlined on the Water UK Website. The link below takes you to their webpage:

https://www.water.org.uk/technical-guidance/developers-services/codes-for-adoption/

A free copy of the new Design & Construction Guidance can be downloaded via the link below:

https://www.water.org.uk/wp-content/uploads/2020/03/SSG-App-C-Des-Con-Guide-v-2-100320-C.pdf

Existing Wastewater Assets Crossing the Site

We have reviewed our records and can confirm that there does not appear to be any charted public sewers located within the boundary of proposed development. However, due to the accuracy of the records and the public sewer transfer legislation in 2011, not all public sewers are shown on our records so we would ask that you proceed with caution and carry out your own site investigation works. If any uncharted sewers are identified while carrying out your works we would ask that you contact United Utilities at the earliest opportunity so that we can offer guidance and update our records.

Please refer to the link below to obtain full details of the processes involved with sewer diversions:

https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-diversions/

Existing Water Assets Crossing the Site

It is the developer responsibility to identify utilities on-site. Where clean water assets are shown on our records, we recommend that you contact our Water Pre-Development Team, via the following email address: **DeveloperServicesWater@uuplc.co.uk**. Further information for this service can be found on our website via the link below:

https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/water-pre-dev/

Connection Application

Although we may discuss and agree discharge points and rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below:

https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-connections/

We recommend that the detailed design should confirm the locations of all utilities in the area and ensure that any proposed drainage solution considers routing and clash checks where required.

If we can be of any further assistance please don’t hesitate to contact us further.

Kind regards,

Graham Perry

Graham Perry
Development Engineer
Developer Services
M: 07557 577548
T: 01925 679405
unitedutilities.com

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