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Flood Risk Assessment & Outline Drainage Strategy

Dalzell Street, Moor Row, Whitehaven

Nigel Kay Homes

Ref: K39568.FRA/001

Version	Date	Prepared By	Checked By	Approved By
Original	13th October 2022	C. Abram	T. Melhuish	T. Melhuish

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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

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7. INTRODUCTION

7.1 BACKGROUND

This report has been prepared by R. G. Parkins & Partners Ltd (RGP) for Nigel Kay Homes in support of their proposals for a new residential development at Dalzell Street, Moor Row, 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 it is classed as major development (over 1 ha) in accordance with The Town and Country Planning Order 2015[3].

The area covered by the assessment is 4.15 ha (hectares) and by reference to the Environment Agency Flood Map, the site lies almost entirely in Flood Zone 1. A small lineal area directly adjacent to the watercourse consistent within the steep sloping banking of the River Keekle is located in Flood Zone 3, however no development is anticipated in this area.

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.

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8. SITE CHARACTERISATION

8.1 SITE LOCATION

The land proposed for development is situated off Dalzell Street on the northern outskirts of Moor Row approx. 2 km southeast of Whitehaven and 1.25 west of Cleator Moor, at National Grid Co-ordinates 300550E 514600N. The location is shown in Figure 8.1.

The land is currently accessible from an existing junction off Dalzell Street.

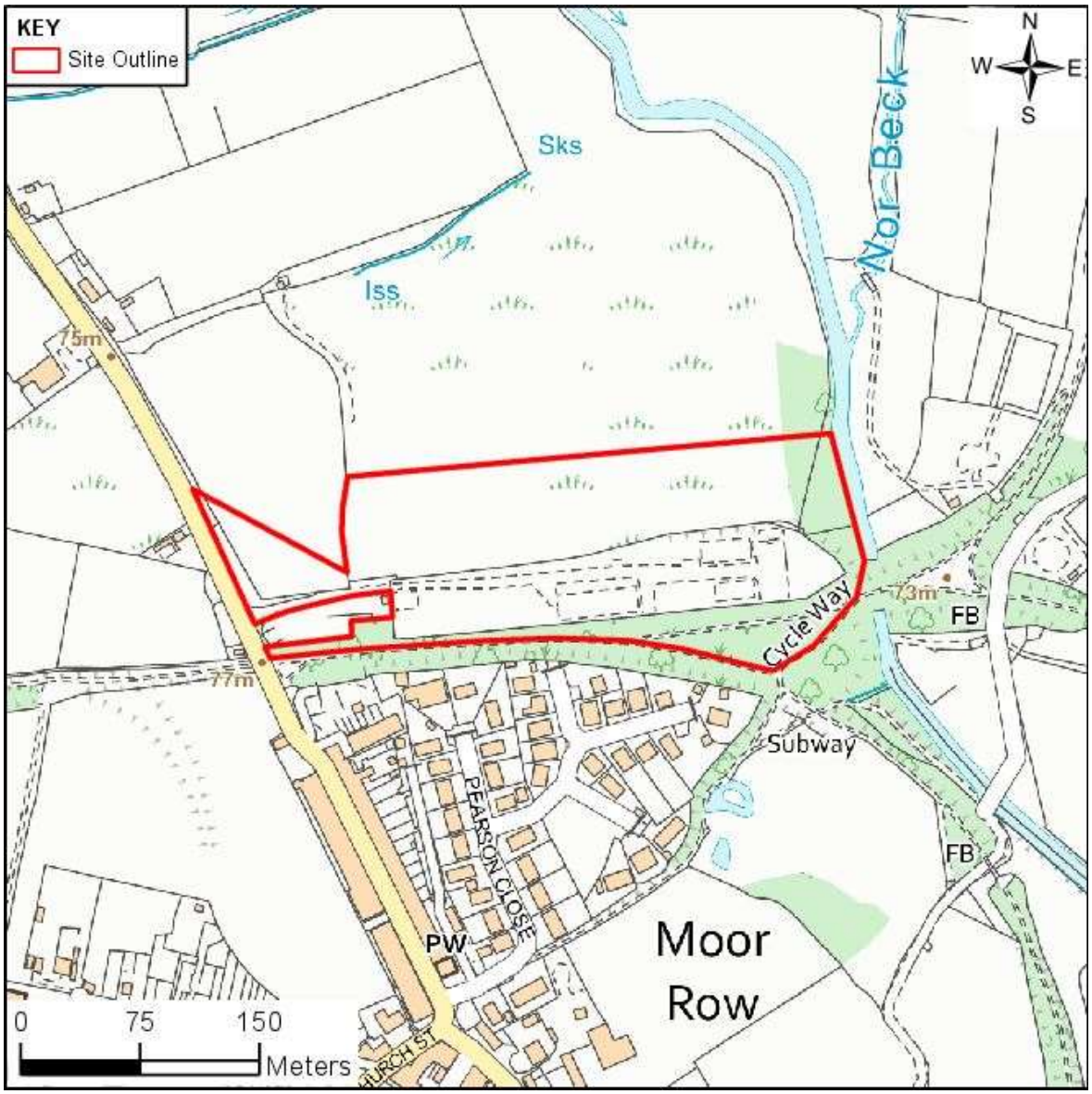

Figure 8.1 Site Location

8.2 SITE DESCRIPTION

The land covered by the assessment covers approximately 4.15 ha. A portion of the site is classified as Brownfield and comprises of hardstanding in an area where it was historically part of

the long since abandoned Moor Row Train Station Depot with the remainder currently used as agricultural pasture and can be classed as Greenfield.

The land is bound by Dalzell Street road to the west, the Cycle Route 72 path to the south on the old railway alignment, with a residential estate on the remote side of the path. Agricultural fields lie to the immediate north with the River Keekle forming the eastern boundary. Just to the south of the entrance road an area of industrial land is to remain as existing and is surrounded by the wider site boundary on all sides.

Topographically levels vary significantly across the land, with the survey indicating levels across the site typically fall from south to north from around 75-74mAOD at a bund along the existing access road to 71-70.5mAOD on the northern boundary, with the exception of areas in and around the River Keekle where levels fall sharply west to east towards the watercourse level of around 60.00mAOD.

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 2.25 km south of the site.

The development site overlies a Principal Aquifer in an area of Soluble Rock Risk with 'Medium-Low' groundwater vulnerability.

Table 8.1 Site Geological Summary

Geological Unit	Classification	Description	Aquifer Classification
Soil	Soilscape 17	Slowly permeable seasonally wet acid loamy and clayey soils	N/A
Drift	Till, Devensian - Diamicton	Sedimentary superficial deposits	Secondary
Solid	Brockram – Breccia	Sedimentary bedrock	Principal

8.4 HYDROLOGY

The River Keekle which bounds the eastern perimeter of the site is designated as 'main river'.

Mapping also indicates the presence of issues and an unnamed watercourse / drainage ditch just to the north of the site boundary in the adjacent field area which has an existing piped or culverted outfall to the River Keekle.

It is also assumed that within the site there will be a series of historic land drainage features serving the fields and former industrial/rail depot area that are assumed to discharge to either the nearby drainage ditch or directly to the River.

The localised sloping topography would suggest that the ditch to the north and the River Keekle to the east act as natural drainage routes for the existing site.

8.5 EXISTING SEWERS

Reference to United Utilities Sewer Records indicate the presence of a 375mm diameter combined public sewer located to the south of the development site on the remote side of the Cycle Path with both foul and surface water public sewers located further to the south in Pearson Close and Montreal Place residential estate site roads. The separate foul sewers from these estates appear to discharge directly to the aforementioned combined sewer at various locations.

Gullies are also visible in Dalzell Street Road indicating the presence of surface water highways drainage.

8.6 GROUND INVESTIGATION

Geo Environmental Engineering Ltd (GEO) were commissioned to carry out a preliminary ground investigation at the site which was carried out on the 5th August 2022.

16 No. trial pits were excavated to variable depths of between 1.20 & 3.00m bgl.

With respect to drainage, in-situ ground permeability testing in two trial pits was undertaken as part of the intrusive investigations. The pits were excavated to depths of approximately 1.55m bgl. Although dry on excavation, standing water was observed after 1 hour indicating ground water ingress. Both pits were then partially filled and the water level monitored over approximately 5 hours, and over this time the water level only dropped between 2cm and 9cm respectively and in both pits the fall in water level was not sufficient to determine a meaningful infiltration rate.

For further information refer to the Geo Environmental Engineering Ground investigation report:

- GEO2022-5470, dated 11 August 2022

Based on the above findings the poor levels of permeability encountered combined with groundwater ingress would impact the efficiency of any soakaway structures and therefore an alternative surface water disposal solution is recommended for this development.

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%

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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
- 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.

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.

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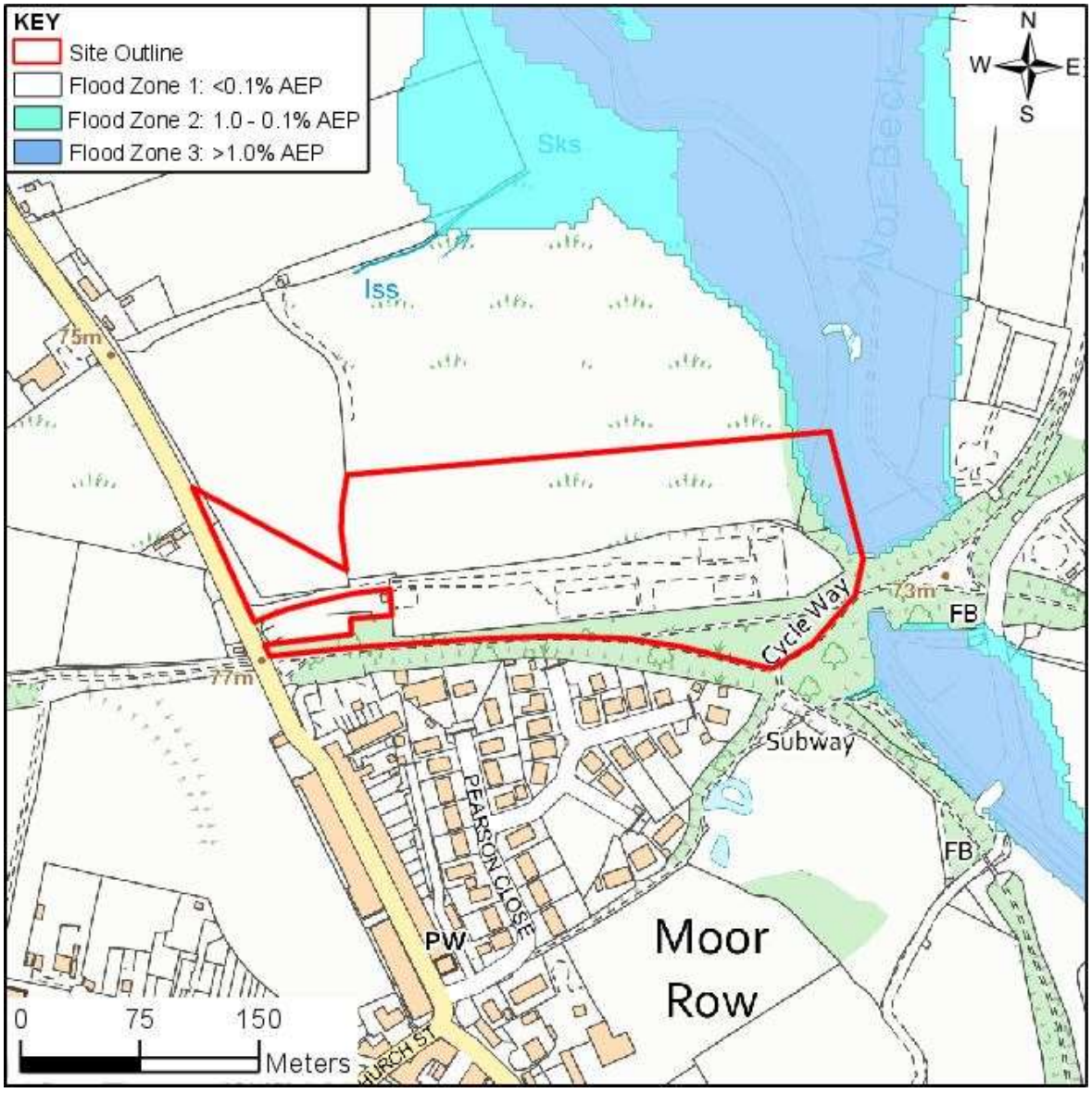

Figure 9.1 Environment Agency Flood Map for Planning

Reference to Figure 9.1 indicates the almost the entirety of 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. The small area of the site that encroaches into Flood Zone 3 is consistent with the steep sloping sides of the adjacent River Keekle banking and no development is proposed in these areas.

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 majority of the 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).

There is a band of 'Low to Medium Probability' surface water flooding shown in the area around the former goods yard. This appears to be attributed to hardstanding in this area.

The surface water flood maps do not take into consideration future site topography, and it is considered that careful reprofiling of the levels in this area in combination with the installation of a new positive drainage system as part of the development will eliminate this existing issue.

Surface water run-off from the site is currently directed towards the drainage ditch and river towards the north and eastern field boundaries. It is noted that there is an existing area of 'High Probability' surface water flooding located around the area associated with the piped/culverted outfall from this ditch and as the development drainage proposals would look to mimic the existing site run-off characteristics, it is proposed to fully investigate and rectify any existing issues associated with the existing outfall pipe to mitigate surface water flooding in this area.

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.

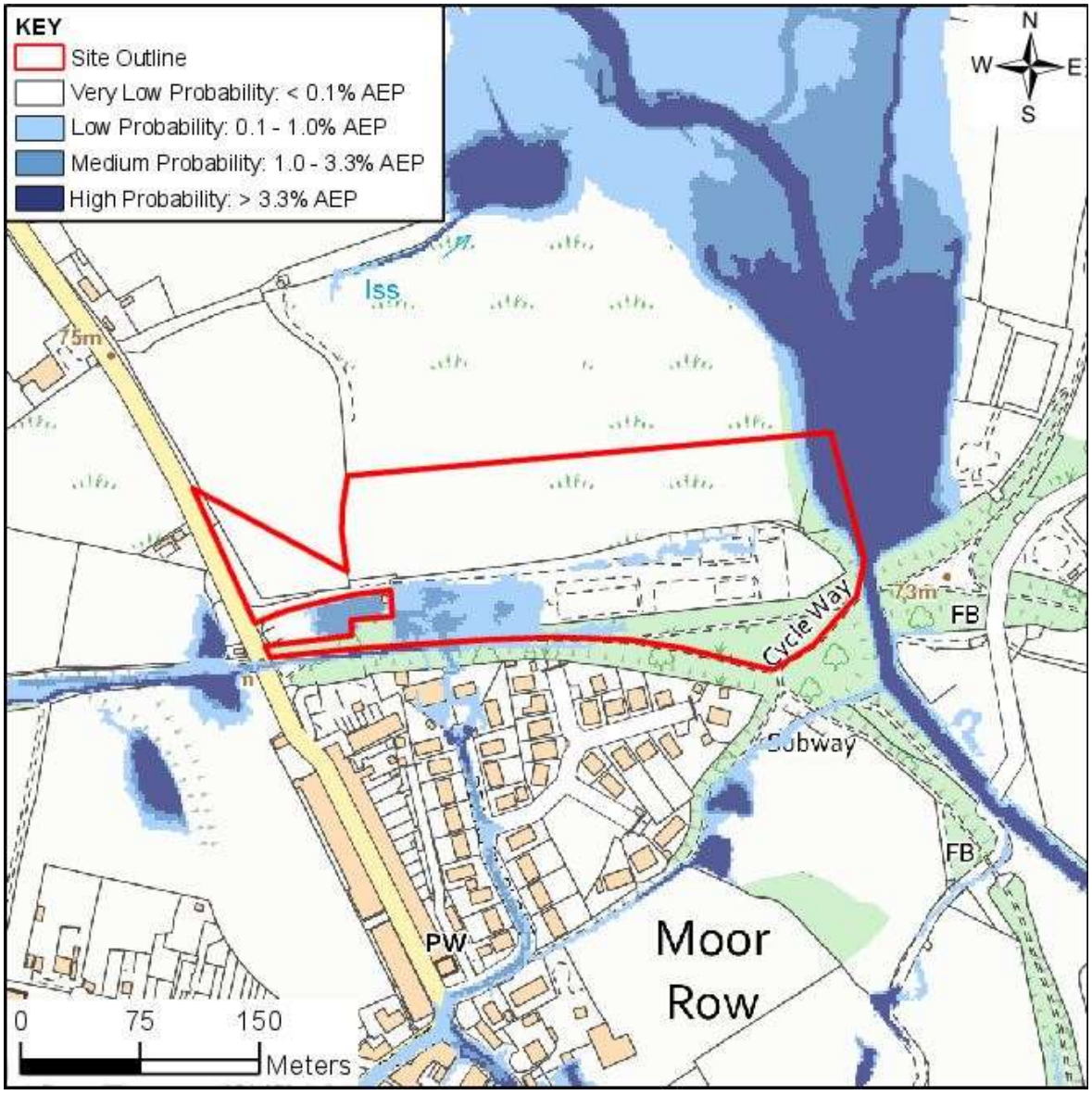

Figure 9.2 Environment Agency Surface Water Flood Map

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.

Groundwater ingress was encountered in some of the trial pits conducted as part of the ground investigations (Section 8.6).

It is likely that groundwater levels will fluctuate throughout the year but given the sloping topography towards the adjacent river the site is unlikely to be significantly affected by groundwater flooding.

Nevertheless, no below ground development is anticipated as part of this proposal.

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 of flooding within the SFRA in this locality.

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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[9]
- Code of Practice for Surface Water Management, BS8582:2013, November 2013[10]
- Rainfall Runoff Management for Developments, Defra/EA, SC030219, October 2013[11]
- Designing for Exceedance in Urban Drainage – Good Practice, CIRIA Report C635, 2006[12]
- Flood Estimation Handbook (FEH)[13]
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993[14]
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983[15]
- Flood Estimation for Small Catchments, Marshall & Bayliss, Institute of Hydrology, Report No. 124 (IoH 124), 1994[16]
- Non-Statutory technical Standards for Sustainable Drainage Systems, Defra, March 2015[17]
- Water UK, Design and Construction Guidance for Foul & Surface Water Sewers March 2020[18]
- Defra, Recommendations to Update Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS), February 2021[19]
- HR Wallingford: Tools for the design and evaluation of Sustainable Drainage Systems (SuDS) [20]

The following assessment and drainage strategy are based on an assumed impermeable area percentage of 60% of the overall site in line with the proposed residential nature. As the development site plan is progressed the level of impermeable areas will become more evident allowing the drainage strategy to be revisited and assessed more accurately in line with the finalised development proposals at detailed design stage.

10.2 SITE AREAS

Based on the sloping topography of the existing Greenfield site it can be concluded that the entirety of the site area drains downslope towards the existing neighbouring drainage ditch to the north and the River Keekle to the east from the natural crest point along the existing site entrance road. As such the pre-development Greenfield runoff rates will be calculated based on the percentage of future impermeable area predicted through development based on total site area.

Table 10.1 therefore gives the total area of existing land cover proposed for development.

Table 10.1 Area of Existing Land Cover

Land Cover	Area		Percentage of total site area
	m²	Ha	
Total Site Area	41,500	4.15	100%

The site can be subdivided into land cover that could be permeable and that which could be impermeable. Potential impermeable areas are regarded as buildings, parking, roads, and hardstanding. All other areas (principally gardens and areas of public open space) are regarded as having a permeable surface.

These Areas have been calculated as shown in Table 10.2.

Table 10.2 Area of Potentially Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	Ha	
Total Impermeable Area	24,900	2.49	60%
Remaining Permeable Area	16,600	1.66	40%

10.3 PRE-DEVELOPMENT GREENFIELD RUNOFF ASSESSMENT

As the total site covers an area of less than 200 ha, (4.15ha) 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.

With reference to Table 10.3 the pre-development runoff assessment has been calculated based on the site area of 24,900 m^2 being classified as greenfield.

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

Event	Greenfield Rate of Runoff (l/s)
Q1	20.1
QBAR	**23.1**
Q10	31.8
Q30	39.2
Q100	48.0
Q100 + 50% CC	72.0

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 from the development site before being released at a controlled rate to the existing nearby watercourses to match the pre-development Greenfield QBAR rate.

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 50% 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

Applies across all of England	Total potential change anticipated for the '2050s'	Total potential change anticipated for the '2070s'
Upper End	45%	50%
Central	30%	35%

10.4.2 URBAN CREEP

BS 8582:2013 [10] 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) is typically applied to the contributing area.

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

In this situation as the number of properties proposed for the development are currently unknown a conservative assumed impermeable percentage of the site area has been used in calculations to account for the anticipated density of housing at this site and allows for urban creep.

Once the development layout has been finalised the impermeable areas associated with the number of dwellings can be recalculated and urban creep can be applied.

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 for drainage design.

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[9]. 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

In-situ permeability testing was undertaken as part of the ground investigation at this site (See Section 8.6) and the slow infiltration rates encountered combined with concluded that disposal of surface water via. soakaways would not form an effective drainage solution for this site.

On this basis it is therefore considered that disposal of surface water using a full infiltration-based SuDS is not viable for this proposed development and an attenuation-based strategy should be progressed.

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 match the pre-development Greenfield QBAR rates, with controlled discharge directed from suitably sized attenuation structures for the site catchment areas to the existing watercourse/ditch located in close proximity to the northern site boundary.

As discussed in Section 9.6 above there appears to be an existing surface water flooding issue associated with the drainage ditch outfall in this location. It is therefore recommended that the existing piped outfall is subject to further intrusive investigations to assess the capacity and condition of the outfall pipe and if required any blockages cleared and if necessary, any replacement/repairs to the pipe are undertaken to ensure functionality of the outfall pipe is maintained.

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 –** insufficient infiltration rates to support effective drainage via. soakaways rule out infiltration as a viable full site 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 –** Full infiltration systems are unsuitable due to road and driveway gradients and inconsistent soil permeability across the site for permeable block paving solutions to work efficiently. Partial infiltration systems may be feasible.

- **Swales –** Would require large areas within the site ideally adjacent to road areas, could potentially be accommodated within the site layout depending upon the available space and scale of development proposed.

- **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** – Detention basins are the preferred option for this site as there is sufficient space available to accommodate the large areas required for this type of solution. As well as providing attenuation and treatment for site surface water run-off the basins would provide attractive permanent features providing biodiversity and amenity benefits within the context of an urban development. The required size of the proposed storage structure has been estimated and is detailed in Section 10.7.

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

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

- **Geocellular attenuation tank systems –** could be used in conjunction with the detention basins to balance the overall size of any proposed above ground storage structures and could be explored as an alternative / additional SuDS component if required at detailed design stage. These tanks would be wrapped and sealed with an impermeable geomembrane to provide a water-tight structure with flows controlled via an HydroBrake or Orifice flow control device.

- **Oversized Pipes –** could be used in conjunction with or as an alternative to geocellular attenuation tanks to provide additional online storage capabilities.

10.6 SURFACE WATER DRAINAGE DESIGN

The proposed surface water attenuation requirements for the developable area of the site have been estimated using Micro Drainage Source Control (results are included in Appendix B).

Within the site area the assumed extent of permeability associated with roads, driveways and all other impermeable areas have been conservatively calculated to equate to approximately 60% of the overall site area.

The drainage design has been estimated to store a future 1% AEP event of critical duration without any flooding. Future climate change (50%) and urban creep (10% to housing roof areas only) is accounted for within the calculations.

It is proposed that all impermeable site areas i.e. roof, driveway and road areas will drain via. gravity through a network of pipes and chambers into a detention basin located in the natural respective low point of the wider site. The final location of the basin will be determined at detailed design stage but in this case it is anticipated that the basin will be located in an area of land in the adjacent field (shown outside the planning boundary) to allow direct outfall to the existing drainage ditch outfall that serves the wider catchment in this area to replicate the existing site drainage characteristics.

The new detention basin will be formed as permanent feature in an area designated as open space and will be designed to incorporate shallow, grassed slopes to provide important amenity and biodiversity benefits to the development.

Roof water, driveway and road runoff will connect directly into the surface water pipe network upstream of the detention basin, with inspection and manhole chambers utilised to route the new pipework to suit the proposed development layout and allow for future inspection and maintenance. Proposed ground levels will need to fall consistently depending on which area they are located, in order to enable gravity connections to the drainage system.

Silt traps will be located upstream of the detention basin and any other proposed attenuation systems, 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 SuDS components.

Hydrobrake flow control chambers will restrict discharge from the detention basin system into the River Keekle. With the cumulative discharge from the initial phase of development culminating in a total discharge rate of 23.1 l/s equivalent to the calculated pre-development greenfield runoff QBAR rates.

In addition, all gardens and landscaped areas could benefit from infiltration trenches and perforated pipes to allow these areas to drain effectively towards the nearest existing surface water feature. This will mitigate any unforeseen risk of uncontrolled overland flows from garden areas.

10.7 VOLUMETRIC STORAGE

A storage estimate has been undertaken for the Q100+50% CC storm event and the detention basin has been designed with sufficient capacity to contain flows without causing flooding, the results are provided in Table 10.8.

It is anticipated that the basin will be constructed to cater for the full scale of the future development therefore the volumetric requirements of the basin have been sized based on the total overall contributing areas and respective discharge rates for the site, using a standard depth of 1.5m with 1:3 gradient side slopes. For conservative design the approximate impermeable area of the basin itself has been included into the contributing catchment area (circa 1000m^2).

For indicative information refer to the Outline Drainage Layout Plan included in Appendix A.

Table 10.5 Attenuation Storage Volumes

Impermeable Catchment Area (m^2)	Volume to TWL (m^3)	Development Controlled Discharge Rate QBAR (l/s)
25,900	1887.2	23.1

Note: TWL - Top Water Level for the Q100 + 50%CC event

10.8 OTHER BENEFITS OF DEVELOPMENT

The development site in its current agricultural form as sparse grazing pasture on sloping land, underlain by relatively impermeable soil, provides little in the way of natural flood defence or attenuation to overland flows and stormwater runoff. The land in its current form also lacks any meaningful biodiversity or amenity value and provides limited benefits to the surrounding community.

It is envisaged that the proposed development site will tie into the existing topography via the careful design 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. Any 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. Any unlikely surface emergence of any groundwater on-site will be intercepted by land drainage systems and directed to the various SuDS attenuation systems/nearby watercourses.

In addition, the proposed detention basin 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 for the overall site would be restricted to 23.1 l/s in comparison to the existing uncontrolled run-off rate of 48.0 l/s.

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 50% allowance for climate change. 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 detention basin, 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 to the nearby watercourse. 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 that this or the basin were to overtop, exceedance flows would be directed towards the existing drainage ditches via. overflow spillways and channels where they would be contained and routed away from the site towards the outfall points.

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.

For the three categories of runoff areas served by the drainage system, Roof areas, residential parking and residential roads, treatment is proposed by directing all surface water runoff via. detention basins before discharge off site.

Tables 10.6 – 10.8 summarise the pollution hazard and mitigation indices for this type of runoff and show that adequate treatment of surface water runoff is provided by the use of detention basins.

Table 10.6 Pollution Hazard & Mitigation Indices - Roof Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.5	0.6
Treatment Suitability	**ADEQUATE**	**ADEQUATE**	**ADEQUATE**

Table 10.7 Pollution Hazard & Mitigation Indices - Residential Parking

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.5	0.6
Treatment Suitability	**ADEQUATE**	**ADEQUATE**	**ADEQUATE**

Table 10.8 Pollution Hazard & Mitigation Indices - Residential Roads

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.5	0.6
Treatment Suitability	**ADEQUATE**	**ADEQUATE**	**ADEQUATE**

10.11 OPERATIONS & MAINTENANCE RESPONSIBILITY

All drainage will be constructed to adoptable standards and adoption of surface water drainage systems and SuDS components by the sewerage undertaker and/or the highways authority is intended wherever possible.

At detailed design stage a full review and consideration of UU requirements shall ensure the maximum practical extent of adoptable drainage in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers[18] and subject to a Section 104 agreement as required.

Highways gullies and associated pipework could be put forward for adoption by Cumbria County Council Under a Section 38 Agreement.

The private individual plot drainage is to be maintained by the property owners.

Alternatively, all access roads and below ground drainage could remain private and be maintained by a third-party management company established by Nigel Kay Homes.

A SuDS 'Operations & Maintenance Plan' will be made available at detailed design stage to suit the finalised development parameters which will specify the requirements for future maintenance of the drainage system.

11. FOUL WATER DRAINAGE STRATEGY

It is proposed that foul water from the site shall be connected to the existing 375mm diameter combined sewer located adjacent to the cycle path near to the south of the site serving the nearby Montreal Place and Pearson Close residential estates. It is understood there is an existing connection from the site to an existing manhole on the public 375mm combined sewer located within the residential development which could be utilised for the new development.

Conventional gravity sewers will be used within the site to the maximum extent possible where site levels allow.

As the existing combined sewer invert and final development levels are currently unknown, and due to the existing sloping site topography away from the public sewer it is anticipated that some plots will be located in naturally lower areas and will require foul flows to be pumped to higher ground within the site to allow disposal via a final gravity connection to the existing 375mm foul public sewer. This could be achieved by using a Type 3 Pumping Station or individual private pumping chambers depending on the No. of dwellings requiring this function.

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'.

A pre-development enquiry has been submitted to United Utilities to confirm acceptability of connection of foul water drainage for the proposed development. Their response provides an approval in principle to discharge foul flows from the site to their asset and have no objection to utilising the existing connection from the site. Correspondence is included in Appendix C for reference.

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 [18].

Based on the site boundary area it is assumed that a maximum of 80 properties could be constructed as part of the development. For conservative design this number of properties has been used to calculate the anticipated foul flows for this stage of development 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 – 80 No. @ 4000 L/day	320,000
Peak Foul Flow Rate from Site (l/s)	3.70

This estimate predicts peak foul flow rates from the development to be 3.70 l/s.

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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 poor levels of permeability and high groundwater and are not deemed suitable for an infiltration-based SuDS solution for a development of this scale.
- The existing sloping 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 a. detention basin, with a flow control device restricting cumulative discharge to the match pre-development Greenfield QBAR rate.
- The size of the detention basin has been estimated based on an assumed impermeable area of 60% of the total site area and respective QBAR discharge rates to contain flows based on a Q100 + 50% storm event.
- Controlled runoff for the development will be restricted to match the equivalent Greenfield QBAR rate of 23.1 l/s prior to discharge to nearby existing drainage ditch outfall.
- It is recommended that the existing outfall pipe associated with the drainage ditch in this location is fully investigated and any defects rectified as part of the development to mitigate against existing surface water flooding associated with this area.
- Adequate treatment of surface water runoff generated by the development will be provided by the detention basin.
- Foul flows from the site will ultimately discharge via. a new connection to the existing 375mm diameter public combined sewer located to the south of the development serving the nearby Montreal Place and Pearson Close residential estates. A pre-development enquiry has been submitted to UU. A Foul Water Pumping Station may be required dependent on final site levels and depth of existing sewers.
- Should planning permission be granted, the developer will accept pre-commencement planning conditions controlling detailed design of the drainage systems. At this point it is

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recommended that the drainage strategy is revisited and re-assessed as part of the detailed design process.

- In addition to these measures, a SuDS Operations and Maintenance Plan will be made available detailing future maintenance requirements of all sustainable drainage systems at detailed design stage to suit the finalised development scale and layout.

13. REFERENCES

[1] Ministry of Housing, Communities and Local Government, National Planning Policy Framework, July 2021.

[2] Ministry of Housing, Communities and Local Government, Planning Practice Guidance to the National Planning Policy Framework, July 2018.

[3] Defra/Environment Agency, The Town and Country Planning Order 2015, 2015 No.595, April 2015.

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[5] Land Information System (LANDIS) - Soilscapes viewer, Accessed February 2022. http://www.landis.org.uk/soilscapes

[6] Defra Magic Maps, 2021. https://magic.defra.gov.uk/MagicMap.aspx. Accessed February 2022

[7] Copeland Borough Council, Strategic Flood Risk Assessment (SFRA), October 2021

[8] Copeland Borough Council Planning Website. https://www.copeland.gov.uk/planning/application-search-terms Accessed April 2022

[9] CIRIA, The SuDS Manual, Report C753, 2015.

[10] BS8582:2013, Code of Practice for Surface Water Management, November 2013.

[11] DEFRA/EA, Rainfall Runoff Management for Developments, SC030219, October 2013.

[12] CIRIA, Designing for Exceedance in Urban Drainage – Good Practice, Report C635, London, 2006.

[13] Centre for Ecology and Hydrology, Flood Estimation Handbook, Vols. 1 – 5 & FEH CD-ROM 3, 2009.

[14] Institute of Hydrology, Flood Studies Report, Volume 1, Hydrological Studies, 1993.

[15] Institute of Hydrology, Flood Studies Supplementary Report No 14 – Review of Regional Growth Curves, August 1983.

[16] Marshall & Bayliss, 1994. Flood Estimation for Small Catchments, Report No. 124 (IoH 124), Institute of Hydrology.

[17] Department for Environment, Food and Rural Affairs, Non-Statutory Technical Standards for Sustainable Drainage Systems, March 2015

[18] Water UK, Design and Construction Guidance for Foul & Surface Water Sewers Offered for Adoption Under the Code for Adoption Agreements for Water and Sewage Companies Operating Wholly or Mainly in England, Approved Version 2.0, March 2020

[19] Defra, Recommendations to Update Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS), February 2021.

[20] HR Wallingford: Tools for the design and evaluation of Sustainable Drainage Systems (SuDS). https://www.uksuds.com Accessed Feb 2022

APPENDIX A

DRAWINGS

TOPOGRAPHIC SURVEY

OUTLINE DRAINAGE LAYOUT

No.	Date	Revision	Initial

ALPHA DESIGN

Architectural Services
Member of the Chartered Institute of Architectural Technologists

Tel: 01900 829199 email: gb@adcumbria.co.uk

Project

RESIDENTIAL DEVELOPMENT,
DALZELL STREET,
MOOR ROW

Client

NIGEL KAY HOMES LTD.

Drawing

EXISTING SITE PLAN

Scale 1:1000 @ A1 Drawn GB

Checked Date AUGUST 2022

Drawing No.

22/07/1026 - 02

DRAINAGE KEY

- Proposed surface water drainage
- Proposed foul drainage
- Existing public combined sewer
- Existing land drainage

Controlled discharge to outfall via. new manhole to existing drainage ditch outfall pipe.

HYDROBRAKE FLOWCONTROL CHAMBER:
Greenfield QBAR Design Flow = 23.1 l/s

FLOOD ZONE 3
INTERPOLATED FROM EA FLOOD MAP FOR PLANNING
[SUBJECT TO EA DATA LEVEL VERIFICATION]

FLOOD ZONE 2
INTERPOLATED FROM EA FLOOD MAP FOR PLANNING
[SUBJECT TO EA DATA LEVEL VERIFICATION]

Incoming site drainage

DETENTION BASIN:
Indicative Size of Detention Basin required for SW attenuation based on assumed total impermeable area of 60% of overall site area.
Storage Volume required = 1887m³
Surface Area required = 1675m² x 1.5m deep
Max side slope gradient 1:3
Equivalent Greenfield QBAR Design Flow = 23.1 l/s

DEVELOPMENT SITE BOUNDARY

Foul sewage to discharge to final chamber located within site boundary to allow connection to existing UU manhole via. gravity pipework.
Foul drainage routing and connection locations to be confirmed to suit final layout.

INDICATIVE ALIGNMENT OF EXISTING 375mm DIAMETER COMBINED PUBLIC SEWER
(location, condition and invert levels to be verified)

Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: PLANNING

Do not scale from this drawing

R G PARKINS
Kendal | 01539 729393 Lancaster | 01524 32548

Scale @ A1: 1/750	First Issue: 30/09/2022	Office of Origin: Kendal	
Drawn by: CA	Checked by:	Approved:	
Project No: K39568	Drawing No: 100	Rev:	

Client: Nigel Kay Homes

Project: Dalzell Street

Drawing Title: Outline Drainage Plan

BIM No:

APPENDIX B

CALCULATIONS

PRE-DEVELOPMENT RUNOFF

SOURCE CONTROL ATTENUATION

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DALZELL STREET MOOR ROW	Date 15/09/2022	Revised TM

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.

Proposed Land Use Changes

Changes to the existing site are as follows:

Greenfield Site to Brownfield Site

Results Summary

Rate of Run-Off (l/s)		
Event	**Greenfield**	[redacted]
Q1	20.1	
QBAR	23.1	
Q10	31.8	
Q30	39.2	
Q100	48.0	
Q100 + 50% CC	72.0	

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SITE AREAS (LAND COVER AREAS)

Existing Impermeable & Permeable Land Cover

Total Site Area: **4.15** ha **41500** m²

Existing Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	5400.0	0.540	13%
Remaining permeable area	36100.0	3.610	87%

Proposed Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	24900.0	2.490	60%
Remaining permeable area	16600.0	1.660	40%

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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

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

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	=	**1222**	mm	From FEH Web Service (point data)

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

Where:				
	S1	=		%
	S2	=		%
	S3	=		%
	S4	=	**100**	%
	S5	=		%
			100	%

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

So, SOIL = **0.47**

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

$QBAR_{rural}$	=	0.463	m^3/s	
	=	463.3	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	=	**24900**	m^2	Excluding significant open space which would remain disconnected from the positive drainage system during flood events.
	=	0.025	km^2	
	=	2.490	ha	
$QBAR_{rural\ site}$	=	0.02307	m^3/s	
	=	**23.07**	l/s	

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GREENFIELD RETURN PERIOD ORDINATES

QBAR can be factored by the UK FSR regional growth curves for return periods <2 years and for all other return periods to obtain peak flow estimates for required return periods.

These regional growth curves are constant throughout a region, whatever the catchment type and size.

See Table 2.39 for region curve ordinates
Use FSSR2 Growth Curves to estimate Qbar

Reference- Pg 173-FSR V.1, ch 2.6.2

Region = **10**

Use Figure A1.1 to determine region

GREENFIELD RETURN PERIOD FLOW RATES

Return Period	Ordinate	Q (l/s)
1	0.87	20.07
2	0.93	21.46
5	1.19	27.45
10	1.38	31.84
25	1.64	37.84
30	1.7	39.22
50	1.85	42.68
100	2.08	47.99
200	2.32	53.52
500	2.73	62.98
1000	3.04	70.14

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515) SuDS Manual

Summary of Results for 100 year Return Period (+50%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	64.496	0.496	23.0	582.9	O K
30 min Summer	64.678	0.678	23.0	819.1	O K
60 min Summer	64.876	0.876	23.0	1091.9	O K
120 min Summer	65.016	1.016	23.0	1293.4	O K
180 min Summer	65.097	1.097	23.0	1413.6	O K
240 min Summer	65.149	1.149	23.0	1492.6	O K
360 min Summer	65.207	1.207	23.0	1582.0	O K
480 min Summer	65.232	1.232	23.0	1620.9	O K
600 min Summer	65.239	1.239	23.0	1631.1	O K
720 min Summer	65.239	1.239	23.0	1631.2	O K
960 min Summer	65.230	1.230	23.0	1617.8	O K
1440 min Summer	65.197	1.197	23.0	1566.4	O K
2160 min Summer	65.132	1.132	23.0	1466.4	O K
2880 min Summer	65.064	1.064	23.0	1363.3	O K
4320 min Summer	64.909	0.909	23.0	1138.8	O K
5760 min Summer	64.774	0.774	23.0	948.8	O K
7200 min Summer	64.666	0.666	23.0	803.1	O K
8640 min Summer	64.578	0.578	23.0	687.8	O K
10080 min Summer	64.508	0.508	23.0	597.3	O K
15 min Winter	64.553	0.553	23.0	654.8	O K
30 min Winter	64.753	0.753	23.0	920.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	123.936	0.0	581.5	22
30 min Summer	87.707	0.0	827.6	37
60 min Summer	59.370	0.0	1142.4	66
120 min Summer	36.292	0.0	1397.8	126
180 min Summer	27.260	0.0	1575.3	184
240 min Summer	22.247	0.0	1714.3	244
360 min Summer	16.667	0.0	1926.4	362
480 min Summer	13.556	0.0	2088.7	480
600 min Summer	11.536	0.0	2220.9	584
720 min Summer	10.103	0.0	2333.1	630
960 min Summer	8.181	0.0	2515.8	760
1440 min Summer	6.066	0.0	2785.3	1024
2160 min Summer	4.492	0.0	3133.3	1448
2880 min Summer	3.640	0.0	3384.3	1852
4320 min Summer	2.727	0.0	3799.9	2640
5760 min Summer	2.243	0.0	4179.2	3400
7200 min Summer	1.946	0.0	4532.0	4112
8640 min Summer	1.745	0.0	4872.9	4840
10080 min Summer	1.599	0.0	5204.9	5544
15 min Winter	123.936	0.0	652.7	22
30 min Winter	87.707	0.0	927.8	36

Summary of Results for 100 year Return Period (+50%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	64.973	0.973	23.0	1230.5	O K
120 min Winter	65.128	1.128	23.0	1460.6	O K
180 min Winter	65.219	1.219	23.0	1599.2	O K
240 min Winter	65.278	1.278	23.0	1692.8	O K
360 min Winter	65.348	1.348	23.0	1804.5	O K
480 min Winter	65.383	1.383	23.0	1860.1	O K
600 min Winter	65.397	1.397	23.0	1883.8	O K
720 min Winter	65.399	1.399	23.0	1887.2	O K
960 min Winter	65.383	1.383	23.0	1859.7	O K
1440 min Winter	65.339	1.339	23.0	1790.2	O K
2160 min Winter	65.244	1.244	23.0	1638.4	O K
2880 min Winter	65.138	1.138	23.0	1475.8	O K
4320 min Winter	64.886	0.886	23.0	1105.3	O K
5760 min Winter	64.663	0.663	23.0	798.9	O K
7200 min Winter	64.496	0.496	23.0	582.1	O K
8640 min Winter	64.378	0.378	22.9	435.2	O K
10080 min Winter	64.300	0.300	22.3	341.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	59.370	0.0	1280.1	66
120 min Winter	36.292	0.0	1566.0	124
180 min Winter	27.260	0.0	1764.7	182
240 min Winter	22.247	0.0	1920.2	240
360 min Winter	16.667	0.0	2157.4	354
480 min Winter	13.556	0.0	2338.7	468
600 min Winter	11.536	0.0	2486.3	578
720 min Winter	10.103	0.0	2611.1	684
960 min Winter	8.181	0.0	2813.7	802
1440 min Winter	6.066	0.0	3103.1	1096
2160 min Winter	4.492	0.0	3509.7	1560
2880 min Winter	3.640	0.0	3790.6	2020
4320 min Winter	2.727	0.0	4257.6	2852
5760 min Winter	2.243	0.0	4681.2	3568
7200 min Winter	1.946	0.0	5076.6	4248
8640 min Winter	1.745	0.0	5458.8	4848
10080 min Winter	1.599	0.0	5832.2	5544

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 300598 514616 NY 00598 14616
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+50

Time Area Diagram

Total Area (ha) 2.590

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.295	4	8	1.295

Model Details

Storage is Online Cover Level (m) 65.500

Tank or Pond Structure

Invert Level (m) 64.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1085.0	1.500	1674.1

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0204-2310-1500-2310
Design Head (m)	1.500
Design Flow (l/s)	23.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	204
Invert Level (m)	64.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	23.1	Kick-Flo®	0.993	18.9
Flush-Flo™	0.454	23.0	Mean Flow over Head Range	-	19.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.0	0.800	21.8	2.000	26.4	4.000	36.9	7.000	48.4
0.200	19.5	1.000	19.0	2.200	27.7	4.500	39.1	7.500	50.0
0.300	22.3	1.200	20.7	2.400	28.9	5.000	41.1	8.000	51.6
0.400	22.9	1.400	22.3	2.600	30.0	5.500	43.0	8.500	53.1
0.500	23.0	1.600	23.8	3.000	32.1	6.000	44.9	9.000	54.6
0.600	22.7	1.800	25.1	3.500	34.6	6.500	46.7	9.500	56.1

APPENDIX C

UU CORRESPONDENCE

PRE-DEVELOPMENT ENQUIRY RESPONSE

Chris Abram

From: wastewaterdeveloperservices@uuplc.co.uk
Sent: 04 October 2022 15:36
To: Chris Abram; nicola.pilkington@uuplc.co.uk
Subject: RE: Our reference - 02852724 Land off Dalzell Street, Dalzell Street, Moor Row , Cumbria, CA24 3JP

Good Afternoon Chris

Pre Development Enquiry for: Land off Dalzell Street UU Reference Number : 02852724

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 6723 723 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 375mm diameter public combined sewer that runs adjacent to the south of your proposed development at a at an unrestricted rate.

We would have no objection to you utilising the existing connection on site (as shown in your indicative drainage layout), however please be aware this is likely a private asset and would therefore need to be adopted if you intend to get any of the proposed foul drainage adopted. This may mean it needs to be brought up to adoptable standards.

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.

In accordance with our infrastructure plans we may ask you to change your point of connection. Therefore please contact us when you are ready to formalise your drainage proposals, we would suggest before you submit for Full Planning.

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 waterbody.

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.

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), however it is noted from your email that the intention is to elave surface water private due to the intention of adding in SuDS features. Please note we do adopt SuDS so the SW system may still be adoptable.

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/sewerage-sector-guidance-approved-documents/

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.

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/wastewater-services/sewer-connections/sewer-connection/

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,

Nicola

United Utilities
Water for the North West

Nicola Pilkington
Developer Engineer
Developer Services & Metering
Customer Services
M: 07795851180
unitedutilities.com

---------- Original Message ----------
From: wastewaterdeveloperservices@uuplc.co.uk [wastewaterdeveloperservices@uuplc.co.uk]
Sent: 26/09/2022 14:21

To: chris.abram@rgparkins.com
Subject: Our reference - 02852724 Land off Dalzell Street, Dalzell Street, Moor Row , Cumbria, CA24 3JP

Good Afternoon Chris

PRE DEVELOPMENT APPLICATION AT: Land off Dalzell Street, Dalzell Street, Moor Row , Cumbria, CA24 3JP
UU Ref: 02852724

Please accept this email as receipt of your application received on 23/09/2022 for the above development. This has now been logged on our system and the job reference is 02852111 we would ask that you quote this reference in all future correspondence.

I have reviewed your application (and attachments) and can confirm this is suitable to be passed to Mike Duckworth for technical assessment. You will receive their response within 8 working days.

Kind regards

Amanda Harding
Customer Advisor Advanced
Developer Services & Metering
Customer Services
Direct Tel: 01925 233186
Tel: 0345 072 6067
unitedutilities.com

If you have received a great service today why not tell us?
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Did you know we now have a live chat facility available to you Mon to Friday 8 -5pm. You just click on the orange live chat box on our webpage and one of our advisors will be ready to chat to you and help you with your enquiry https://www.unitedutilities.com/builders-developers/ or you can email us at WastewaterDeveloperServices@uuplc.co.uk