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# Flood Risk Assessment & Drainage Strategy

## Proposed Residential Development, Griffin Close, Frizington

Thomas Armstrong Construction and Home Group

Ref: K41128.FRA/001

| Version | Date | Prepared By | Checked By | Approved By |
|---|---|---|---|---|
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| | | | | |



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# CONTENTS

## FIGURES



## TABLES

## GLOSSARY OF TERMS

| | |
|---|---|
| AEP | Annual Exceedance Probability |
| AOD | Above Ordnance Datum |
| BGL | Below Ground Level |
| BGS | British Geological Society |
| CC | Climate Change |
| 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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# 1. INTRODUCTION

## 1.1 BACKGROUND

This report has been prepared by R. G. Parkins & Partners Ltd (RGP) for Thomas Armstrong Construction and Home Group in support of their proposals to construct 18 new dwellings at a residential development located at Griffin Close, Frizington.

RGP has been appointed to undertake a Flood Risk Assessment and Foul and Surface Water Drainage Strategy to support a planning application that fulfils the requirements of the Local Planning Authority, Lead Local Flood Authority, Environment Agency and the Sewerage Undertaker.

The following report demonstrates the proposed development will not adversely affect flood risk elsewhere.

## 1.2 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."

## 1.3 THE DEVELOPMENT IN THE CONTEXT OF PLANNING POLICY

Owing to the size of the development in terms of number of properties (18 no.), 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 0.502 ha (hectares) and by reference to the Environment Agency Flood Map, the site lies entirely 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 1.1.

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.



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*Table 1.1 Vulnerability Classification*

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

# 2. SITE CHARACTERISATION

## 2.1 SITE LOCATION

The site is located to the west of Frizington in Cumbria on a plot of land located to the immediate west of Griffin Close and to the north of Greenvale Court Road. The National Grid Co-Ordinates to the centre of the site are 303350E 5173600N (Figure 2.1).

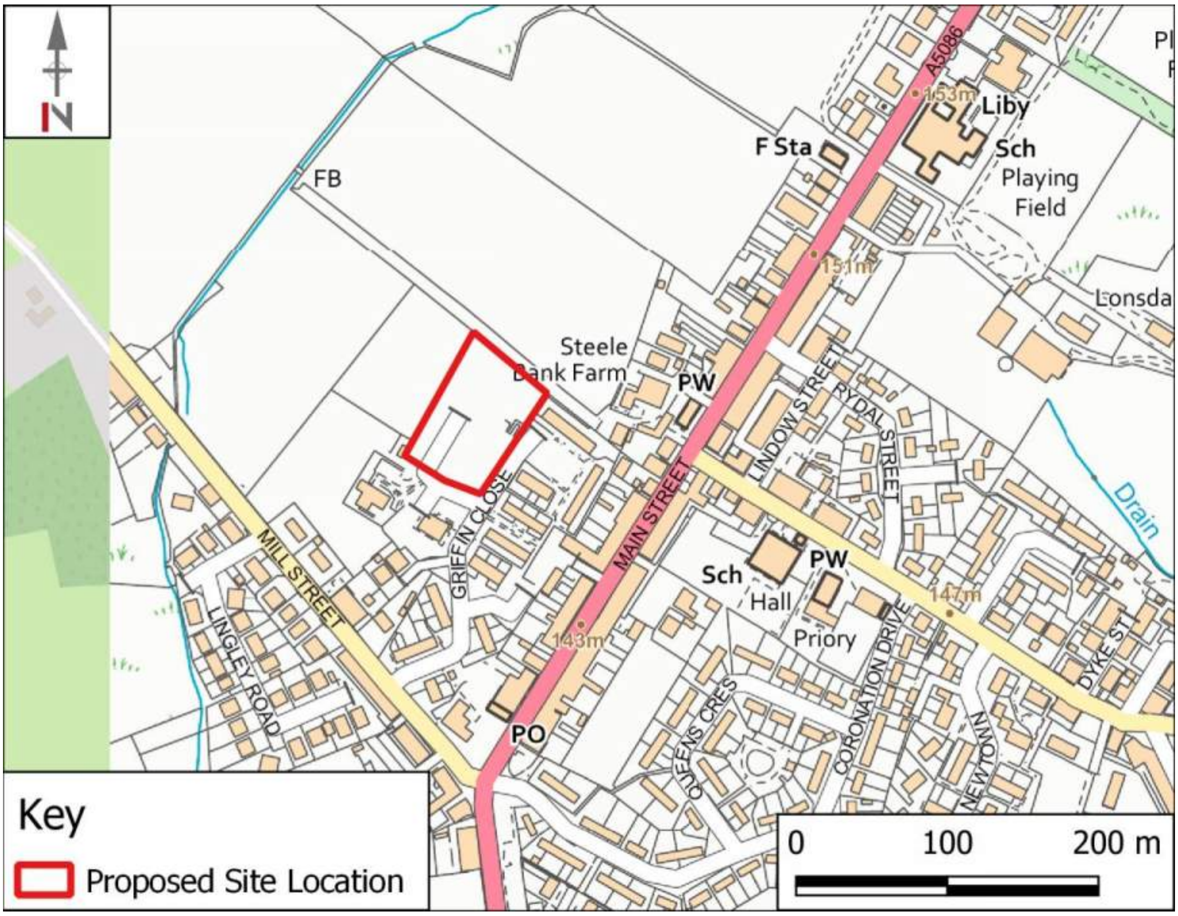


*Figure 2.1 Site Location*

## 2.2 SITE DESCRIPTION

The site covers an area of approximately 0.502 ha (5,016.5 m²). The site was formerly the location of the now demolished Greenvale Court sheltered accommodation complex, with some remnants of its former use such as hardstanding car park areas, abandoned drainage inspection chamber covers and retaining walls still visible in some areas. However the majority of the site at present is unused greenspace.

The site is bounded to the south by Greenvale Court Road, with Lindisfarne Residential Home and Griffin Close Medical Centre situated on the opposite side of this road. Griffin Close Road and residential area forms the eastern boundary. Agricultural land forms the neighbouring boundaries to the western and northern perimeters.



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Topographically, the site is relatively level with a typical fall from east to west ranging from circa. 139.00 mAOD to 138.25 mAOD. Along the eastern boundary with Griffin Close the levels slope steeply up towards the existing road to an approx. higher level of around 140.5 mAOD.

Access to the site is by road via. Griffin Close with pedestrian access available down a set of steps located off Griffin Close.

## 2.3 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 2.1. The Defra Magic Maps [6] indicates the nearest Source Protection Zone is located c. 6.70 km to the south (Zone III Total Catchment).

The site is not located within a drinking water protected area or drinking water safeguard zone for surface water or groundwater.

The development site overlies a secondary aquifer with 'Medium' groundwater vulnerability and falls within an area classified as a 'Soluble Rock Risk'.

***Table 2.1 Site Geological Summary***

| Geological Unit | Classification | Description | Aquifer Classification |
|---|---|---|---|
| Soil | Soilscape 18 | Slowly permeable, seasonally wet, slightly acid but base rich loamy and clayey soils. | N/A |
| Drift | Till, Devensian | Diamicton – clay, silt, sands and gravel | Summary: Secondary (undifferentiated) |
| Solid | Pennine Middle Coal Measures Formation | Mudstone, siltstone and sandstone | Summary: Secondary A |

## 2.4 HYDROLOGY

Reference to OS Mapping indicates the nearest open watercourse Lingla Beck lies approx. 210 m to the northwest. This watercourse is classified as 'Main River' and is therefore regulated by the Environment Agency.

## 2.5 EXISTING SEWERS

Reference to the United Utilities sewer records indicates the nearest public sewer to the site location is a foul sewer located in Griffin Close situated at a much higher level to the development that would not allow for a direct gravity connection. The nearest potential public sewer that would allow a connection from the development shown on the records is a combined sewer located towards the rear of 'The Laurels' residences south of the development site. However, the sewer records appear to be incomplete whereby this section of sewer (and others nearby) do not appear to be linked, warranting further investigation of the local sewer network.



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Separate existing private foul and surface water drainage runs that serviced the former building are still present on the site with outfall chambers towards the southern boundary near the existing entrance having the potential to be utilised for the new development if suitable. CCTV drainage investigations have been undertaken as discussed below.

The neighbouring Medical Centre and Lindisfarne Residential Home buildings located to the south of the site on the remote side of Greenvale Court Road are known to have functioning drainage systems that appear to be routed in the same direction to the existing site drainage outfall routes.

## 2.6 DRAINAGE SURVEY INVESTIGATIONS

SK Drainage Solutions have carried out initial CCTV investigations on the existing site drainage in July 2022. This identified that the existing site drainage has separate surface and foul water networks that are routed off site under Greenvale Court Road for ultimate disposal.

The surface water outfall pipe was traced in the direction of the surgery where approximately 36m downstream the pipe was found to be fractured and in very poor condition preventing the passage of the crawler unit, the downstream connection point was not therefore able to be verified. In addition, access issues to potential connecting downstream manholes being located in third party land in an areas of dense vegetation have thus far prevented any further investigation.

The foul sewer run was traced all the way through to a manhole in the surgery car park and beyond this appeared to be routed towards the section of combined public sewer as shown on the sewer records towards the rear of 'The Laurels' access issues again prevented further investigation.

Further CCTV drainage investigations were carried out in April 2024 by SK Drainage Solutions of the wider sewer network outside of the site to try and establish the disposal route and connection points of the existing site drainage. Whilst missing sections of the sewer records were established in the Mill Street and Lingley Fields areas further away from the site the overall disposal route and connection points of the existing site drainage was still not established due to the same access issues to manholes as incurred previously.

Access agreements are now in the process of being established with the landowner (Cumberland Council) to allow the clearance of obstructing vegetation to gain access to these manholes. Once finalised a further round of CCTV survey investigations will be carried out in an attempt to verify the overall downstream disposal route and condition of the existing pipework to determine their condition and suitability for use in the new development.

## 2.7 GROUND INVESTIGATION

A Phase 2 Ground Investigation report has been issued by GEO Environmental Engineering Ltd [17] in February 2023 which included intrusive ground investigations undertaken at the site between September and October 2022.

The below information regarding ground conditions are taken from this report.



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Ground investigations comprised dynamic windowless sampling boreholes, rotary openholed boreholes, mechanically excavated trial pits and trenches. In situ geotechnical testing and chemical laboratory testing was also conducted.

Made ground was encountered across the site to depths of between c.0.40m and 6.60m bgl.

The made ground was noted as deepest across the northeastern part where it was recorded as topsoil overlying deep clay fill. The reason for such deep made ground is unclear at present and further works are recommended to confirm and delineate the extents of the fill material.

Made ground across the rest of the site, was typically 0.40m to 2.70m deep and comprised topsoil with occasional gravel of clinker, coal, slag and brick, overlying soft and firm sandy clay fill with gravel of clinker, coal, sandstone and brick. Occasional wood fragments, peat, topsoil and black organic silt inclusions were also noted. This was occasionally underlain by gravel of coarse dolomite.

The natural drift deposits typically comprised firm to stiff or stiff light brown and grey, silty sandy gravelly clay. A band of medium dense slightly clayey gravelly sand was also encountered between c.1.90m and c.3.00m bgl (WS01). The clay encountered directly beneath the made ground in borehole WS02 at c.5.50m bgl was noted as a very soft. A comment on the log suggests that this could be possible fill material.

Solid strata/bedrock was encountered in the rotary boreholes at depths of between c.2.90m and 6.60m bgl. The bedrock was described as light grey and reddish brown mudstone with occasional thin, hard siltstone and sandstone bands.

Up to three seams of coal were encountered in the rotary boreholes from depths of between 7.30m and 19.20m bgl. The seams appear to dip to the south west. These varied between 0.20m and 1.40m in thickness. The seams were noted as intact in the boreholes, which could potentially be representative of coal pillars if workings are present.

Three trenches were pulled across the area where a mine shaft is shown on The Coal Authority Plan. The trenches encountered made ground which was typically less than c.1.30m deep, however, a localised pocket of made ground extending to c.2.70m bgl was noted. This comprised firm grey brown gravelly clay with occasional black organic. No direct evidence of a mine shaft was encountered.

The exploratory holes were typically dry during the intrusive ground investigation works. However, significant groundwater ingress was noted in one trial pit (TP03) at c.1.30m bgl. This was noted as perched water within the made ground and the flow was noted to cease quickly.

The rotary boreholes were drilled with water flush which masked any groundwater ingress. Groundwater monitoring of installations placed in the boreholes has been carried out on six occasions between September and December 2022.



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Standing groundwater levels have been recorded between c.0.20m and c.1.00m bgl. Given the ground conditions, it is likely that the water has resulted from surface ingress which has been trapped/perched within the boreholes rather than a continuous groundwater table.

For further details refer to Geo Environmental Engineering Report No. GEO2023-5496.

## 2.8 COAL MINING INVESTIGATIONS

The intrusive ground investigations works did not positively identify any evidence of a mine shaft at the location indicated by Coal Authority records. However, boreholes in the north eastern part of the site encountered anomalies that could be associated with a mine shaft. As such, further works are recommended in this respect.

A Coal Authority License is required to enable investigation of the shallow mine workings and mine shaft identified.

Further intrusive works are programmed that include a geophysical survey, trial trenching, excavations and supplementary boreholes to investigate for potential historic mine shaft and mine workings within the site locality subject to receipt of the relevant Coal Authority Permit.



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# 3. ASSESSMENT OF FLOOD RISK

## 3.1 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.

## 3.2 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 3.1 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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## 3.3 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
- Development layout plan
- Topographic survey

## 3.4 ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING

Figure 3.1 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.

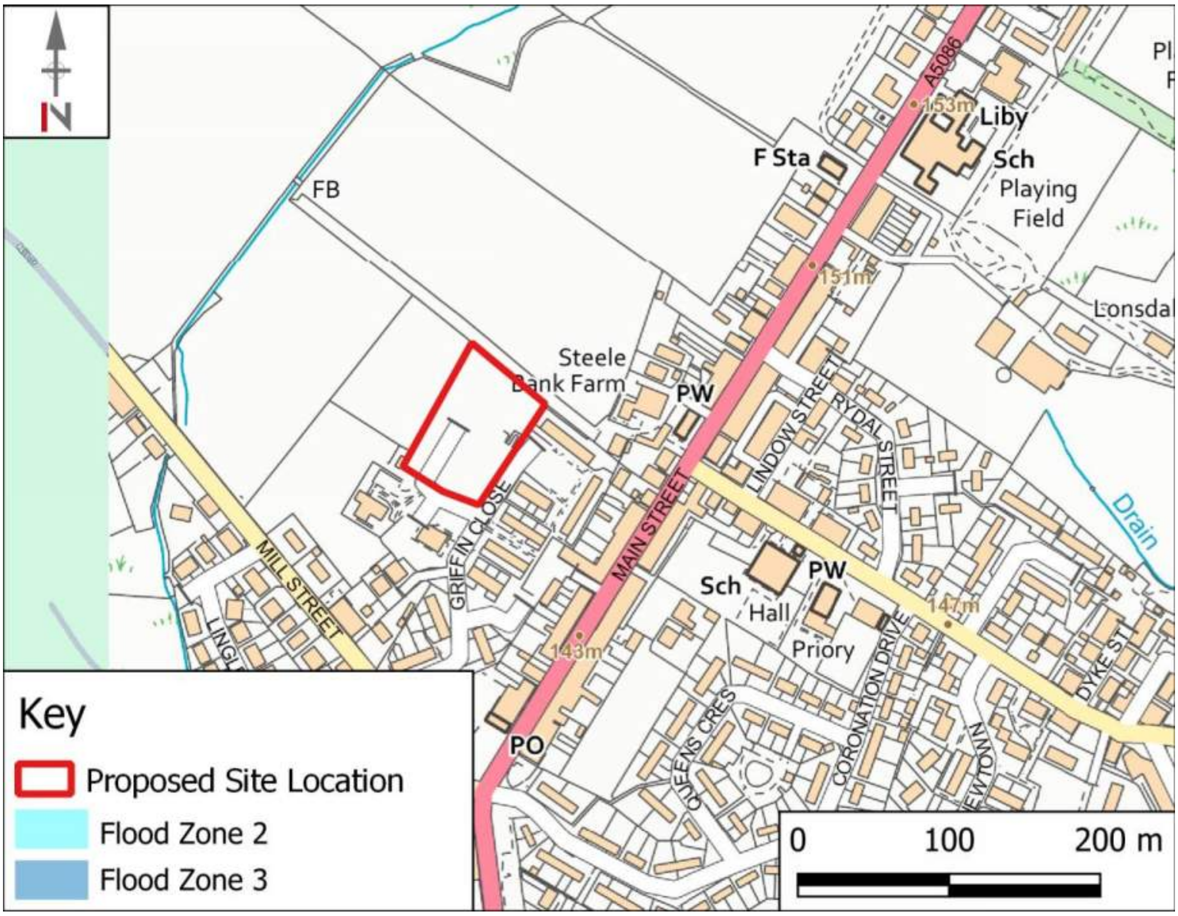


*Figure 3.1 Environment Agency Flood Map for Planning*

Reference to Figure 3.1 indicates the site lies entirely 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.

## 3.5 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 3.2 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 a small, localised area within the proposed development boundary is shown in dark blue and at ‘high’ risk of surface water flooding with the risk of flooding being greater than 3.3% AEP.

It is unclear how up to date the surface water flood maps are, but as the surface water flooding area is contained to one localised area within the site it is likely attributable to runoff from hardstanding areas congregating in a localised depression. This does not align with the topographic



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survey information obtained for the site which shows levels in this area gently and consistently sloping away towards the western boundary. It is likely this surface water flood mapping predates the demolition of the former assisted living complex and therefore cannot be relied upon for accuracy.

As any new development resulting in an increase in impermeable areas could cause additional run-off if not properly managed. It is therefore proposed to incorporate sufficient drainage features, SuDS measures and attenuation storage to mitigate this as part of the overall Drainage Strategy. This is discussed in further detail in Section 4.

Flooding via this mechanism is therefore not considered to be a risk for the proposed development.

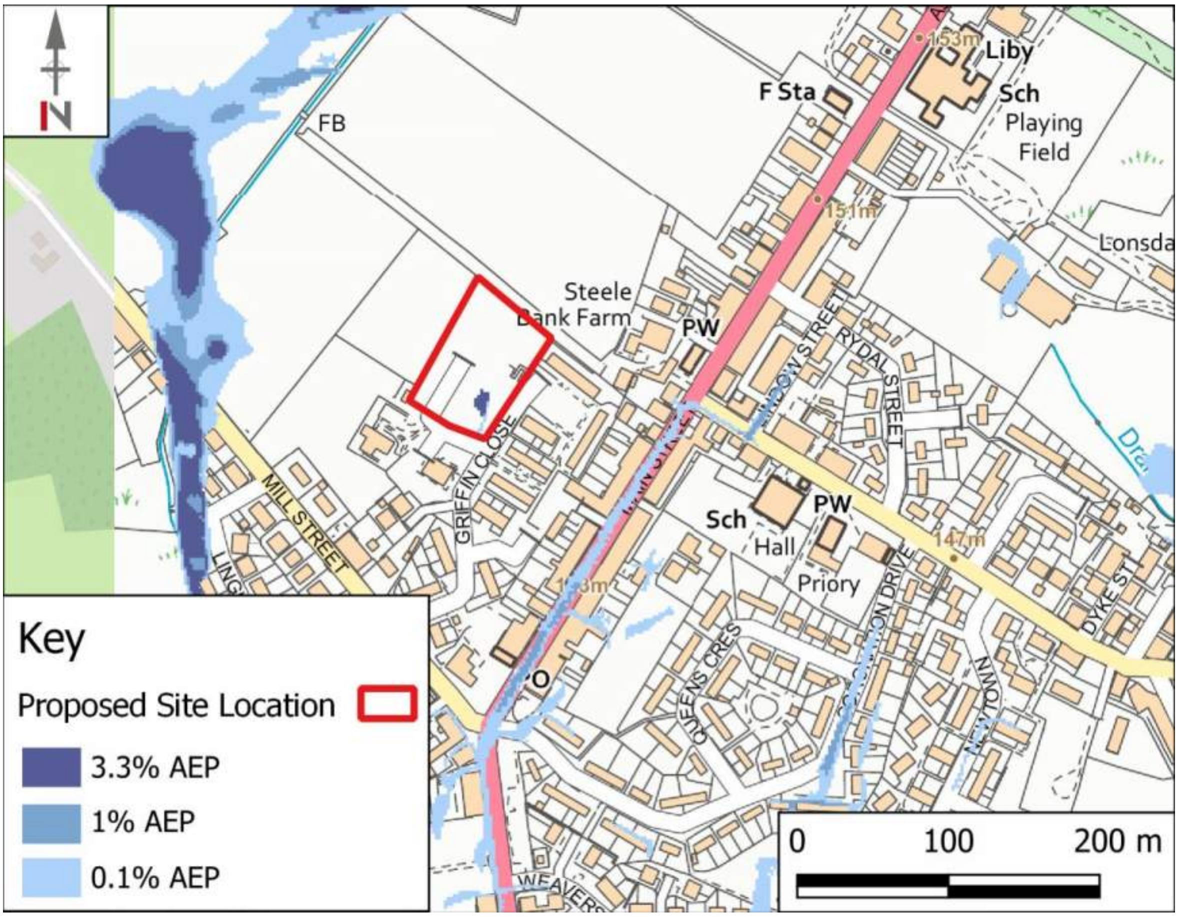


***Figure 3.2 Environment Agency Surface Water Flood Map***

It should be noted that EA guidance on the use of surface water flood maps states the following: *"Information Warnings: Risk of Flooding from Surface Water is not to be used at property level. If the Content is displayed in map form to others we recommend it should not be used with basemapping more detailed than 1:10,000 as the data is open to misinterpretation if used as a more detailed scale. Because of the way they have been produced and the fact that they are indicative, the maps are not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence."*

(https://www.data.gov.uk/dataset/d5ca01ec-e535-4d3f-adc0-089b4f03687d/risk-of-flooding_from-surface-water-suitability)

### 3.6 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.

As discussed in Section 2.7 the geotechnical testing undertaken at the site location found that there was no significant water ingress noted during the ground investigations other than that considered as trapped/perched water due to surface ingress.

Nevertheless, no below ground development is proposed in any case therefore groundwater would not pose a risk of flooding to the site.

### 3.7 FLOODING FROM RESERVOIRS, CANALS OR OTHER ARTIFICIAL SOURCES

No reservoirs canals or artificial structures are recorded as being within the vicinity of the site and the site is not considered at risk of flooding by these methods.

Flooding from these methods is usually based on a worst-case scenario of catastrophic failure of a dam or reservoir structure and therefore the likelihood of reservoir flooding etc. is, however 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 proposed development site is not however shown to be affected in any case.

### 3.8 FLOODING FROM SEWERS

United Utilities (UU) do not provide information on flood risk from their assets and there have been no reports of flooding from this method. It is therefore concluded the site is not at risk of flooding from these sources as they should be properly maintained by the sewerage undertaker.

# 4. SURFACE WATER DRAINAGE STRATEGY & DESIGN

## 4.1 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 [7]
- Code of Practice for Surface Water Management, BS8582:2013, November 2013[8]
- Rainfall Runoff Management for Developments, Defra/EA, SC030219, October 2013[9]
- Designing for Exceedance in Urban Drainage – Good Practice, CIRIA Report C635, 2006[10]
- Flood Estimation Handbook (FEH)[11]
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993[12]
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983[13]
- Flood Estimation for Small Catchments, Marshall & Bayliss, Institute of Hydrology, Report No. 124 (IoH 124), 1994[14]
- Department for Environment, Food and Rural Affairs, Non-Statutory Technical Standards for Sustainable Drainage Systems, March 2015[15]

The following drainage strategy is based on the latest site layout plan by Architects Plus (Drawing No. 22031-02). Any alterations to the site plan resulting in changes to impermeable areas will require the drainage strategy to be revisited.

## 4.2 SURFACE WATER DISPOSAL

Surface water disposal has been considered in line with the hierarchy outlined in the SuDS Manual[7]. The approach considers infiltration drainage in preference to disposal to watercourse, in preference to discharge to sewer.

Cumberland 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 (e.g. permeable paving).



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- **Site Control**: Management of water in the local area (e.g. swales, detention basins).
- **Regional Control**: Management of runoff from sites (e.g. balancing ponds, wetlands).

### 4.2.1 DISCHARGE TO GROUND

Geotechnical testing undertaken at the site by GEO Environmental Engineering has indicated that the ground is not suitable to facilitate soakaway drainage. For further information refer to Section 2.7. Based on the historic coal mine workings and significant levels and variable depths of made ground encountered across the site, an infiltration drainage strategy is not considered appropriate due to the risk of inundation settlement of the made ground.

In addition, as the existing hardstanding areas of the site and former care home are/were positively drained on separate systems for conveyance for off-site disposal via existing sewers, this also indicates that soakaways are not a viable drainage solution.

### 4.2.2 DISCHARGE TO WATERCOURSE

Disposal to watercourse (Lingla Beck) has been discounted due to the fact it would require a long complex route through third party owned land and it is unclear as to whether the receiving beck levels are compatible with the development to allow a gravity fed connection. Significant lengths of new pipework would also need to be installed and agreements would have to be sought with potentially multiple third-party landowners to enable a route to be established.

### 4.2.3 DISCHARGE TO SURFACE WATER SEWER

It is therefore considered most appropriate to replicate the original surface water drainage disposal arrangement utilising the existing surface water drainage pipework for conveyance off site. There is a small section of pipework near the surgery that will need to be repaired/replaced.

## 4.3 ASSESSMENT OF 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 4.2 shows the measured proposed land cover areas.

***Table 4.1 Land Cover Areas***

| Land Cover | Area | | Percentage of total site area |
|---|---|---|---|
| | $m^2$ | Ha | |
| Total housing roof area | 763.2 | 0.076 | 15% |
| Total parking and paved area | 1017.3 | 0.102 | 20% |
| Total road area | 1115.5 | 0.112 | 22% |
| Contributing garden & landscaped areas | 1017.6 | 0.102 | 20% |
| Remaining garden & landscaped areas not contributing to the drainage network | 1102.9 | 0.110 | 22% |

To develop the detailed drainage design, only certain surfaces and areas will be positively drained into the surface water network. Positively drained areas include roof areas, car parking, access road and footways. All other areas (principally gardens and landscaping) will either have a permeable surface or will have no positive drainage.

Having assessed the site proposals the landscaped and garden areas can however be split into two distinct areas, those considered to be disconnected from the development drainage (Plots 13-18 and green space on the western extent of the site falling away from the development) and those which could contribute some level of runoff to the drainage network i.e. garden/green areas that could contribute some level of runoff onto drained hardstanding areas (Plots 1-12 and the greenspace forming the sloping north eastern perimeter).

Table 4.3 summarises this and shows that the total catchment area which could contribute to the drained network as covering 78% of the overall site area with the remaining undrained areas making up the remaining 22%.

A surface water catchment plan is provided in Appendix A for reference.

***Table 4.2 Summary of drained and undrained areas into surface water drainage system***

| Land Cover | Area | | Percentage of total site area |
|---|---|---|---|
| | m² | Ha | |
| Total Contributing Catchment Drainage Area | 3913.6 | 0.391 | 78% |
| Remaining permeable/undrained Area | 1102.9 | 0.110 | 22% |

Without attenuation-based SuDS, the proposed development would increase the Rate of Runoff from the developed areas of the site.

## 4.4 PRE-DEVELOPMENT RUNOFF ASSESSMENT

As the site covers an area of less than 200 ha the Greenfield calculations have been undertaken in accordance with methodology described in IoH 124[14]. 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. The calculation has been based on the entire site area of 0.52 ha.

Despite there being existing areas of hardstanding present on the site the entire site area has been classified as Greenfield for the purposes of deriving the runoff calculations. This approach is highly conservative as the peak runoff rate from the former care home would have been significantly higher than the greenfield runoff rate calculated.

Full details of the calculations and the methodology for deriving the Peak Rate of Runoff are in included in Appendix B, and a summary included in Table 4.1.

The proposed discharge rate matching the equivalent Greenfield QBAR runoff of 4.1 l/s is also a considerable improvement on the rate of discharge that would previously have occurred when the site was occupied by the assisted living development which was positively drained at an unrestricted brownfield rate. By direct comparison if we assume the former complex had impermeable areas of only 50% of the overall site area, the equivalent brownfield QBAR runoff rate can be calculated as 36.7 l/s demonstrating that a significant level of betterment is proposed.



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*Table 4.3 Pre-Development Greenfield Runoff Rates*

| Rate of Runoff (l/s) | |
|---|---|
| **Event** | **Greenfield** |
| Q1 | 3.5 |
| QBAR | 4.1 |
| Q10 | 5.6 |
| Q30 | 6.9 |
| Q100 | 8.5 |
| Q100 + 50% CC | 12.7 |

## 4.5 RUNOFF CONTRIBUTION FROM PERMEABLE AREAS

A 40% contribution from affecting pervious / permeable areas should be allowed for within the calculations.

On this basis, of the 1017.6 $m^2$ of potentially contributing garden and landscaped catchment areas identified in Table 4.1, an additional 408 $m^2$ (40%) of this catchment has been accounted for as impermeable area in the drainage modelling.

Guidance by HR Wallingford stipulates a 30% contribution is the proposed default factor attributable to greenspace, the (40%) inclusion of this uplift from the potentially contributing greenspace and garden/landscaped areas of plots 1 to 12 at this site will result in highly conservative design.

## 4.6 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:

### 4.6.1 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.

The EA have provided a peak rainfall online map showing the anticipated changes in peak rainfall intensity across the UK. Climate change allowances are now provided on a catchment by catchment basis. The site falls within the South West Lakes catchment. Table 4.4 outlines the EA guidance for this catchment, for the anticipated design life of the proposed development.

In line with current guidance and for conservative design, a 50% allowance shall be used within this assessment.



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*Table 4.4 South West Lakes Management Catchment Peak Rainfall Allowances (1.0 AEP)*

| South West Lakes (1.0%AEP) | Central Allowance (%) | Upper End Allowance (%) |
|---|---|---|
| 2050s | 30 | 45 |
| 2070s | 35 | 50 |

4.6.2 URBAN CREEP

BS 8582:2013[8] 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 has been applied to the contributing area used for surface water drainage design.

4.6.3 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.

4.6.4 VOLUMETRIC RUNOFF COEFFICIENT (CV)

The volumetric runoff coefficient describes the volume of surface water 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 0.75 for summer and 0.84 for winter and are used for design on the basis that a percentage of contributing green areas has been included in the site catchment calculations.

4.6.5 RAINFALL MODEL

The calculations use the REFH2 unit hydrograph methodology in line with best practice as outlined in the SuDS Manual[7]. The calculations use the most up to date available catchment descriptors (2022) provided by the Centre for Ecology and Hydrology Flood Estimation Handbook web service.

4.7 SURFACE WATER DRAINAGE DESIGN

The proposed surface water drainage network serving the entire developable area of the site has been modelled using Causeway Flow (results are included in Appendix B).

The drainage design has been sized 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) and 40% uplift for contributing green spaces is accounted for within the calculations.

It is proposed that all impermeable site areas i.e. roof, driveway and road areas will ultimately drain via. gravity through a network of pipes and chambers either directly into or 'offline' via the flow control device to a single shared geocellular attenuation crate tank system located in the natural respective low point of the site to facilitate the drainage system.

Roof water, driveway and path runoff will connect directly into the surface water pipe network upstream of the attenuation systems, with inspection chambers utilised to route the new pipework and allow for future inspection and maintenance. Proposed external levels will fall consistently to enable gravity connections to the drainage system.

Silt traps will be located upstream of the 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 tank will be founded at a suitable level providing a minimum depth of suitable cover whilst allowing for connection to the surface water network. The tank will be wrapped and sealed with an impermeable membrane to provide a water-tight structure.

The geocellular tank will be formed as a permanent feature under a shared private driveway/parking area to facilitate future access and maintenance requirements.

The attenuation tank will provide a minimum storage capacity of 220 $m^3$ in order to service the development. A 1.2m deep x 8m wide x 24m long tank has been calculated to provide the required volumetric capacity.

A flow control chamber incorporating a Hydro-brake will be located downstream of the attenuation tank restricting discharge to the equivalent site greenfield runoff rate (QBAR) of 4.1 l/s, prior to discharge via the existing surface water drainage pipe connection and outfall route.

Hydro-brake design information is included in Appendix C for reference.

The access road and car parking areas will be constructed using conventional surfacing in the form of asphalt. The access road will be drained via. a series of highway gullies and/or channel drains into the proposed surface water drainage network.

Full details of the drainage proposals are shown on RGP drawings K41128-10, 12 & 13, included in Appendix A.

## 4.8 OTHER BENEFITS OF DEVELOPMENT

The development site in its current form is sparse vegetation, underlain by relatively impermeable soil, which 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.

The proposed development site will tie into the existing topography via careful design. Slopes, gardens and open space areas will be carefully landscaped using a variety of plants, shrubs and trees, providing a net gain in biodiversity and enhanced storage/protection against overland flows.

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 and service trenches.

Hydraulic gradients and velocities will be reduced, and the risk of downstream flooding would not be increased.

## 4.9 DESIGNING FOR LOCAL DRAINAGE SYSTEM FAILURE

In accordance with the general principles discussed in CIRIA Report C635 – Designing for Exceedance in Urban Drainage [10] the proposed surface water drainage, where practical, should be designed to ensure there is no increased risk of flooding to the proposed dwellings on the site or elsewhere as a result of extreme rainfall, lack of maintenance, blockages or other causes. These measures are discussed below.

### 4.9.1 BLOCKAGE & EXCEEDANCE

The sustainable drainage system has been designed to attenuate a 100-year design storm including a 50% allowance for climate change, with no flooding. The drainage system will also provide capacity for lower probability (greater design storm events) which are not critical duration.

Should flooding occur within any of the flow control devices, manholes or silt traps, exceedance flows would follow the road gradients, re-entering the network via capture from the proposed new road gullies.

In the highly unlikely event that exceedance flows were to bypass any of the proposed development drainage it is proposed to install a new double gully just outside the site boundary which could be formed as part of the new road entrance installation works to provide additional redundancy and ensure the interception and capture of any such flows generated in extreme events.

### 4.9.2 SURFACE STORAGE & EXTERNAL LEVELS

The site levels have been 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 have been raised to channel surface water runoff back into the drainage system or onto the existing highway.

### 4.9.3 BUILDING LAYOUT & DETAIL

The finished floor levels to the new dwellings have been designed and situated to ensure that they are not at risk of flooding from overland flow. Finished floor levels will typically be set 150mm above external paved areas (whilst providing level access where needed). External footpaths typically fall away from the thresholds, ensuring that any flood water runs away from, rather than towards the dwellings. Threshold drains could be incorporated at level access points for additional redundancy.

### 4.9.4 DRAINAGE CONTINGENCY

The proposed surface water system will be designed to provide adequate storage volume against flooding for the Q100 event, including a 50% allowance to account for climate change. The drainage system will also provide capacity for lower probability (greater design storm events) which are not critical duration.



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## 4.10 SURFACE WATER TREATMENT

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[7] 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.

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. a hydrodynamic vortex separator before discharge off site. Tables 4.5-4.7 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 a hydrodynamic vortex separator (or similar device) which removes sediments, oils and floatables from the site stormwater runoff.

***Table 4.5 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 4.6 Pollution Hazard & Mitigation Indices - Parking Areas***

| 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 4.7 Pollution Hazard & Mitigation Indices - Road Areas***

| 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** |

It should be noted that if an existing surface water connection from the site to the public combined sewer is established then treatment of the surface water may not be required as all water will be routed for treatment via the local wastewater treatment works. The above information is therefore included for completeness and confirmation of the surface water treatment requirements will be established at Detailed Design stage.



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### 4.11 OPERATIONS & MAINTENANCE RESPONSIBILITY

The drainage systems will be privately maintained by Home Group. A SuDS '*Operations & Maintenance Plan'* has been prepared by RGP detailing the requirements for future maintenance of the SuDS components.

## 5. FOUL WATER DRAINAGE STRATEGY

It is proposed that foul water from the new development shall be drained via gravity within the site for disposal via connection to an existing private foul sewer chamber located on the southern boundary.

This sewer is routed south under Greenvale Court Road and likely discharges into the public combined sewer to the rear of 'The Laurel' residences.

The new connections will be subject to formal application to UU under S106 agreements. 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'*.

All private drainage will be constructed in accordance with The Building Regulations Approved Document Part H.

Foul water discharge calculations have been undertaken for the 18 no. dwellings in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers [16], as shown in Table 5.1.

Once the existing foul disposal route has been verified a pre-development enquiry will be submitted to UU to determine acceptance in principle.

***Table 5.1 Peak Foul Flow Rates***

| Sewerage Sector Design & Construction Guidance Clause B3.1 | |
|---|---|
| Total Peak Load based on Number of Dwellings, 18 no. units @ 4000 l/day | 72,000 |
| Peak Flow Rate from Site (l/s) | 0.83 |

The estimated total peak foul flow rate for the development is 0.83 litres/sec.

For further details, refer to the Outline Drainage Layout Plan included in Appendix A (K41128-10).

# 6. CONCLUSIONS AND RECOMMENDATIONS

The proposed Flood Risk Assessment and Drainage Strategy can be summarised as follows:

- 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).
- By reference to the National Planning Policy Framework [1] on Flood Risk, More Vulnerable development is acceptable within this flood zone.
- 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 confirmed that the underlying strata is not suitable for infiltration-based SuDS components.
- The watercourse located to the west of the site is not a suitable point of discharge due to third party land ownership and routing complications.
- It is proposed that surface water drainage shall be positively drainage and attenuated, using a geocellular tank system, with a hydro-brake flow control device restricting discharge to match the equivalent pre-development Greenfield QBAR rate of 4.1 l/s.
- Attenuated surface water disposal will be into the existing surface water system that served the original care home. A small section of this existing outfall pipework near the surgery will need to be repaired / renewed.
- Treatment of surface water runoff will be provided through a Hydrodynamic Vortex Separator if required.
- A SuDS Operations and Maintenance Plan has been prepared detailing future maintenance requirements of all sustainable drainage systems.
- Foul flows from the site shall discharge via gravity to the existing foul water drainage system that served the original care home, which discharges into the existing downstream UU public combined sewer. A pre-development wastewater enquiry will be submitted to UU.



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# 7. REFERENCES


[1] Ministry of Housing, Communities and Local Government, National Planning Policy Framework, December 2023.

[2] Ministry of Housing, Communities and Local Government, Planning Practice Guidance to the National Planning Policy Framework, August 2023

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

[4] British Geological Survey, Geoindex: http://mapapps2.bgs.ac.uk/geoindex/home.html

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

[6] Defra Magic Maps, 2024 https://magic.defra.gov.uk/MagicMap.aspx .

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

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

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

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

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

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

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

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

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

[16] 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

[17] GEO Environmental Engineering Ltd, February 2023. Phase II: Ground Investigation Report Proposed Residential Development of Land off Griffin Close, Frizington Cumbria. Report no. 2023-5496




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# APPENDIX A

DRAWINGS


General

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|---|---|---|---|---|---|

Issue Purpose: PLANNING

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| | | | |
|---|---|---|---|
| Client: Thomas Armstrong | Scale @ A1: 1:200 | First Issue: 28/06/2024 | Office of Origin: Kendal |
| Project: Griffin Close, Frizington | Drawn by: CA | Checked by: TM | Approved: |
| Drawing Title: Foul and Surface Water Drainage Layout | Project No: K41128 | Drawing No: 10 | Rev: |
| | BIM No: | | |


## KEY:

| | | DRAINAGE CONTRIBUTION |
|---|---|---|
| ROOF AREAS | | - 0.084 Ha<br>(10% urban creep uplift on roof areas) |
| ROAD/FOOTWAY AREAS | | - 0.112 Ha |
| PARKING/PAVED AREAS | | - 0.102 Ha |
| GARDEN/LANDSCAPE AREAS | | - 0.041 Ha<br>(40% contribution from gardens and greenspace) |
| TOTAL CATCHMENT | | - 0.339 Ha |

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| | | | |
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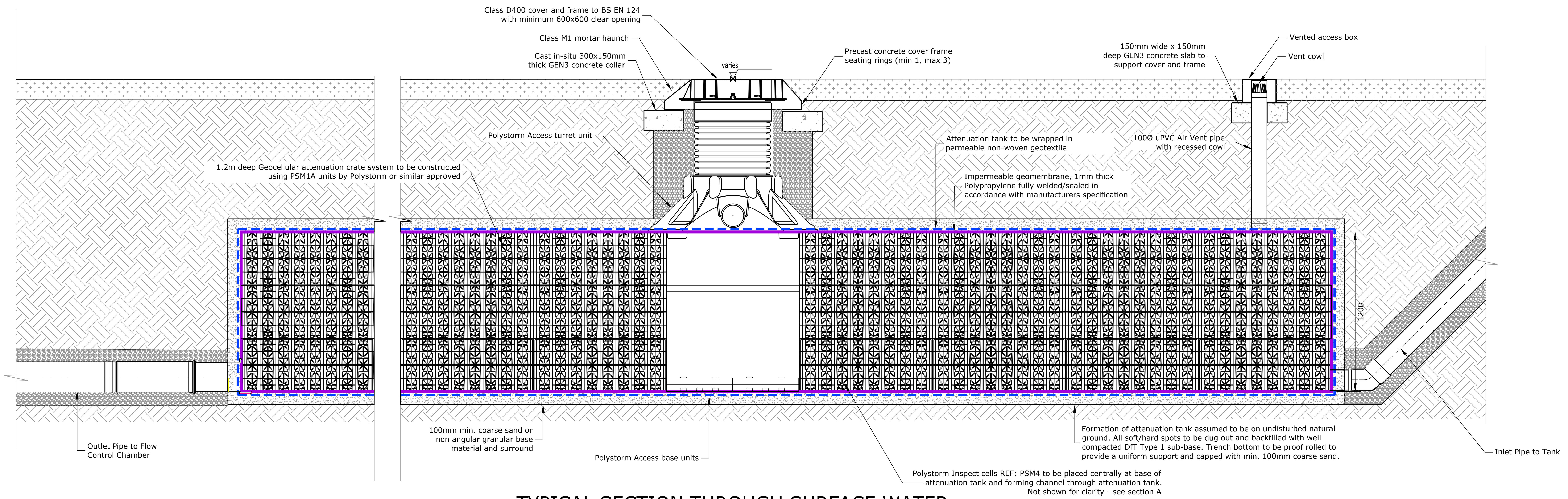
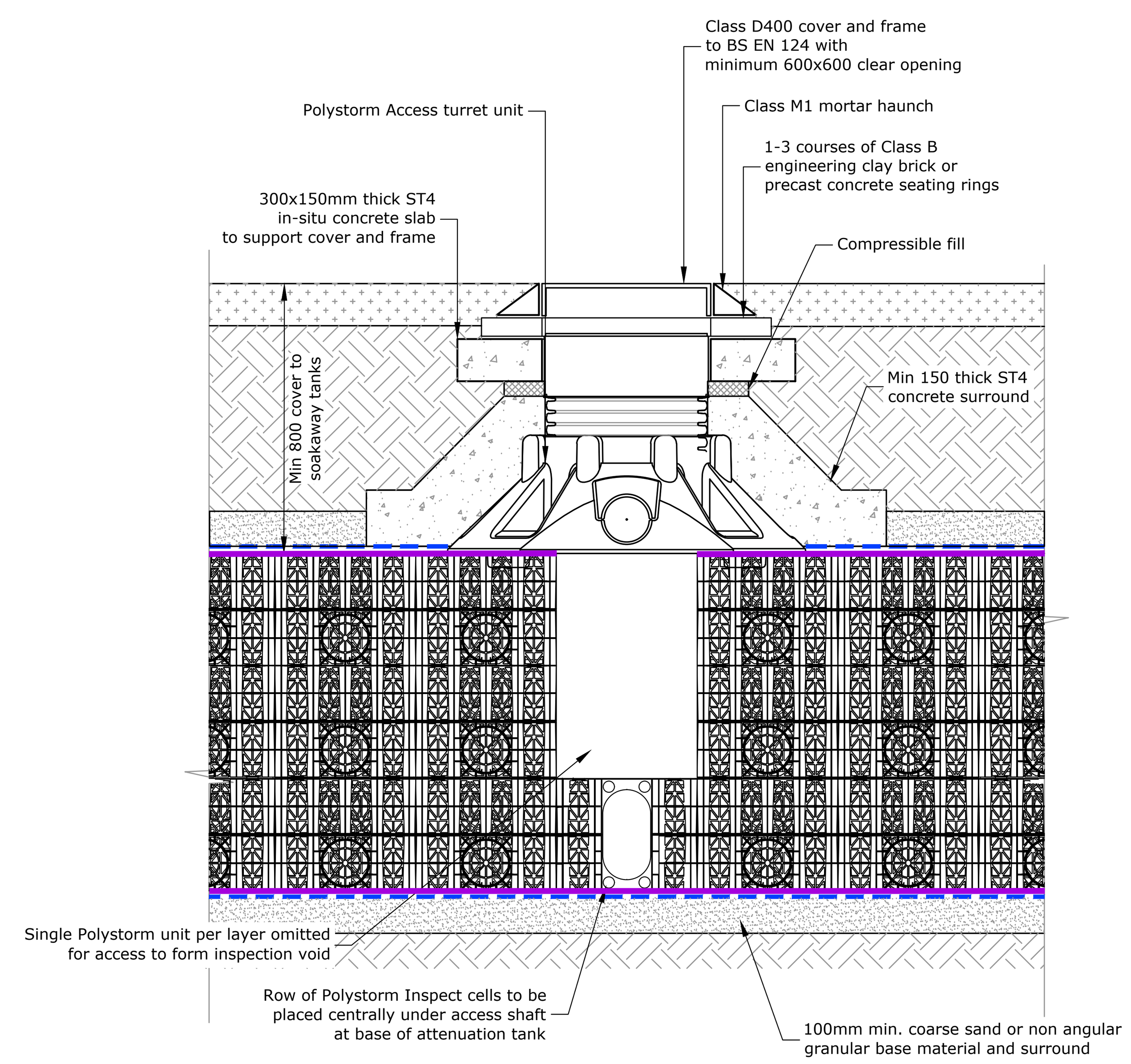
| Client: Thomas Armstrong | Scale @ A1: 1:200 | First Issue: 28/06/2024 | Office of Origin: Kendal |
| Project: Griffin Close, Frizington | Drawn by: CA | Checked by: TM | Approved: |
| Drawing Title: Surface Water Catchment Plan | Project No: K41128 | Drawing No: 11 | Rev: |
| | BIM No: | | |




## TYPICAL SECTION THROUGH SURFACE WATER DRAINAGE ATTENUATION TANK

SCALE 1:20




## SECTION A-A THROUGH ACCESS TURRET

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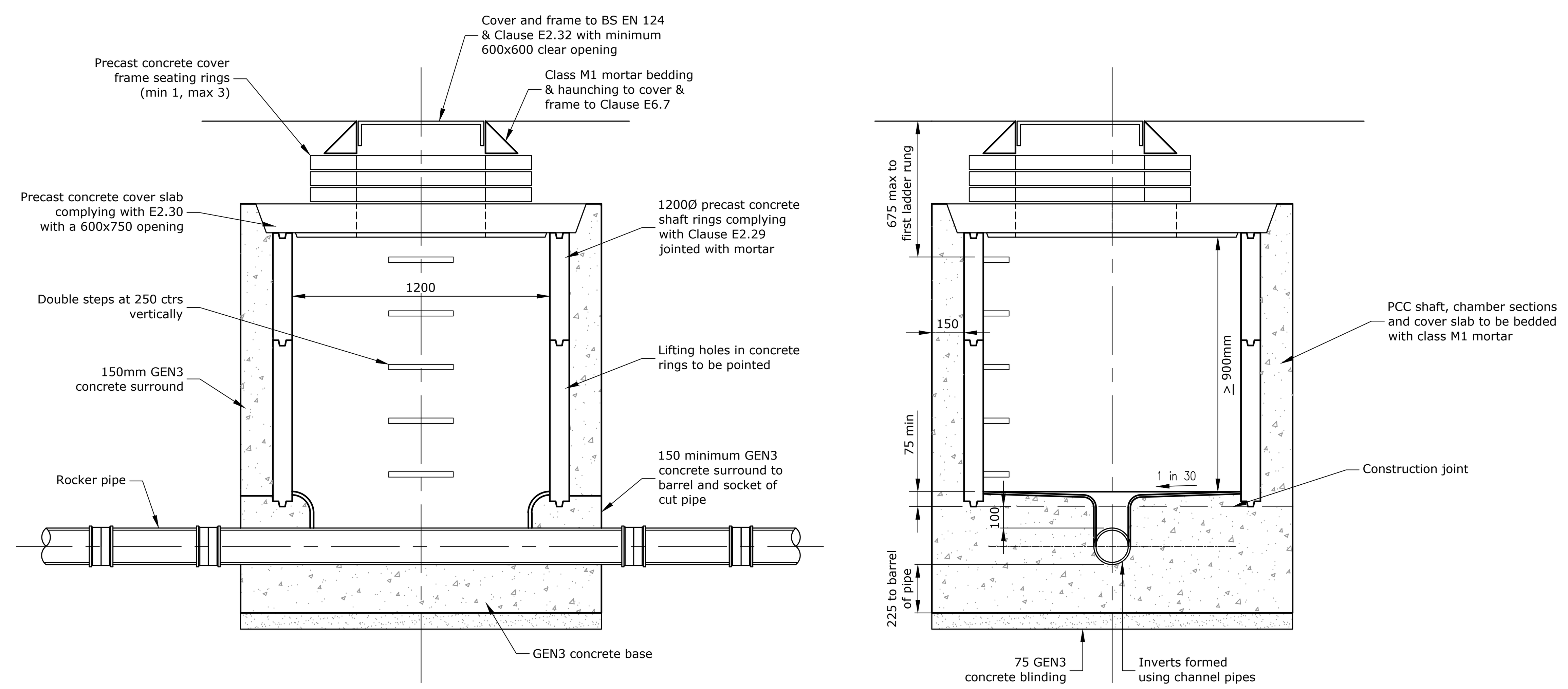
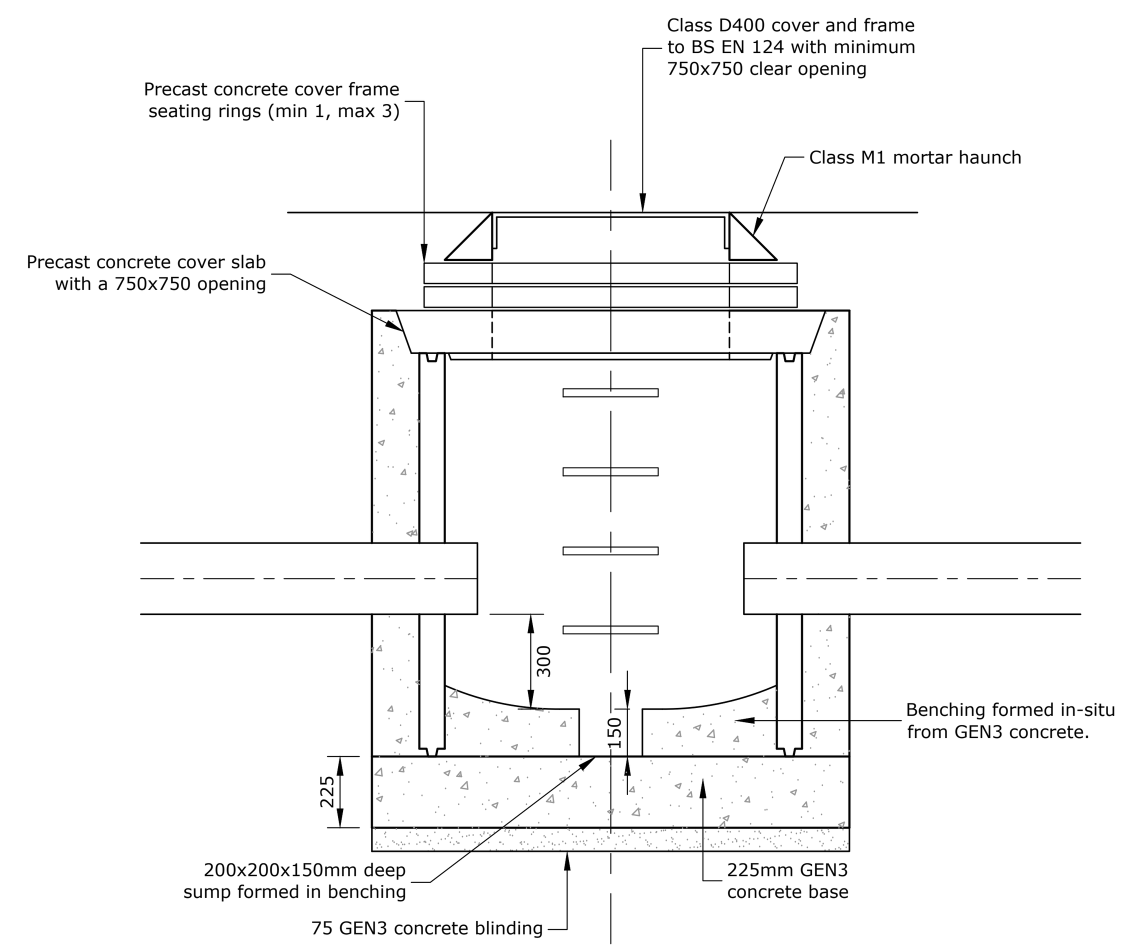


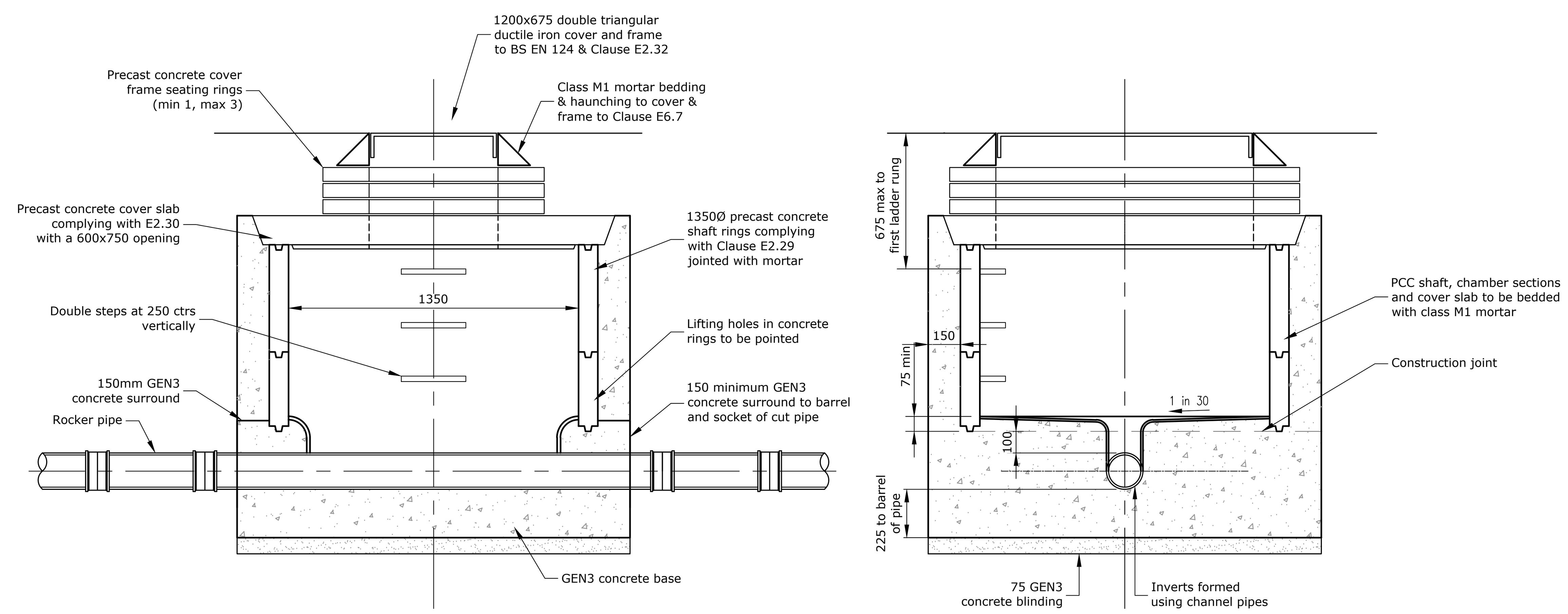

## TYPICAL MANHOLE DETAIL - TYPE B DEPTH FROM COVER LEVEL TO SOFFIT OF PIPE 1.5m TO 3m (1200Ø)

Scale 1:20




## TYPICAL SILT TRAP MANHOLE

Scale 1:20




## TYPICAL MANHOLE DETAIL - TYPE C DEPTH FROM COVER LEVEL TO SOFFIT OF PIPE LESS THAN 1.5m (1350Ø) 450mm MAX PIPE DIAMETER

Scale 1:20

General

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| Project: Griffin Close, Frizington | Drawn by: CA | Checked by: TM | Approved: |
| Drawing Title: Typical Drainage Construction Details Sheet 1 of 2 | Project No: K41128 | Drawing No: 12 | Rev: |
| | BIM No: | | |

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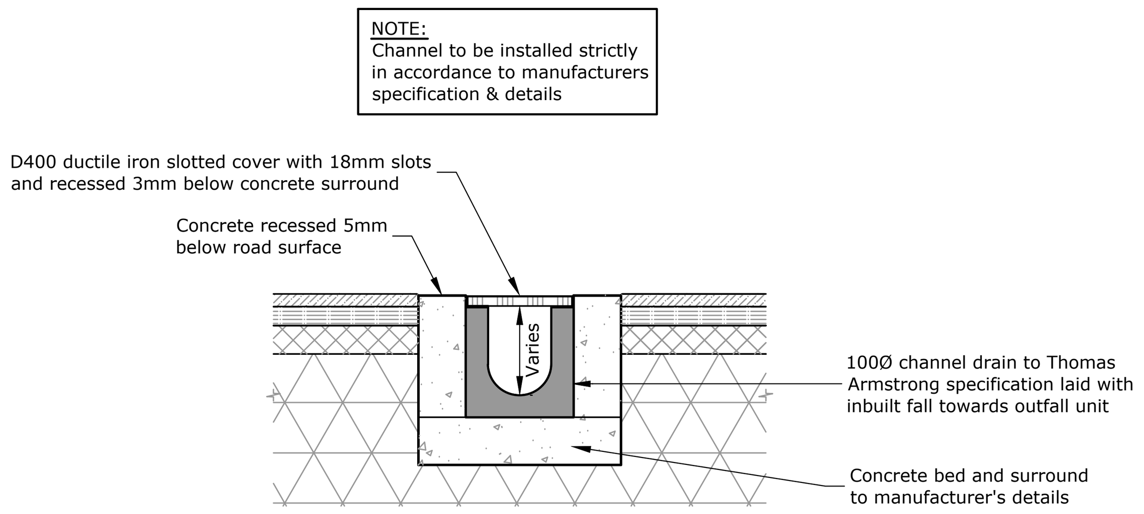
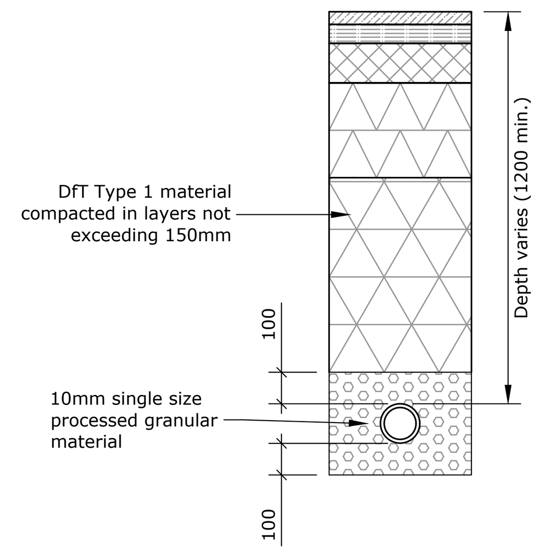
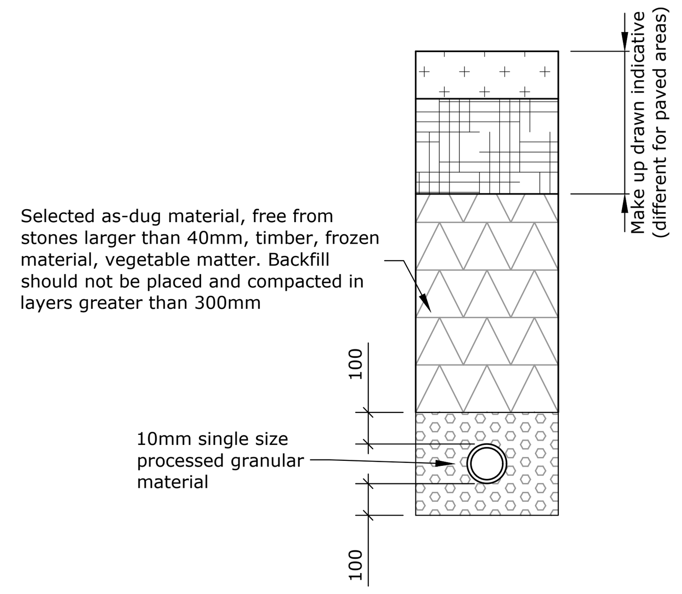


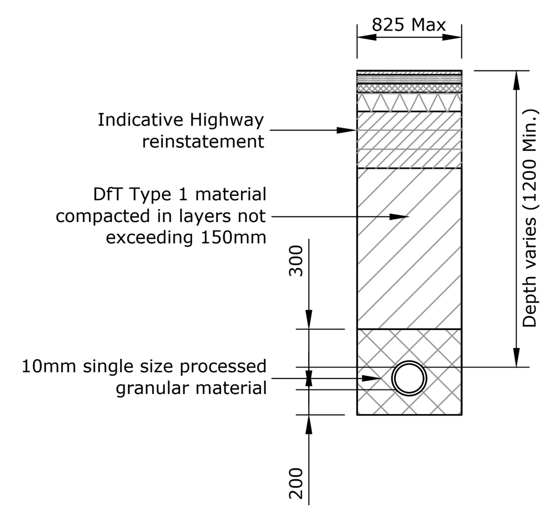

TYPICAL CHANNEL DRAIN DETAIL
SCALE 1:20




PIPE BEDDING FOR 100Ø/150Ø PIPES IN HARD LANDSCAPED AREAS
SCALE 1:20

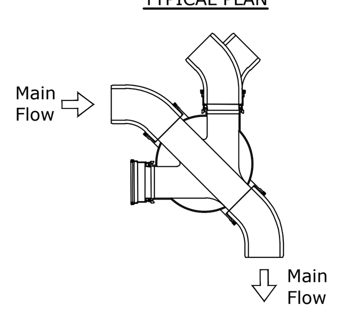



PIPE BEDDING FOR 100Ø/150Ø PIPES IN SOFT LANDSCAPED AREAS
SCALE 1:20




TYPE 7 EMBEDMENT CLASS S FOR 225Ø PIPE
SCALE 1:50

TYPICAL PLAN



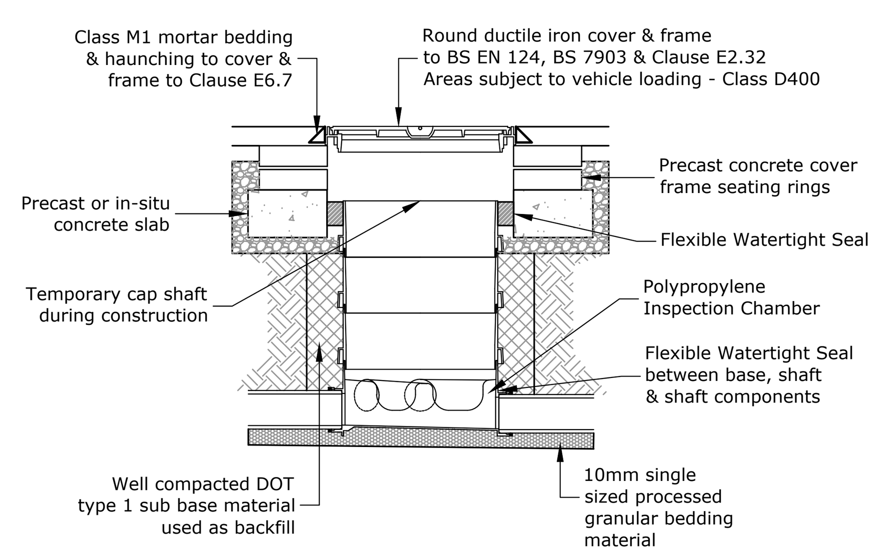

Where chambers are positioned on 90° corners always use the main channels by fitting a 45° bend on inlet & outlet

Bends of up to max 45° can be used on any inlet or the outlet

Short steep branch connections to be connected via a 45° inlet using a bend where necessary

Inlet stoppers to remain where connection not required

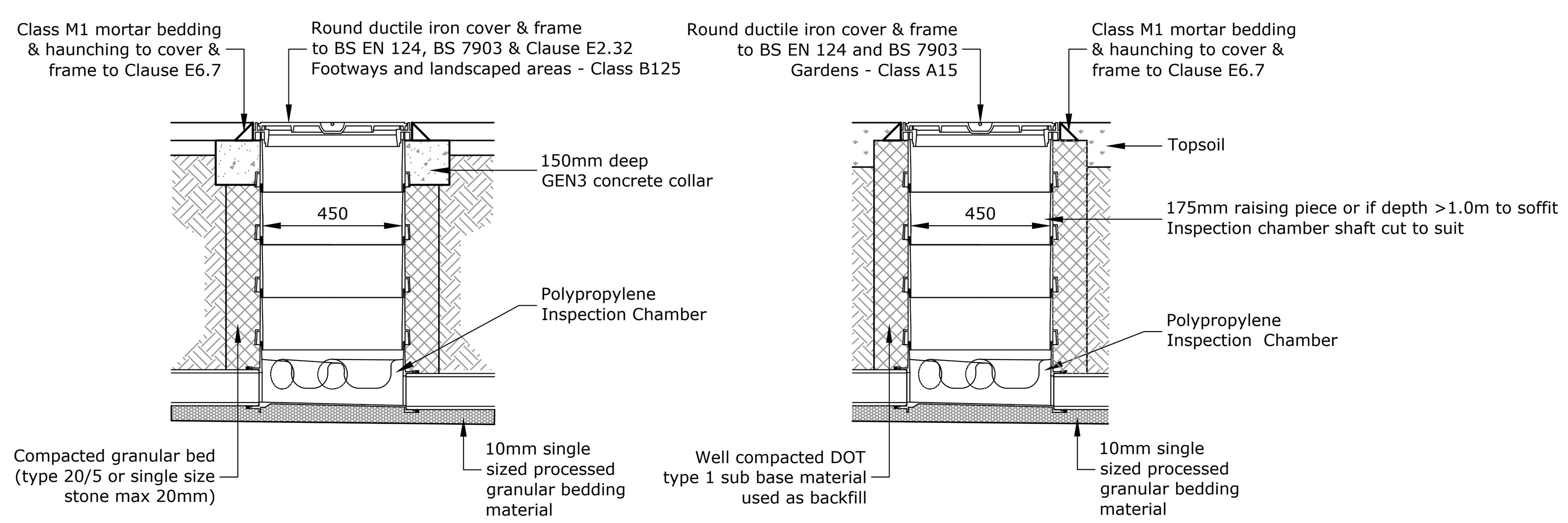
NOTE:
350Ø restricted access opening to be used where depth of chamber to soffit is >1.0m



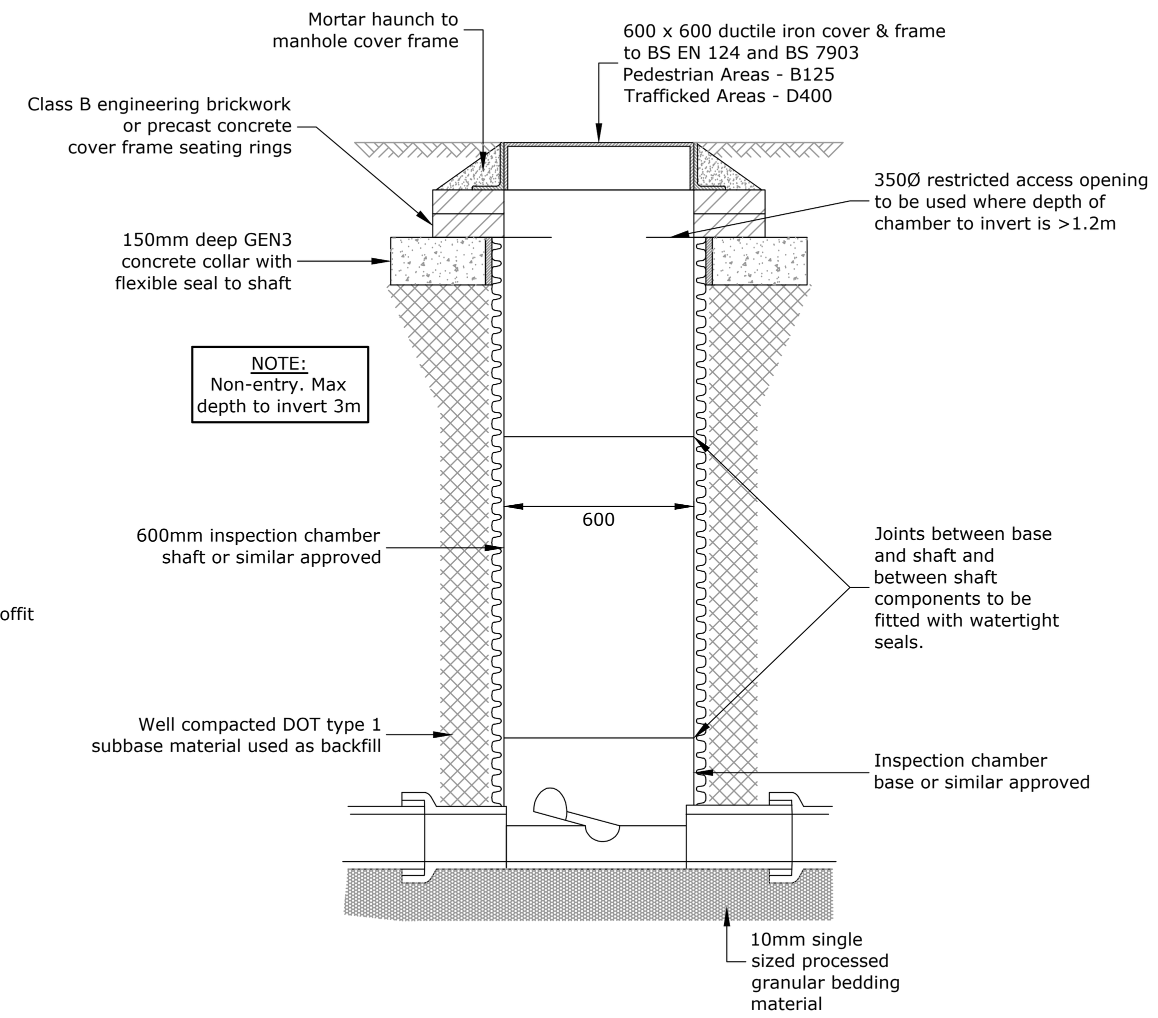

TYPICAL INSPECTION CHAMBER DETAIL (VEHICLE LOADING)
Scale 1:20

SITED IN DRIVEWAYS & FOOTWAYS

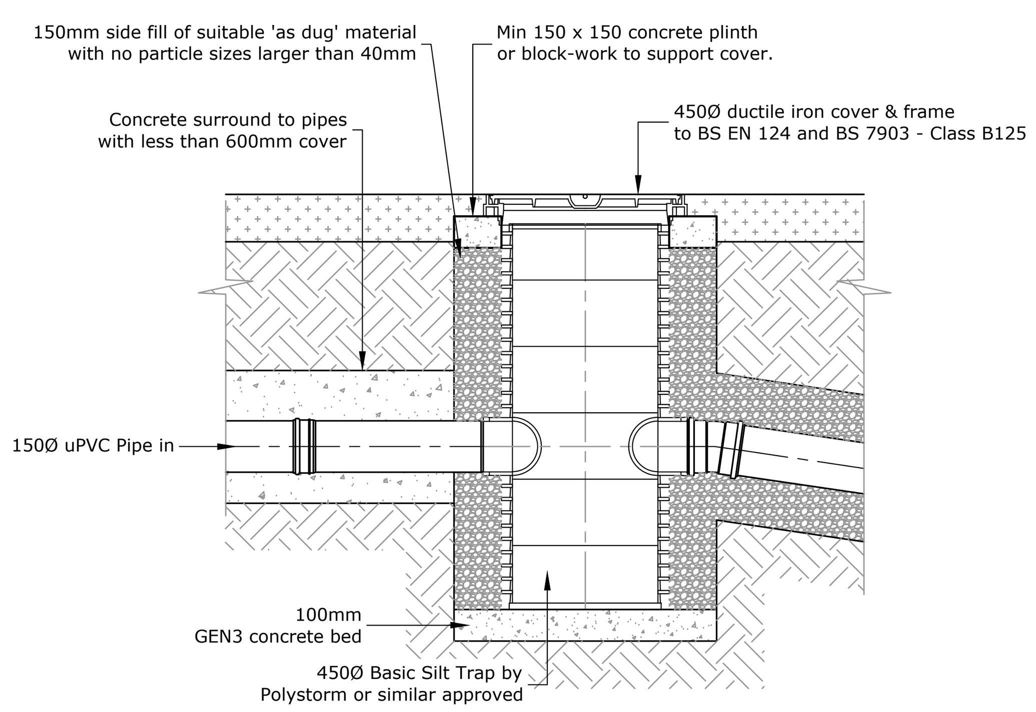
SITED IN GARDENS




TYPICAL INSPECTION CHAMBER DETAIL (LIGHT LOADING)
Scale 1:20




LARGE ACCESS CHAMBER DETAIL
Scale 1:20




TYPICAL 450Ø SILT TRAP
scale 1:20

| Rev | Description | Date | Revised by | Checked by | Approved |
|---|---|---|---|---|---|

Issue Purpose: PLANNING

Do not scale from this drawing

R G PARKINS
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| | | | |
|---|---|---|---|
| Scale @ A1: 1:100 | First Issue: 28/06/2024 | Office of Origin: Kendal |
| Drawn by: CA | Checked by: TM | Approved: |
| Project No: K41128 | Drawing No: 13 | Rev: |
| BIM No: | | |

Client: Thomas Armstrong
Project: Griffin Close, Frizington
Drawing Title: Typical Drainage Construction Details Sheet 2 of 2

# APPENDIX B

CALCULATIONS

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| Wallingford Runoff Estimation | Job Number K41128 | Page Number 1 of 4 |
|---|---|---|
| | Calc by CA | Check by TM |
| Griffin Close Frizington | Date 18/06/2024 | Revised XX |

## 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** |
| Q1 | 3.6 |
| QBAR | 4.1 |
| Q10 | 5.6 |
| Q30 | 6.9 |
| Q100 | 8.5 |
| Q100 + 50% CC | 12.7 |

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## SITE AREAS (LAND COVER AREAS)

### Existing Impermeable & Permeable Land Cover

Total Site Area: **0.50165** ha **5016.5** 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 | 5016.5 | 0.502 | 100% |

### Proposed Land Cover Areas

| Land Cover | Area | | Percentage of total site area |
| --- | --- | --- | --- |
| | m² | ha | |
| Total housing roof area | 763.2 | 0.076 | 15% |
| Total parking and paved area | 1017.3 | 0.102 | 20% |
| Total road area | 1115.5 | 0.112 | 22% |
| Contributing Garden & landscaped areas | 1017.6 | 0.102 | 20% |
| Disconnected Garden & landscaped areas | 1102.9 | 0.110 | 22% |

### Proposed Impermeable & Permeable Land Cover

| Land Cover | Area | | Percentage of total site area |
| --- | --- | --- | --- |
| | m² | ha | |
| Total contributing catchment area | 3913.6 | 0.391 | 78% |
| Remaining permeable/undrained area | 1102.9 | 0.110 | 22% |

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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 | = | **1352** | 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.

| | | | |
|---|---|---|---|
| $QBAR_{rural}$ | = | 0.521 | $m^3/s$ |
| | = | 521.4 | 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 | = | **3914** | $m^2$ |
| | = | 0.004 | $km^2$ |
| | = | 0.391 | ha |
| $QBAR_{rural\ site}$ | = | 0.00408 | $m^3/s$ |
| | = | **4.08** | l/s |

Excluding significant open space which would remain disconnected from the positive drainage system during flood events.

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| | | | |
|---|---|---|---|
| **Wallingford Runoff Estimation** | Job Number<br>K41128 | Page Number<br>4 of 4 | |
| | Calc by<br>CA | Check by<br>TM | |
| Griffin Close<br>Frizington | Date<br>18/06/2024 | Revised<br>XX | |

## 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 | 3.55 |
| 2 | 0.93 | 3.80 |
| 5 | 1.19 | 4.86 |
| 10 | 1.38 | 5.63 |
| 25 | 1.64 | 6.69 |
| 30 | 1.7 | 6.94 |
| 50 | 1.85 | 7.55 |
| 100 | 2.08 | 8.49 |
| 200 | 2.32 | 9.47 |
| 500 | 2.73 | 11.14 |
| 1000 | 3.04 | 12.41 |

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515) SuDS Manual

## Design Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FEH-13 | Minimum Velocity (m/s) | 1.00 |
| Return Period (years) | 100 | Connection Type | Level Soffits |
| Additional Flow (%) | 50 | Minimum Backdrop Height (m) | 0.200 |
| CV | 0.840 | 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) |
|---|---|---|---|---|---|---|---|
| 1 | 0.039 | 5.00 | 138.995 | 1200 | 303368.011 | 517389.539 | 1.395 |
| 2 | 0.020 | 5.00 | 138.675 | 1200 | 303356.019 | 517390.255 | 1.355 |
| 3 | 0.036 | 5.00 | 138.450 | 1200 | 303336.971 | 517377.463 | 1.909 |
| 4 | 0.036 | 5.00 | 138.425 | 1200 | 303329.763 | 517362.746 | 2.075 |
| 5 | | | 138.400 | 1200 | 303326.806 | 517357.538 | 2.200 |
| 6 | | | 138.530 | 1200 | 303328.480 | 517354.826 | 2.500 |
| 7 | 0.007 | 5.00 | 138.800 | 450 | 303372.713 | 517422.109 | 0.700 |
| 8 | 0.015 | 5.00 | 138.800 | 450 | 303364.450 | 517408.782 | 0.961 |
| 9 | 0.010 | 5.00 | 138.800 | 450 | 303362.488 | 517405.618 | 1.023 |
| 10 | 0.013 | 5.00 | 138.800 | 450 | 303354.322 | 517392.448 | 1.284 |
| 11 | 0.009 | 5.00 | 139.200 | 450 | 303386.554 | 517389.885 | 0.700 |
| 12 | 0.015 | 5.00 | 139.200 | 450 | 303373.162 | 517398.035 | 1.092 |
| 13 | 0.021 | 5.00 | 139.050 | 450 | 303359.241 | 517373.966 | 0.750 |
| 14 | 0.009 | 5.00 | 138.600 | 450 | 303336.002 | 517366.022 | 0.600 |
| 15 | 0.027 | 5.00 | 138.600 | 450 | 303349.286 | 517357.780 | 1.050 |
| 16 | | | 138.700 | 450 | 303347.398 | 517354.629 | 2.240 |
| 17 | 0.009 | 5.00 | 138.685 | 450 | 303367.914 | 517355.207 | 0.595 |
| 18 | 0.010 | 5.00 | 139.040 | 450 | 303363.184 | 517347.298 | 1.240 |
| 19 | 0.019 | 5.00 | 138.840 | 450 | 303358.051 | 517345.408 | 1.240 |
| 20 | 0.025 | | 138.800 | 450 | 303355.130 | 517347.220 | 2.350 |
| 21 | 0.019 | 5.00 | 138.530 | 450 | 303334.699 | 517359.814 | 2.130 |

## 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.002 | 1 | 2 | 12.013 | 0.600 | 137.600 | 137.320 | 0.280 | 42.9 | 225 | 5.34 | 50.0 |
| 1.004 | 2 | 3 | 22.945 | 0.600 | 137.320 | 136.541 | 0.779 | 29.5 | 225 | 5.63 | 50.0 |
| 1.005 | 3 | 4 | 16.387 | 0.600 | 136.541 | 136.350 | 0.191 | 85.8 | 225 | 5.82 | 50.0 |
| 1.006 | 4 | 5 | 5.989 | 0.600 | 136.350 | 136.200 | 0.150 | 39.9 | 150 | 5.88 | 50.0 |
| 1.007 | 5 | 6 | 3.187 | 0.600 | 136.200 | 136.030 | 0.170 | 18.7 | 150 | 5.90 | 50.0 |
| 1.000 | 7 | 8 | 15.681 | 0.600 | 138.100 | 137.839 | 0.261 | 60.0 | 150 | 5.20 | 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) |
|---|---|---|---|---|---|---|---|
| 2.002 | 2.002 | 79.6 | 19.1 | 1.170 | 1.130 | 0.084 | 0.0 |
| 1.004 | 2.419 | 96.2 | 33.9 | 1.130 | 1.684 | 0.149 | 0.0 |
| 1.005 | 1.412 | 56.2 | 42.1 | 1.684 | 1.850 | 0.185 | 0.0 |
| 1.006 | 1.597 | 28.2 | 54.6 | 1.925 | 2.050 | 0.240 | 0.0 |
| 1.007 | 2.337 | 41.3 | 54.6 | 2.050 | 2.350 | 0.240 | 0.0 |
| 1.000 | 1.301 | 23.0 | 1.6 | 0.550 | 0.811 | 0.007 | 0.0 |

## 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.001 | 8 | 9 | 3.723 | 0.600 | 137.839 | 137.777 | 0.062 | 60.0 | 150 | 5.25 | 50.0 |
| 1.002 | 9 | 10 | 15.496 | 0.600 | 137.777 | 137.516 | 0.261 | 59.4 | 150 | 5.45 | 50.0 |
| 1.003 | 10 | 2 | 2.773 | 0.600 | 137.516 | 137.395 | 0.121 | 22.9 | 150 | 5.47 | 50.0 |
| 2.000 | 11 | 12 | 15.677 | 0.600 | 138.500 | 138.108 | 0.392 | 40.0 | 150 | 5.16 | 50.0 |
| 2.001 | 12 | 1 | 9.936 | 0.600 | 138.108 | 137.675 | 0.433 | 22.9 | 150 | 5.24 | 50.0 |
| 3.000 | 13 | 1 | 17.873 | 0.600 | 138.300 | 137.675 | 0.625 | 28.6 | 150 | 5.16 | 50.0 |
| 5.000 | 14 | 15 | 15.633 | 0.600 | 138.000 | 137.550 | 0.450 | 34.7 | 150 | 5.15 | 50.0 |
| 5.001 | 15 | 16 | 3.673 | 0.600 | 137.550 | 136.550 | 1.000 | 3.7 | 150 | 5.16 | 50.0 |
| 6.000 | 17 | 18 | 9.215 | 0.600 | 138.090 | 137.800 | 0.290 | 31.8 | 150 | 5.09 | 50.0 |
| 6.001 | 18 | 19 | 5.470 | 0.600 | 137.800 | 137.600 | 0.200 | 27.3 | 150 | 5.13 | 50.0 |
| 6.002 | 19 | 20 | 3.437 | 0.600 | 137.600 | 136.450 | 1.150 | 3.0 | 225 | 5.14 | 50.0 |
| 4.000 | 21 | 4 | 5.741 | 0.600 | 136.400 | 136.350 | 0.050 | 114.8 | 225 | 5.08 | 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) |
|---|---|---|---|---|---|---|---|
| 1.001 | 1.301 | 23.0 | 5.0 | 0.811 | 0.873 | 0.022 | 0.0 |
| 1.002 | 1.307 | 23.1 | 7.3 | 0.873 | 1.134 | 0.032 | 0.0 |
| 1.003 | 2.112 | 37.3 | 10.2 | 1.134 | 1.130 | 0.045 | 0.0 |
| 2.000 | 1.596 | 28.2 | 2.0 | 0.550 | 0.942 | 0.009 | 0.0 |
| 2.001 | 2.111 | 37.3 | 5.5 | 0.942 | 1.170 | 0.024 | 0.0 |
| 3.000 | 1.890 | 33.4 | 4.8 | 0.600 | 1.170 | 0.021 | 0.0 |
| 5.000 | 1.713 | 30.3 | 2.0 | 0.450 | 0.900 | 0.009 | 0.0 |
| 5.001 | 5.296 | 93.6 | 8.2 | 0.900 | 2.000 | 0.036 | 0.0 |
| 6.000 | 1.792 | 31.7 | 2.0 | 0.445 | 1.090 | 0.009 | 0.0 |
| 6.001 | 1.932 | 34.1 | 4.3 | 1.090 | 1.090 | 0.019 | 0.0 |
| 6.002 | 7.623 | 303.1 | 8.7 | 1.015 | 2.125 | 0.038 | 0.0 |
| 4.000 | 1.219 | 48.5 | 4.3 | 1.905 | 1.850 | 0.019 | 0.0 |

## 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.002 | 12.013 | 42.9 | 225 | Circular | 138.995 | 137.600 | 1.170 | 138.675 | 137.320 | 1.130 |
| 1.004 | 22.945 | 29.5 | 225 | Circular | 138.675 | 137.320 | 1.130 | 138.450 | 136.541 | 1.684 |
| 1.005 | 16.387 | 85.8 | 225 | Circular | 138.450 | 136.541 | 1.684 | 138.425 | 136.350 | 1.850 |
| 1.006 | 5.989 | 39.9 | 150 | Circular | 138.425 | 136.350 | 1.925 | 138.400 | 136.200 | 2.050 |
| 1.007 | 3.187 | 18.7 | 150 | Circular | 138.400 | 136.200 | 2.050 | 138.530 | 136.030 | 2.350 |
| 1.000 | 15.681 | 60.0 | 150 | Circular | 138.800 | 138.100 | 0.550 | 138.800 | 137.839 | 0.811 |
| 1.001 | 3.723 | 60.0 | 150 | Circular | 138.800 | 137.839 | 0.811 | 138.800 | 137.777 | 0.873 |
| 1.002 | 15.496 | 59.4 | 150 | Circular | 138.800 | 137.777 | 0.873 | 138.800 | 137.516 | 1.134 |

| Link | US Node | Dia (mm) | Node Type | MH Type | DS Node | Dia (mm) | Node Type | MH Type |
|---|---|---|---|---|---|---|---|---|
| 2.002 | 1 | 1200 | Manhole | Adoptable | 2 | 1200 | Manhole | Adoptable |
| 1.004 | 2 | 1200 | Manhole | Adoptable | 3 | 1200 | Manhole | Adoptable |
| 1.005 | 3 | 1200 | Manhole | Adoptable | 4 | 1200 | Manhole | Adoptable |
| 1.006 | 4 | 1200 | Manhole | Adoptable | 5 | 1200 | Manhole | Adoptable |
| 1.007 | 5 | 1200 | Manhole | Adoptable | 6 | 1200 | Manhole | Adoptable |
| 1.000 | 7 | 450 | Manhole | Adoptable | 8 | 450 | Manhole | Adoptable |
| 1.001 | 8 | 450 | Manhole | Adoptable | 9 | 450 | Manhole | Adoptable |
| 1.002 | 9 | 450 | Manhole | Adoptable | 10 | 450 | Manhole | Adoptable |

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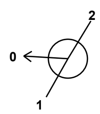
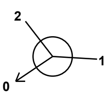
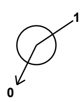
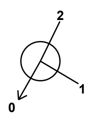
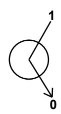
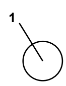
## Pipeline Schedule

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 2.773 | 22.9 | 150 | Circular | 138.800 | 137.516 | 1.134 | 138.675 | 137.395 | 1.130 |
| 2.000 | 15.677 | 40.0 | 150 | Circular | 139.200 | 138.500 | 0.550 | 139.200 | 138.108 | 0.942 |
| 2.001 | 9.936 | 22.9 | 150 | Circular | 139.200 | 138.108 | 0.942 | 138.995 | 137.675 | 1.170 |
| 3.000 | 17.873 | 28.6 | 150 | Circular | 139.050 | 138.300 | 0.600 | 138.995 | 137.675 | 1.170 |
| 5.000 | 15.633 | 34.7 | 150 | Circular | 138.600 | 138.000 | 0.450 | 138.600 | 137.550 | 0.900 |
| 5.001 | 3.673 | 3.7 | 150 | Circular | 138.600 | 137.550 | 0.900 | 138.700 | 136.550 | 2.000 |
| 6.000 | 9.215 | 31.8 | 150 | Circular | 138.685 | 138.090 | 0.445 | 139.040 | 137.800 | 1.090 |
| 6.001 | 5.470 | 27.3 | 150 | Circular | 139.040 | 137.800 | 1.090 | 138.840 | 137.600 | 1.090 |
| 6.002 | 3.437 | 3.0 | 225 | Circular | 138.840 | 137.600 | 1.015 | 138.800 | 136.450 | 2.125 |
| 4.000 | 5.741 | 114.8 | 225 | Circular | 138.530 | 136.400 | 1.905 | 138.425 | 136.350 | 1.850 |

| Link | US Node | Dia (mm) | Node Type | MH Type | DS Node | Dia (mm) | Node Type | MH Type |
|---|---|---|---|---|---|---|---|---|
| 1.003 | 10 | 450 | Manhole | Adoptable | 2 | 1200 | Manhole | Adoptable |
| 2.000 | 11 | 450 | Manhole | Adoptable | 12 | 450 | Manhole | Adoptable |
| 2.001 | 12 | 450 | Manhole | Adoptable | 1 | 1200 | Manhole | Adoptable |
| 3.000 | 13 | 450 | Manhole | Adoptable | 1 | 1200 | Manhole | Adoptable |
| 5.000 | 14 | 450 | Manhole | Adoptable | 15 | 450 | Manhole | Adoptable |
| 5.001 | 15 | 450 | Manhole | Adoptable | 16 | 450 | Junction | |
| 6.000 | 17 | 450 | Manhole | Adoptable | 18 | 450 | Manhole | Adoptable |
| 6.001 | 18 | 450 | Manhole | Adoptable | 19 | 450 | Manhole | Adoptable |
| 6.002 | 19 | 450 | Manhole | Adoptable | 20 | 450 | Junction | |
| 4.000 | 21 | 450 | Junction | | 4 | 1200 | Manhole | Adoptable |

## Manhole Schedule

| Node | Easting (m) | Northing (m) | CL (m) | Depth (m) | Dia (mm) | Connections | | Link | IL (m) | Dia (mm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 303368.011 | 517389.539 | 138.995 | 1.395 | 1200 |  | 1 | 3.000 | 137.675 | 150 |
| | | | | | | | 2 | 2.001 | 137.675 | 150 |
| | | | | | | | 0 | 2.002 | 137.600 | 225 |
| 2 | 303356.019 | 517390.255 | 138.675 | 1.355 | 1200 |  | 1 | 2.002 | 137.320 | 225 |
| | | | | | | | 2 | 1.003 | 137.395 | 150 |
| | | | | | | | 0 | 1.004 | 137.320 | 225 |
| 3 | 303336.971 | 517377.463 | 138.450 | 1.909 | 1200 |  | 1 | 1.004 | 136.541 | 225 |
| | | | | | | | 0 | 1.005 | 136.541 | 225 |
| 4 | 303329.763 | 517362.746 | 138.425 | 2.075 | 1200 |  | 1 | 4.000 | 136.350 | 225 |
| | | | | | | | 2 | 1.005 | 136.350 | 225 |
| | | | | | | | 0 | 1.006 | 136.350 | 150 |
| 5 | 303326.806 | 517357.538 | 138.400 | 2.200 | 1200 |  | 1 | 1.006 | 136.200 | 150 |
| | | | | | | | 0 | 1.007 | 136.200 | 150 |
| 6 | 303328.480 | 517354.826 | 138.530 | 2.500 | 1200 |  | 1 | 1.007 | 136.030 | 150 |

## Manhole Schedule

| Node | Easting (m) | Northing (m) | CL (m) | Depth (m) | Dia (mm) | Connections | Link | IL (m) | Dia (mm) |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 303372.713 | 517422.109 | 138.800 | 0.700 | 450 | 0 | 1.000 | 138.100 | 150 |
| 8 | 303364.450 | 517408.782 | 138.800 | 0.961 | 450 | 1 | 1.000 | 137.839 | 150 |
| | | | | | | 0 | 1.001 | 137.839 | 150 |
| 9 | 303362.488 | 517405.618 | 138.800 | 1.023 | 450 | 1 | 1.001 | 137.777 | 150 |
| | | | | | | 0 | 1.002 | 137.777 | 150 |
| 10 | 303354.322 | 517392.448 | 138.800 | 1.284 | 450 | 1 | 1.002 | 137.516 | 150 |
| | | | | | | 0 | 1.003 | 137.516 | 150 |
| 11 | 303386.554 | 517389.885 | 139.200 | 0.700 | 450 | 0 | 2.000 | 138.500 | 150 |
| 12 | 303373.162 | 517398.035 | 139.200 | 1.092 | 450 | 1 | 2.000 | 138.108 | 150 |
| | | | | | | 0 | 2.001 | 138.108 | 150 |
| 13 | 303359.241 | 517373.966 | 139.050 | 0.750 | 450 | 0 | 3.000 | 138.300 | 150 |
| 14 | 303336.002 | 517366.022 | 138.600 | 0.600 | 450 | 0 | 5.000 | 138.000 | 150 |
| 15 | 303349.286 | 517357.780 | 138.600 | 1.050 | 450 | 1 | 5.000 | 137.550 | 150 |
| | | | | | | 0 | 5.001 | 137.550 | 150 |
| 16 | 303347.398 | 517354.629 | 138.700 | 2.240 | 450 | 1 | 5.001 | 136.550 | 150 |
| 17 | 303367.914 | 517355.207 | 138.685 | 0.595 | 450 | 0 | 6.000 | 138.090 | 150 |
| 18 | 303363.184 | 517347.298 | 139.040 | 1.240 | 450 | 1 | 6.000 | 137.800 | 150 |
| | | | | | | 0 | 6.001 | 137.800 | 150 |
| 19 | 303358.051 | 517345.408 | 138.840 | 1.240 | 450 | 1 | 6.001 | 137.600 | 150 |
| | | | | | | 0 | 6.002 | 137.600 | 225 |

## Manhole Schedule

| Node | Easting (m) | Northing (m) | CL (m) | Depth (m) | Dia (mm) | Connections | Link | IL (m) | Dia (mm) |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 303355.130 | 517347.220 | 138.800 | 2.350 | 450 | 1 | 6.002 | 136.450 | 225 |
| 21 | 303334.699 | 517359.814 | 138.530 | 2.130 | 450 | 0 | 4.000 | 136.400 | 225 |

## Simulation Settings

| | | | | | |
|---|---|---|---|---|---|
| Rainfall Methodology | FEH-13 | Analysis Speed | Detailed | Additional Storage (m³/ha) | 20.0 |
| Summer CV | 0.840 | Skip Steady State | x | Check Discharge Rate(s) | x |
| Winter CV | 0.840 | Drain Down Time (mins) | 240 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440 |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 100 | 50 | 0 | 0 |

## Node 4 Online Hydro-Brake® Control

| | | | |
|---|---|---|---|
| Flap Valve | x | Objective | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓ | Sump Available | ✓ |
| Invert Level (m) | 136.350 | Product Number | CTL-SHE-0092-4100-1250-4100 |
| Design Depth (m) | 1.250 | Min Outlet Diameter (m) | 0.150 |
| Design Flow (l/s) | 4.1 | Min Node Diameter (mm) | 1200 |

## Node 21 Flow through Pond Storage Structure

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity | 0.95 | Main Channel Length (m) | 24.000 |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m) | 136.400 | Main Channel Slope (1:X) | 400.0 |
| Safety Factor | 2.0 | Time to half empty (mins) | | Main Channel n | 0.200 |

**Inlets**

| | |
|---|---|
| 20 | 16 |

| Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) |
|---|---|---|---|---|---|---|---|---|
| 0.000 | 192.0 | 0.0 | 1.200 | 192.0 | 0.0 | 1.201 | 0.0 | 0.0 |

Flow+ v10.6.234 Copyright © 1988-2024 Causeway Technologies Ltd

**Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 98.54%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 30 minute summer | 1 | 20 | 138.220 | 0.620 | 49.0 | 1.0485 | 0.0000 | SURCHARGED |
| 30 minute summer | 2 | 20 | 138.126 | 0.806 | 68.5 | 1.1497 | 0.0000 | SURCHARGED |
| 30 minute summer | 3 | 20 | 137.651 | 1.110 | 85.9 | 1.6738 | 0.0000 | SURCHARGED |
| 480 minute winter | 4 | 456 | 137.633 | 1.283 | 18.7 | 1.8963 | 0.0000 | SURCHARGED |
| 480 minute winter | 5 | 456 | 136.235 | 0.035 | 4.1 | 0.0399 | 0.0000 | OK |
| 480 minute winter | 6 | 456 | 136.062 | 0.032 | 4.1 | 0.0000 | 0.0000 | OK |
| 30 minute summer | 7 | 20 | 138.321 | 0.221 | 4.1 | 0.0792 | 0.0000 | SURCHARGED |
| 30 minute summer | 8 | 20 | 138.317 | 0.478 | 12.8 | 0.2250 | 0.0000 | SURCHARGED |
| 30 minute summer | 9 | 20 | 138.299 | 0.522 | 16.4 | 0.1853 | 0.0000 | SURCHARGED |
| 30 minute summer | 10 | 20 | 138.190 | 0.674 | 22.8 | 0.2441 | 0.0000 | SURCHARGED |
| 15 minute summer | 11 | 10 | 138.544 | 0.044 | 5.4 | 0.0185 | 0.0000 | OK |
| 30 minute summer | 12 | 20 | 138.276 | 0.168 | 14.1 | 0.0729 | 0.0000 | SURCHARGED |
| 15 minute summer | 13 | 9 | 138.364 | 0.064 | 12.6 | 0.0461 | 0.0000 | OK |
| 15 minute summer | 14 | 10 | 138.043 | 0.043 | 5.4 | 0.0197 | 0.0000 | OK |
| 480 minute winter | 15 | 456 | 137.634 | 0.084 | 3.1 | 0.0564 | 0.0000 | OK |
| 480 minute winter | 16 | 456 | 137.634 | 1.174 | 3.1 | 0.0000 | 0.0000 | OK |
| 15 minute summer | 17 | 10 | 138.132 | 0.042 | 5.4 | 0.0193 | 0.0000 | OK |
| 15 minute summer | 18 | 10 | 137.870 | 0.070 | 11.4 | 0.0224 | 0.0000 | OK |
| 15 minute summer | 19 | 10 | 137.641 | 0.041 | 22.7 | 0.0191 | 0.0000 | OK |
| 480 minute winter | 20 | 456 | 137.634 | 1.184 | 5.5 | 0.2522 | 0.0000 | OK |
| 480 minute winter | 21 | 456 | 137.633 | 1.233 | 16.6 | 0.2195 | 0.0000 | SURCHARGED |

| Link Event (Outflow) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | 1 | 2.002 | 2 | 43.1 | 1.505 | 0.541 | 0.4778 | |
| 15 minute summer | 2 | 1.004 | 3 | 68.0 | 1.710 | 0.707 | 0.9125 | |
| 15 minute summer | 3 | 1.005 | 4 | 85.3 | 2.145 | 1.519 | 0.6517 | |
| 480 minute winter | 4 | Hydro-Brake® | 5 | 4.1 | | | | |
| 480 minute winter | 5 | 1.007 | 6 | 4.1 | 1.405 | 0.100 | 0.0094 | 159.3 |
| 30 minute summer | 7 | 1.000 | 8 | 5.2 | 0.486 | 0.227 | 0.2761 | |
| 15 minute summer | 8 | 1.001 | 9 | 12.1 | 0.973 | 0.525 | 0.0655 | |
| 15 minute summer | 9 | 1.002 | 10 | 17.6 | 1.185 | 0.761 | 0.2728 | |
| 15 minute summer | 10 | 1.003 | 2 | 25.2 | 1.786 | 0.675 | 0.0488 | |
| 15 minute summer | 11 | 2.000 | 12 | 5.4 | 0.930 | 0.190 | 0.1344 | |
| 15 minute summer | 12 | 2.001 | 1 | 14.1 | 1.742 | 0.379 | 0.1541 | |
| 15 minute summer | 13 | 3.000 | 1 | 12.5 | 1.586 | 0.376 | 0.2210 | |
| 15 minute summer | 14 | 5.000 | 15 | 5.4 | 1.179 | 0.177 | 0.0723 | |
| 15 minute summer | 15 | 5.001 | 16 | 21.5 | 4.060 | 0.230 | 0.0408 | |
| 15 minute summer | 16 | Flow through pond | 21 | -32.5 | -0.025 | -0.024 | 79.4709 | |
| 15 minute summer | 17 | 6.000 | 18 | 5.4 | 0.899 | 0.170 | 0.0556 | |
| 15 minute summer | 18 | 6.001 | 19 | 11.3 | 1.910 | 0.331 | 0.0327 | |
| 15 minute summer | 19 | 6.002 | 20 | 22.7 | 1.654 | 0.075 | 0.0766 | |
| 15 minute summer | 20 | Flow through pond | 21 | -32.5 | -0.025 | -0.024 | 79.4709 | |
| 15 minute summer | 21 | 4.000 | 4 | -100.4 | -2.524 | -2.071 | 0.2283 | |

## 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 |

| R G PARKINS<br>Kendal \| 01539 729393 Lancaster \| 01524 32548 | CALCULATION | | Job No. | K41128 | Page | 2 of 4 |
|---|---|---|---|---|---|---|
| | Job | Griffin Close | Drg no. | | Date | 25/06/2024 |
| | | Frizington | Revision | | Initial | CA |
| | Title | Sustainable Drainage - Treatment | | | Checked | TM |

## POLLUTION HAZARD INDEX

| Source of Runoff | Pollution Hazard | Pollution Hazard Indices<br>Suspended Solids | <br>Metals | <br>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<br>Suspended Solids | <br>Metals | <br>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 |

## POLLUTION HAZARD INDEX

| | | Pollution Hazard Indices | | |
|---|---|---|---|---|
| Source of Runoff | Pollution Hazard | Suspended Solids | Metals | carbon s |
| Residential parking | 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-carbon s |
| 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 |

## POLLUTION HAZARD INDEX

| | | Pollution Hazard Indices | | |
|---|---|---|---|---|
| Source of Runoff | Pollution Hazard | Suspended Solids | Metals | carbon s |
| 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-carbon s |
| 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

HYDRO-BRAKE DESIGN INFORMATION

## Technical Specification

| Control Point | Head (m) | Flow (l/s) |
|---|---|---|
| Primary Design | 1.250 | 4.100 |
| Flush-Flo™ | 0.379 | 4.094 |
| Kick-Flo® | 0.776 | 3.288 |
| Mean Flow | | 3.595 |

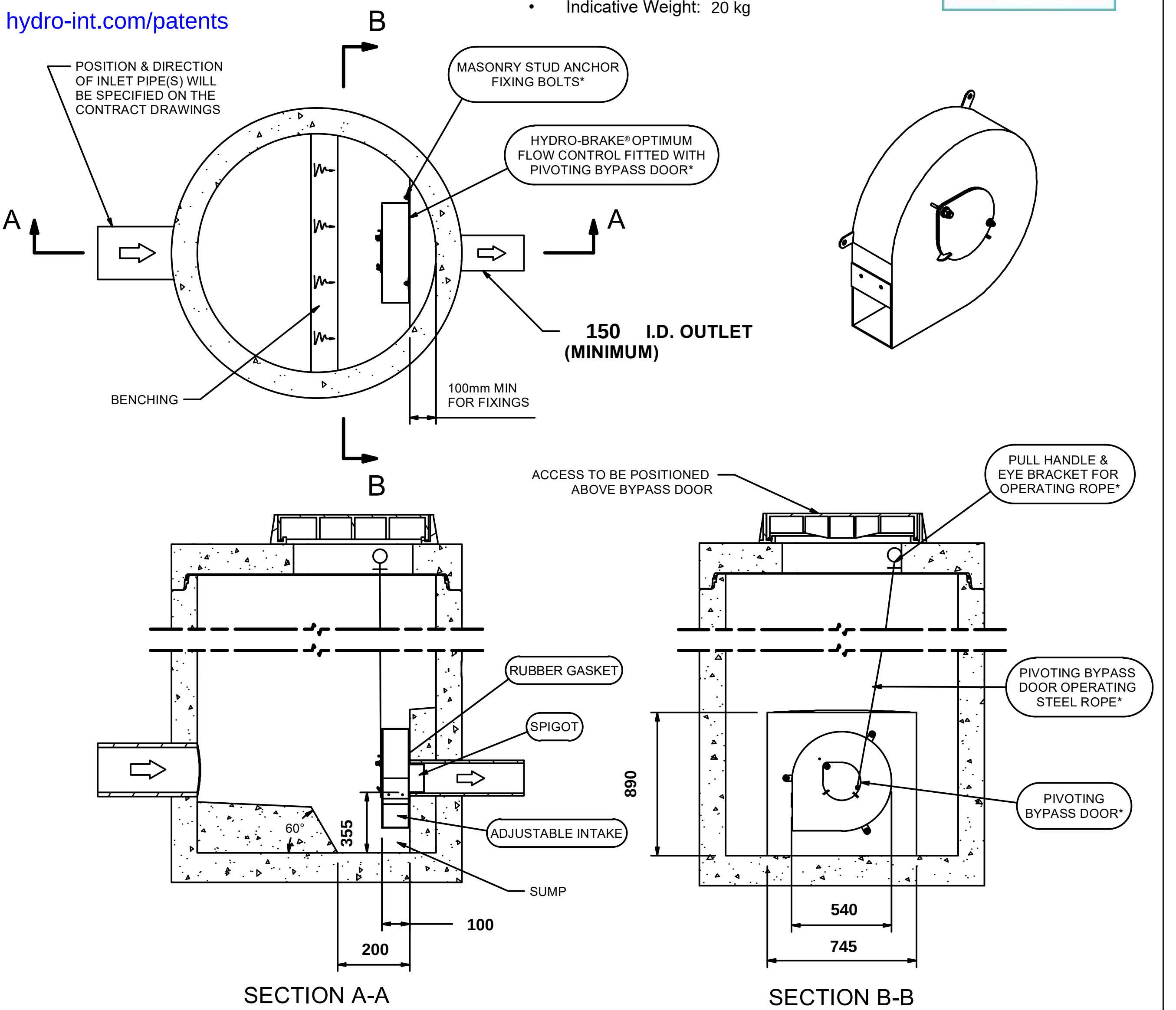
hydro-int.com/patents

Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet
- Variable flow rate post installation via adjustable inlet
- Indicative Weight: 20 kg

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

wrc approved PT/503/0422




**IMPORTANT:** LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

**THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.**

DESIGN ADVICE !

The head/flow characteristics of this SHE-0092-4100-1250-4100 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
**The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International A CRH COMPANY

| | |
|---|---|
| DATE | 26/06/2024 08:00 |
| SITE | Griffin Close |
| DESIGNER | Chris Abram |
| REF | K41128 |

SHE-0092-4100-1250-4100
Hydro-Brake® Optimum

© 2024 Hydro International Ltd • Unit 2, Rivermead Court • Kenn Business Park • Windmill Road • Kenn • Clevedon • BS21 6FT • Tel: 01275 878371 • www.hydro-int.com • Email: enquiries@hydro-int.com

chris.abram@rgparkins.com

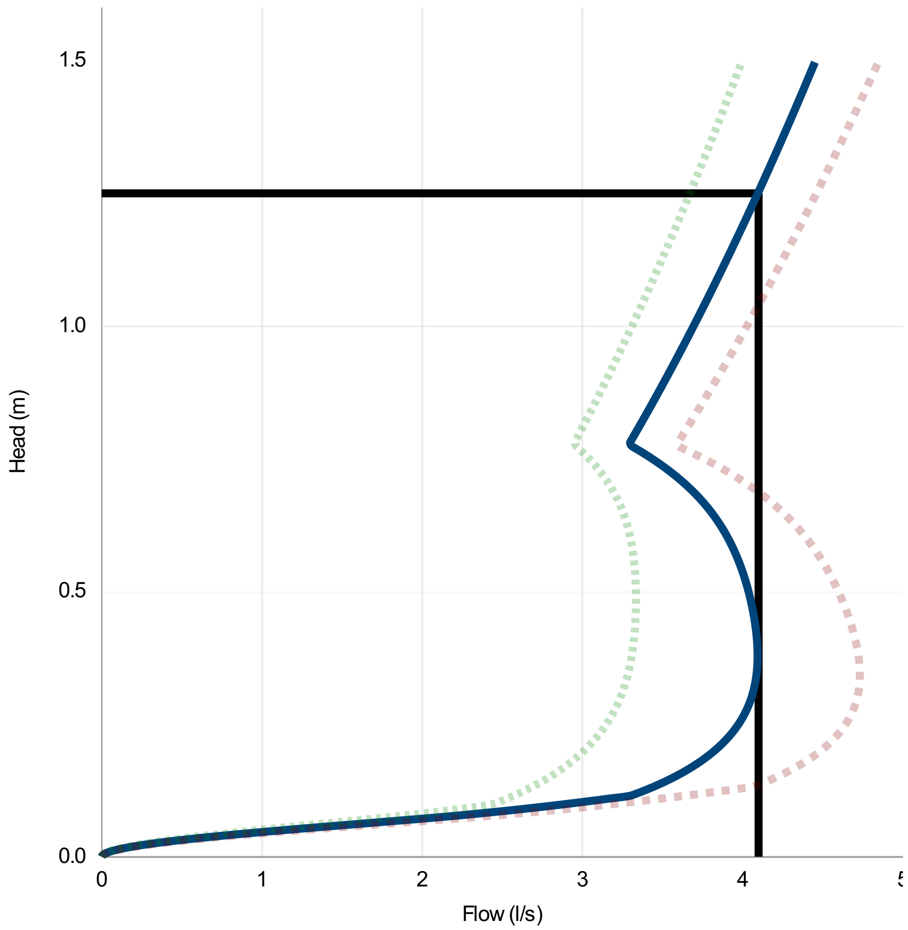
## Technical Specification

| | Original Setting | | Minimum Setting | | Maximum Setting | |
|---|---|---|---|---|---|---|
| **Control Point** | **Head (m)** | **Flow (l/s)** | **Head (m)** | **Flow (l/s)** | **Head (m)** | **Flow (l/s)** |
| Primary Design | 1.250 | 4.100 | 1.250 | 3.671 | 1.250 | 4.461 |
| Flush-Flo™ | 0.379 | 4.094 | 0.486 | 3.335 | 0.343 | 4.732 |
| Kick-Flo® | 0.776 | 3.288 | 0.776 | 2.944 | 0.774 | 3.583 |
| Mean Flow | | 3.595 | | 3.063 | | 4.028 |

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE No 08/4596

wrc approved PT/503/0422

hydro-int.com/patents




| Head (m) | Flow (l/s) |
|---|---|
| 0.000 | 0.000 |
| 0.043 | 0.873 |
| 0.086 | 2.510 |
| 0.129 | 3.424 |
| 0.172 | 3.702 |
| 0.216 | 3.881 |
| 0.259 | 3.993 |
| 0.302 | 4.057 |
| 0.345 | 4.087 |
| 0.388 | 4.093 |
| 0.431 | 4.082 |
| 0.474 | 4.057 |
| 0.517 | 4.021 |
| 0.560 | 3.971 |
| 0.603 | 3.903 |
| 0.647 | 3.811 |
| 0.690 | 3.686 |
| 0.733 | 3.517 |
| 0.776 | 3.301 |
| 0.819 | 3.371 |
| 0.862 | 3.451 |
| 0.905 | 3.529 |
| 0.948 | 3.605 |
| 0.991 | 3.680 |
| 1.034 | 3.753 |
| 1.078 | 3.824 |
| 1.121 | 3.894 |
| 1.164 | 3.962 |
| 1.207 | 4.029 |
| 1.250 | 4.095 |

DESIGN ADVICE

!

The head/flow characteristics of this SHE-0092-4100-1250-4100 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

**The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International A CRH COMPANY

| | |
|---|---|
| DATE | 26/06/2024 08:00 |
| Site | Griffin Close |
| DESIGNER | Chris Abram |
| Ref | K41128 |

SHE-0092-4100-1250-4100

Hydro-Brake® Optimum

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