# Flood Risk Assessment & Drainage Strategy

## Salcombe Avenue, Jarrow

## South Tyneside Homes

December 2016

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# Document Validation

# Revision History

| Revision Ref | Issue Date | Purpose of issue / description of revision |
|---|---|---|
| A | 22/12/2016 | Pre Planning Application |
| B | 31/03/2016 | Updated to include NWL response to PDE |
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### Quality Assurance

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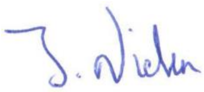
| | Signature |  |  |  |

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# Contents

# Introduction

CK21 have been appointed by South Tyneside Homes to prepare a Drainage Strategy to supplement their FULL planning application for a proposed residential development off Salcombe Avenue, Jarrow.

Whilst the development area is 0.38 ha, under the 1 hectare threshold to require a full Flood Risk Assessment, the flood risk has been assessed.

The aim of this flood risk assessment report is to evaluate the current proposals with regard to flood risk and drainage, and identify potential flood risk to the development site. CK21 have undertaken the following as part of this study:

Assessment of the development potential of the site, with regard Flood Risk, in line with the National Planning Policy Framework and Technical Guidance to the National Policy Framework, (NPPF) and the South Tyneside Council Strategic Flood Risk Assessment, (SFRA).

As set out in the National Planning Policy Framework, inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. For these purposes:

“areas at risk of flooding” means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency;

“flood risk” means risk from all sources of flooding - including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

A risk based approach should be adopted at all levels of planning. Applying the source pathway-receptor model to planning for development in areas of flood risk requires;

A strategic approach which avoids adding to the causes or “sources” of flood risk, by such means as avoiding inappropriate development in flood risk areas,  minimising run-off from new development onto adjacent and/or other downstream property, and into the river systems;

Managing flood “pathways” to reduce the likelihood of flooding by ensuring that the design and location of the development maximises the use of SUDS, and takes account of its susceptibility to flooding, the performance and processes of river/coastal systems and appropriate flood defence infrastructure, and of the likely routes and storage of floodwater including its influence on flood risk downstream;

Reducing the adverse consequences of flooding on the “receptors” (i.e. people, property, infrastructure, habitats and statutory sites) b avoiding inappropriate development in areas at risk of flooding.

The report is presented in the structure of *“Paragraph 068 of the Planning Practice Guidance – Model checklist for a site specific flood risk assessment”.*

# 1. Development Site & Location

The development site is located off Salcombe Avenue, Jarrow, South Tyneside. The site is currently a Greenfield site (farmland) and measures approximately 0.38 hectares.

- Nearest post code = NE32 3QZ
- Ordnance Survey X = 433743
- Ordnance Survey Y = 564247
- Nat Grid Ref = NZ337642

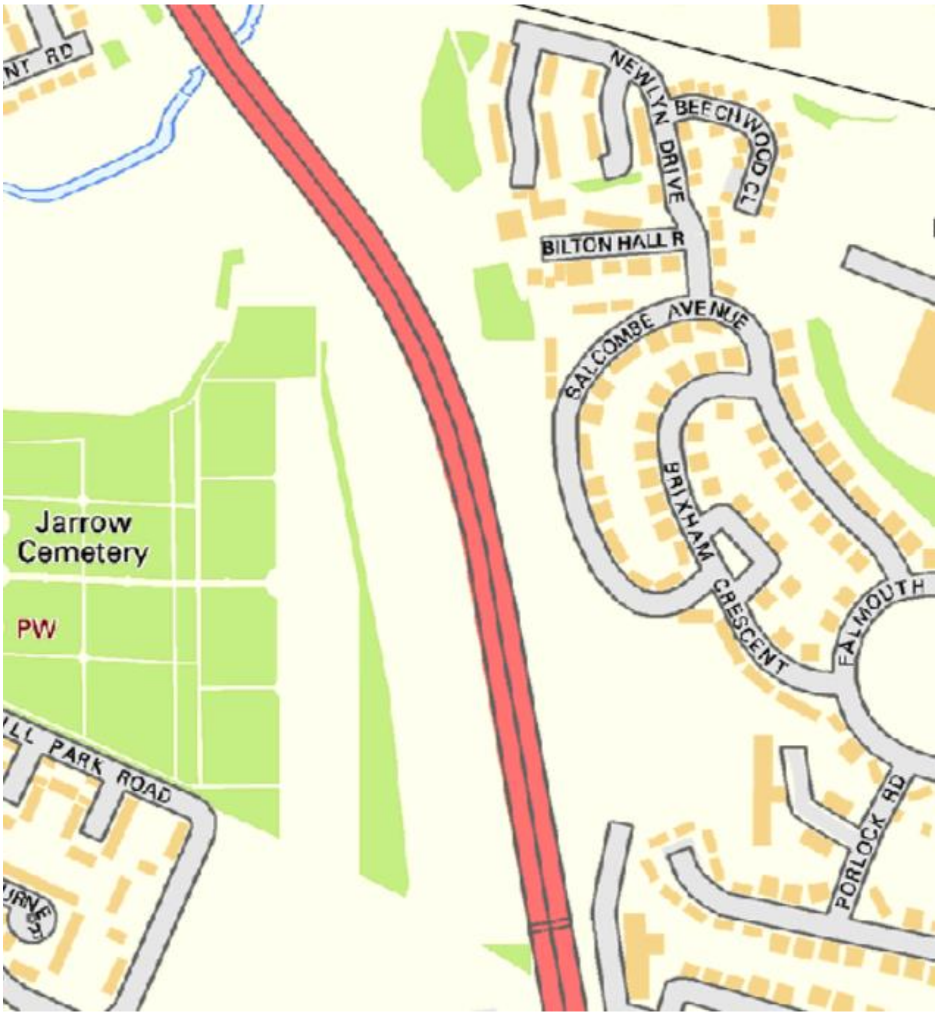



Figure 1 - Location Map

The site is within Flood Zone 1, as classified by the Environment Agency flood maps. The nearest watercourse is River Don, which is located approximately 300m to the north of the development site. The development lies within the natural catchment of the River Don.

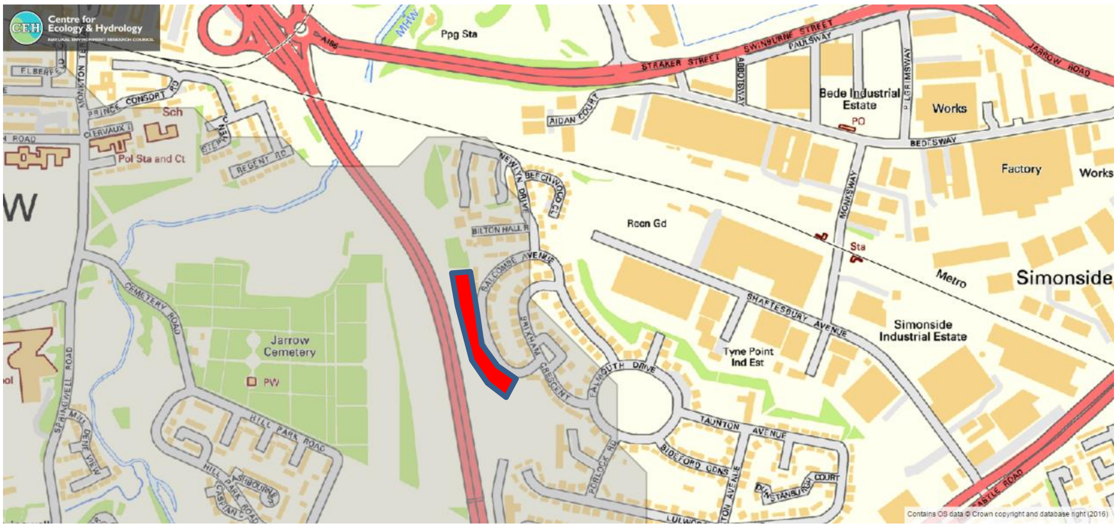



**Figure 2 – Extract from FEH Catchment Map, indicating the site within the catchment of the River Don**

The development proposals are to construct a 20 unit residential development off the existing Salcombe Avenue. The units consist of bungalows, 2 storey housing and apartments.

A proposed site plan can be found within the appendices.

The impermeable areas of the proposed new development will occupy approximately 60% of the developed site. An increase from the 100% permeable current site conditions.

The proposed development would not involve a change of planning use category, the developments Flood Risk Vulnerability classification is considered as **'More vulnerable'.**

# 2. Sequential Test

As set out in the National Planning Policy Framework, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. The flood zones (see table 1) are the starting point for this sequential approach. Zones 2 and 3 are shown on the flood map1 with Flood Zone 1 being all the land falling outside Zones 2 and 3. These flood zones refer to the probability of sea and river flooding only, ignoring the presence of existing defences.

Strategic Flood Risk Assessments (see paragraphs 7-8) refine information on the probability of flooding, taking other sources of flooding and the impacts of climate change (see paragraphs 11-15) into account. They provide the basis for applying the Sequential Test, on the basis of the flood zones in table 1. Where table 1 indicates the need to apply the Exception Test (as set out in the National Planning Policy Framework), the scope of a Strategic Flood Risk Assessment will be widened to consider the impact of the flood risk management infrastructure on the frequency, impact, speed of onset, depth and velocity of flooding within the flood zones considering a range of flood risk management maintenance scenarios. Where a Strategic Flood Risk Assessment is not available, the Sequential Test will be based on the Environment Agency flood zones.

The overall aim should be to steer new development to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses (see table 2) and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required (see table 3). Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

Table 1: Flood zones

| |
|---|
| Zone 1 - low probability<br><br>Definition<br><br>This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).<br><br>Appropriate uses ;<br><br>All uses of land are appropriate in this zone.<br><br>Flood risk assessment requirements ;<br><br>For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment. This need only be brief unless the factors above or other local considerations require particular attention.<br><br>Policy aims :<br><br>In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. |
| Zone 2 - medium probability<br><br>Definition :<br><br>This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.<br><br>Appropriate uses :<br><br>Essential infrastructure and the water-compatible, less vulnerable and more vulnerable uses, as set out in table 2, are appropriate in this zone. The highly vulnerable uses are *only* appropriate in this zone if the Exception Test is passed.<br><br>Flood risk assessment requirements :<br><br>All development proposals in this zone should be accompanied by a flood risk assessment.<br><br>Policy aims ;<br><br>In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage systems. |

| |
|---|
| Zone 3a - high probability<br><br>Definition<br><br>This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.<br><br>Appropriate uses :<br><br>The water-compatible and less vulnerable uses of land (table 2) are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone.<br><br>The more vulnerable uses and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.<br><br>Flood risk assessment requirements :<br><br>All development proposals in this zone should be accompanied by a flood risk assessment.<br><br>Policy aims :<br><br>In this zone, developers and local authorities should seek opportunities to:<br><br>reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems.<br><br>Relocate existing development to land in zones with ta lower probability of flooding; and<br><br>Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage. |
| Zone 3b - the functional floodplain<br><br>Definition<br><br>This zone comprises land where water has to flow or be stored in times of flood.<br><br>Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions to identify the functional floodplain.<br><br>Appropriate uses<br><br>Only the water-compatible uses and the essential infrastructure listed in table 2 that has to be there should be permitted in this zone. It should be designed and constructed to:<br><br>- remain operational and safe for users in times of flood;<br>- result in no net loss of floodplain storage;<br>- not impede water flows; and not increase flood risk elsewhere.<br>- Essential infrastructure in this zone should pass the Exception Test.<br><br>Flood risk assessment requirements :<br><br>All development proposals in this zone should be accompanied by a flood risk assessment. |

Policy aims :

In this zone, developers and local authorities should seek opportunities to:

- reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems;
- relocate existing development to land with a lower probability of flooding.

Table 2: Flood risk vulnerability classification

| |
|---|
| Essential infrastructure<br>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<br>Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational 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 consent4. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”). |
| More vulnerable<br>Hospitals.<br>Residential institutions such as residential care homes, children’s homes, social services 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 educational establishments.<br>Landfill and sites used for waste management facilities for hazardous waste6.<br>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan. |
| Less vulnerable<br>Police, ambulance and fire stations which are not required to be operational during flooding.<br>Buildings used for shops, financial, professional and other services,<br>restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure.<br>• Land and buildings used for agriculture and forestry.<br>• Waste treatment (except landfill and hazardous waste facilities).<br>• Minerals working and processing (except for sand and 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<br>Flood control infrastructure.<br>Water transmission infrastructure and pumping stations.<br>Sewage transmission infrastructure and pumping stations.<br>Sand and gravel working.<br>Docks, marinas and wharves.<br>Navigation facilities.<br>Ministry of Defence defence installations.<br>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.<br>Water-based recreation (excluding sleeping accommodation).<br>Lifeguard and coastguard stations.<br>Amenity open space, nature conservation and 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 and evacuation plan* |

Table 3: Flood risk vulnerability and flood zone ‘compatibility’

| Flood risk vulnerability classification (see table 2) | Essential infrastructure | Water compatible | Highly vulnerable | More vulnerable | Less vulnerable |
|---|---|---|---|---|---|
| Zone 1 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Zone 2 | ✓ | ✓ | Exception Test Required | ✓ | ✓ |
| Zone 3a | Exception Test Required | ✓ | X | Exception Test Required | ✓ |
| Zone 3b functional Floodplain | Exception Test Required | ✓ | X | X | X |

Key:

✓ Development is appropriate.

X Development should not be permitted.

Notes to table 3:

This table does not show:

a. the application of the Sequential Test which guides development to Flood Zone 1 first, then Zone 2, and then Zone 3;

b. flood risk assessment requirements; or

c. the policy aims for each flood zone.

# 3. Climate Change

The National Planning Policy Framework (NPPF) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and supporting planning practise guidance on Flood Risk and Coastal change explain when and how flood risk assessments should be used. This includes demonstrating how flood risk will be managed now and over the developments lifetime, taking climate change into account. Local planning authorities refer to this when preparing local plans and considering planning applications.

**Revised Environment Agency Climate Changes Allowances for Flood Risk Assessments**

In February 2016 the Environment Agency released their revised climate change allowances, for use when considering flood risk.

***What are the climate change allowances?***

To assess the potential impacts that climate change may have on extreme rainfall, river flood flows, sea level rise and storm surges, climate change allowances are provided in Annex 1. The climate change allowances quantify the potential change (as either mm or percentage increase, depending on the variable) to the baseline. The climate change allowances are based on the best available, credible, peer-reviewed scientific evidence from UKCP09, but given the complexity of the science around climatic projections, there are significant uncertainties attributed to the climate change allowances. This is why the climate change allowances are presented as a range of possibilities (Lower, Central, Higher Central and Upper), to reflect the potential variation in climate change impacts over three epochs from the present day to 2115. It is recommended that the performance of flood risk management options are assessed against all of the change allowances covering the whole of the decision lifetime.

| | Total potential change anticipated for '2020s' (2015-39 | Total potential change anticipated for '2050s' (2040-69 | Total potential change anticipated for '2080s' (2070-15) |
|---|---|---|---|
| Northumbria River Basins | | | |
| Upper (90th percentile) | 20% | 30% | 50% |
| Higher Central (70th percentile) | 15% | 20% | 25% |
| Central (50% percentile) | 10% | 15% | 20% |
| Lower (10th percentile) | 5% | 5% | 10% |

Table 1: Potential changes in peak river flow for Northumbria River Basin District

| | Total potential change anticipated for '2020s' (2015-39 | Total potential change anticipated for '2050s' (2040-69 | Total potential change anticipated for '2080s' (2070-15) |
|---|---|---|---|
| Northumbria River Basins | | | |
| Upper estimate | 10% | 20% | 40% |
| Central estimate | 5% | 10% | 20% |

Table 2: Change to extreme rainfall intensity compared to a 1961-90 baseline

**Impact on Development**

The development design proposals should allow for the effects of climate change, appropriate to the anticipated lifetime of the development.

The proposed development is outside the zone of influence of any increase in river flows, however, an allowance for 40% climate change should be allowed for in the design of the surface water drainage network. With consideration given to site and finished floor levels with regards potential flood paths for the extreme storm events.

# 4. Site Specific Flood Risk

The following chapter will review the potential flood risk to the development from all sources, in accordance with the requirements of both the NPPF and the Local Authority Planning Validation Checklist.

The impact of the following potential sources of risk of flooding to the proposed development over its expected lifetime, including appropriate allowances for the impact of climate change will be considered and assessed.

- Fluvial Flooding

  This occurs when a river or stream is unable to take on water draining in to it from surrounding land. The additional water causes the water to risk above its banks or retaining structures and subsequently flows onto the land.

  Flood Zones

  A flood zone is described as the area of land which will flood if there is river or coastal flooding. This data does not account for the presence of flood defences. This data displays the area of land that is likely to be flooded in such an event. The Flood Zones are in grouped into three categories:

  Flood Zone 1 – Low probability less than 0.1% chance in any year (any area that is not considered at risk of flooding)

  Flood Zone 2 (identified in green on the Groundsure flood maps) – Medium probability, greater than 0.1% but less than 1% from rivers and 0.5% from the sea.

  Flood Zone 3 is split into 3a and 3b.

  Zone 3a High risk (1% of greater from rivers and 0.5% or greater from the sea in any given year).

  Zone 3b is the “functional floodplain” or used as a flood storage area – this is a very high flood risk area.

- Pluvial Flooding

  Results from overland flow before the runoff enters a watercourse or sewer. It is usually the result of high intensity rainfall, but can occur with lower intensity rainfall when the land has a low permeability and/or is already saturated, frozen or developed.

- Groundwater Flooding

  Groundwater flooding is caused by the emergence of water from underground, either at point or diffuse locations. The occurrence of groundwater flooding is usually very local and unlike flooding from rivers and the sea, does not generally pose a significant risk to life due to the slow rate at which the water level rises.

- Sewerage Flooding

  Extreme rainfall events may overwhelm sewer systems and cause local flooding. This is not something that can be predicted/modelled. Historical sewer flood events can be found on the DG5 'At Risk Register' which is compiled by water companies.

# Flood Risk to the Site

## Fluvial Flooding

A review of the Environment Agency maps have been undertaken to assess the sites suitability for development. The site lies within flood zone 1.

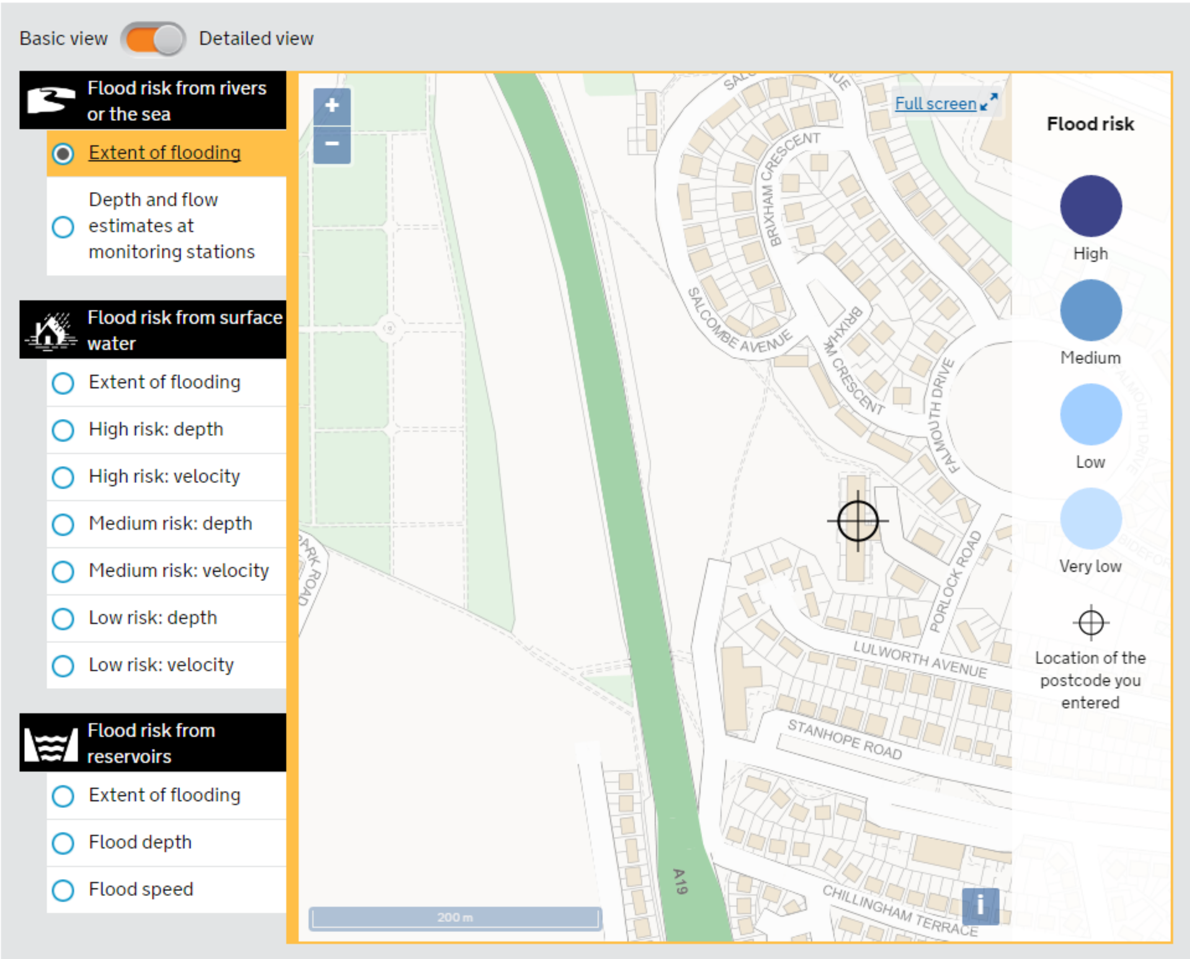



**Figure 3 - Extract from Environment Agency Map "Flood Risk from rivers or the sea"**

The surrounding area to the site location is confirmed on the Environment Agencies' online tool as being *"an area that has A Very Low chance of flooding from rivers or the sea as being in Flood Zone 1."*

**Assessment of Impact:** Low

**Assessment of Probability:** Low

## Pluvial Flooding

Reference to the Environment Agency 'Flood Risk from Surface Water' Map indicated the site is not subject to any risk. Nor, due to the topography is the site likely to receive any significant overland flows from the neighbouring areas.

There is an are identified to the west of the site, against the embankment of the A19, however, this area is outside the development boundary and will not affect the site or infrastructure.

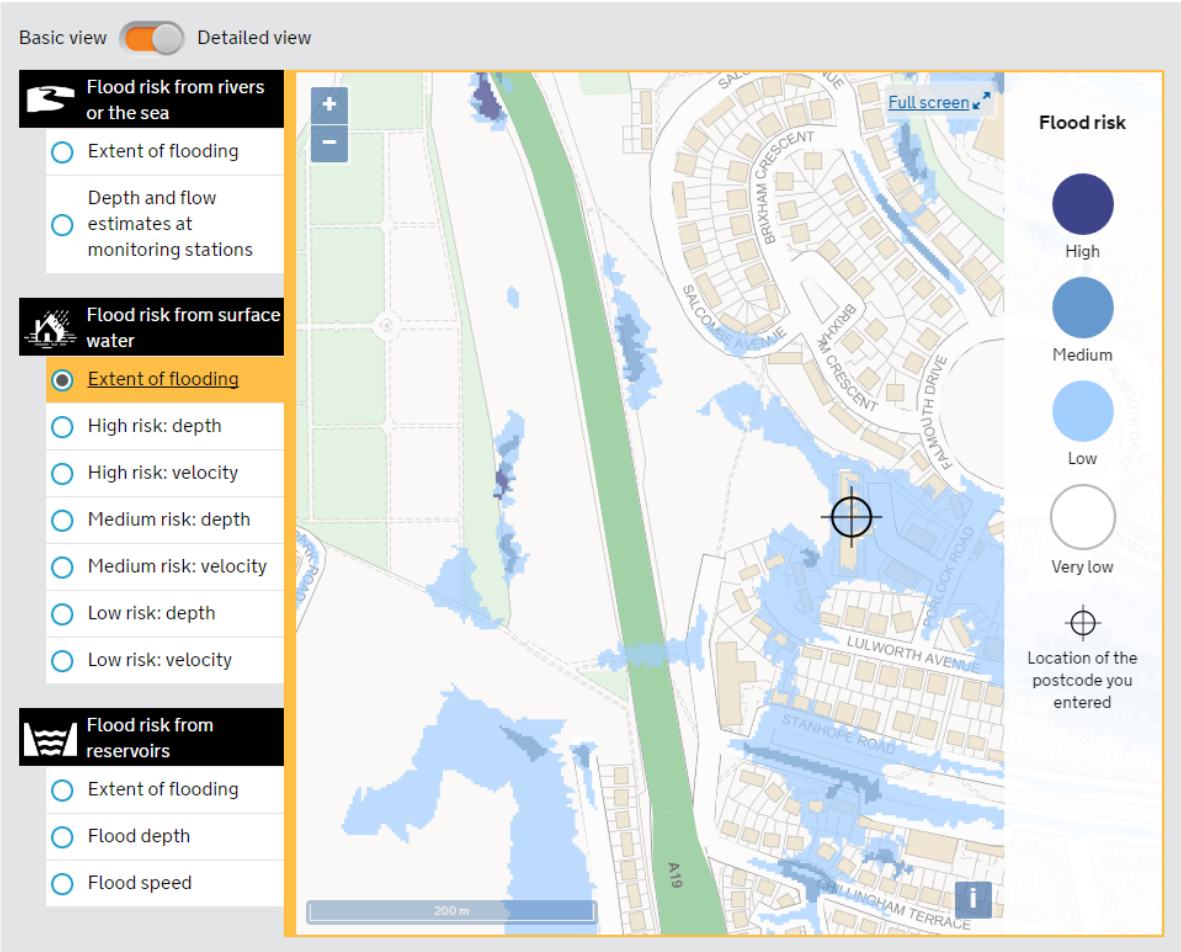



Figure 4 - Extract from Environment Agency Map "Flood risk from surface water"

**Assessment of Impact:** LOW

**Assessment of Probability:** LOW

## Groundwater Flooding

The Environment Agencies Groundwater source protection Zones Map indicates that the area is not within a Groundwater Source Protection Zone.

The EA online map of groundwater vulnerability identifies the development site to be located above a Minor Aquifer high vulnerability. An aquifer at high vulnerability indicates that the area is likely to have high leaching soils which could make it unsuitable for infiltration drainage due to potential mobilisations of pollutants. This will be confirmed following a full intrusive ground investigation. Minor aquifers are typically granular bands within clay deposits and have limited resource potential.

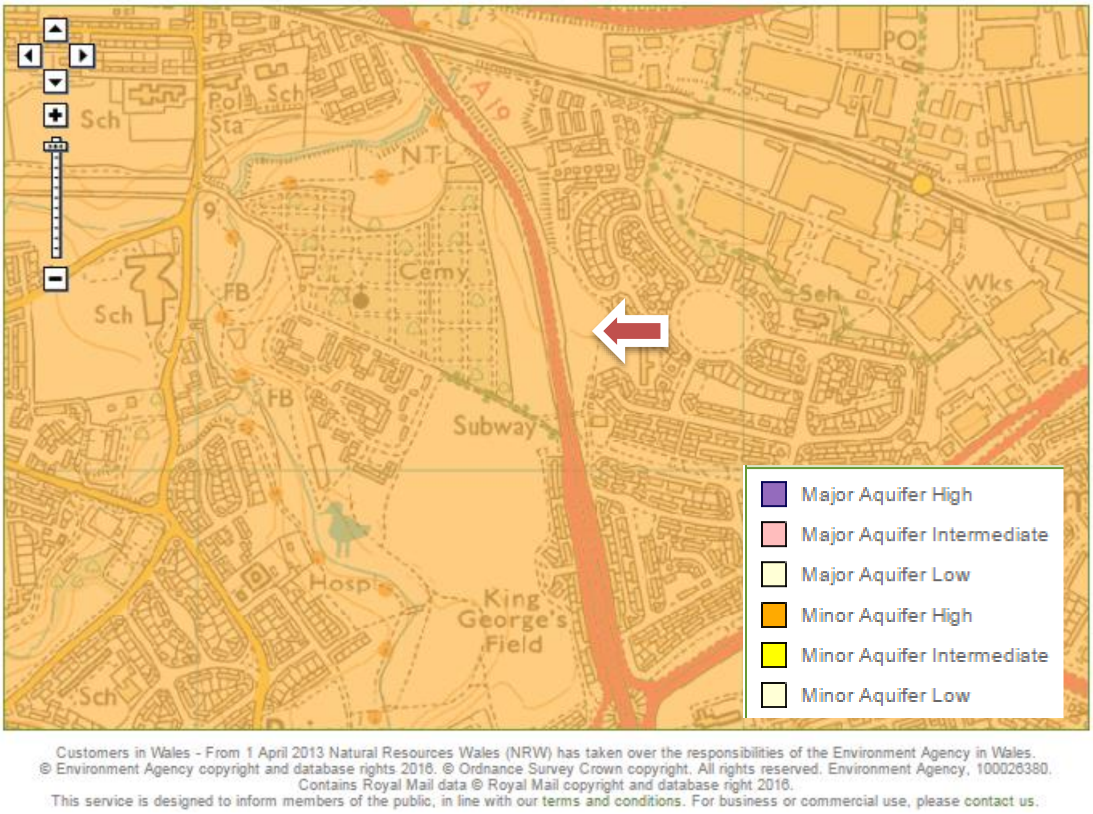



**Figure 5 - Extract from Environment Agency Map 'Groundwater'**

In addition an extract from the DEFRA Soilscapes map indicates that the underlying soil conditions are described as 'loamy & clayey' with 'Slowly permeable seasonally wet, slightly acid but base rich loamy and clayey soils." The drainage properties are described as 'impeded drainage'.

Freely draining soils absorb rainfall readily and allow it to drain through to underlying layers. Slightly impeded drainage refers to soils with a tight, compact deep subsoil that impedes downward water movement; after heavy rainfall, particularly during the winter, the subsoil becomes waterlogged**. In soils with impeded drainage the effect is more severe and winter waterlogging results in very wet ground conditions.** In the uplands, many soils have a greasy surface peat layer that holds water through the winter. These soils are described as having surface wetness, and can be reasonably dry beneath. In low-lying sites, permeable soils are often affected by high ground water that has drained from the surrounding landscape. They are described as naturally wet.

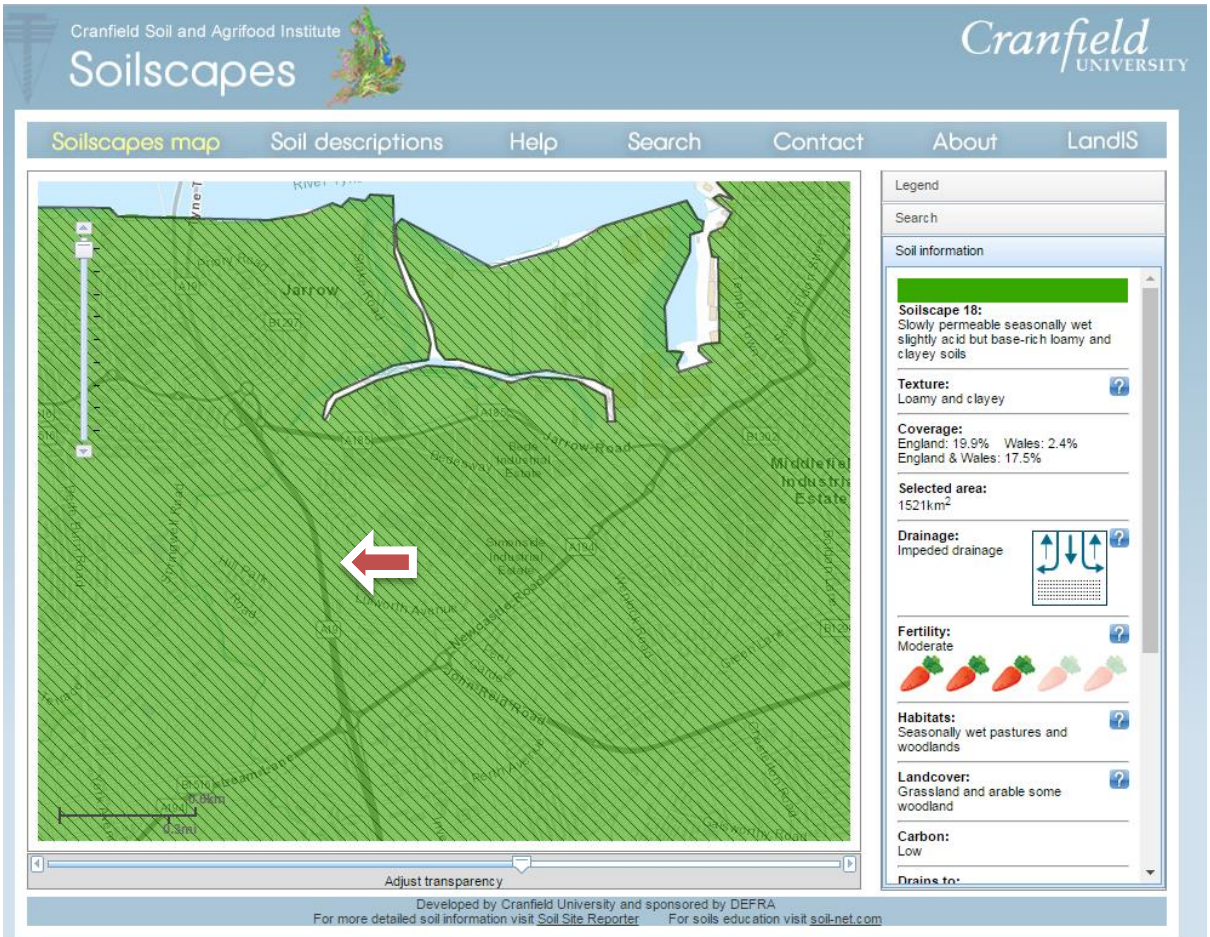



**Figure 6 - Extract from DEFRA Soilscapes Map**

Flooding from Ground water is considered to be of low risk.

**Assessment of Impact: LOW**
**Assessment of Probability: LOW**

## Sewer Flooding

Northumbrian Water have provided a copy of the Sewer Flooding plan for the area (App G). The plan provides an indication of 100m squares within which sewer flooding, caused by a lack of capacity, have occurred up to and including the 1 in 20 year event.

NWL have confirmed there are no reported sewer flooding incidents for this site, or in areas within the catchment of this site.

NWL categorise the risk as:

- Blue hatched areas reported sewer flooding from sewers lower than 1 in 20 year storm.
- Red hatched areas reported sewer flooding from sewers during an extreme event greater than 1 in 20 year storm.

Significant flooding is not expected from the public sewer network and therefore the risk of sewer flooding is considered to be low. This is due to the fact the “at risk” locations are positioned beyond the site and there are no sewer flooding reports in the immediate vicinity of the site.

A review of the topography confirms that there is no risk of flows in this identified area reaching the proposed development site.

**Assessment of Impact:** **LOW**
**Assessment of Probability:** **LOW**

The risk of sewer flooding is considered to be of low risk.

## Conclusion

It can be concluded that the proposed development is not at risk of flooding from any of the sources examined within this assessment.

# 5. Surface Water Drainage Strategy

## Managing surface water

In this chapter the report will show how surface water runoff generated by the developed site will be managed. This chapter should be read in conjunction with Existing & Proposed Drainage Arrangement drawings and calculations provided within the appendices.

## The Drainage Hierachy

The surface water drainage strategy has been initially developed in line with, and will continue to comply with, the requirements of the Tyne & Wear Validation Document, Section 14.

*Information needs to be submitted to evidence all surface water shall be managed for the development. The drainage hierarchy is:*
*1. Infiltration*
*2. Watercourse*
*3. Surface water sewer*
*4. Combined sewer*

*It requires infiltration systems to be investigated before controlled attenuation discharge to watercourse is considered. Only then if these forms of flood attenuation are not possible should developments consider surface water and eventually combined sewer means of surface water drainage.*

1. Infiltration

A review of the DEFRA Soilscapes mapping and experience of development in the local area would indicate that disposal of surface water from the proposed development via means of infiltration will not be feasible. The underlying soils are not deemed to be suitable to accommodate infiltration.

2. Watercourse

An existing ordinary watercourse has been identified approximately 300m to the north of the site. Due to topography and the existing build environment it is not considered feasible to make a direct connection to the watercourse.

3. Sewers

There is an existing NWL surface water sewer, flowing South/North, on the western boundary of the development. It is proposed to make connection to this sewer. The flows will be restricted to the equivalent Greenfield run off rates. A pre development enquiry was submitted to NWL, December 2016, identifying manhole 6302 as the preferred outfall.

NWL’s response is included within the appendices, demonstrating their acceptance of the proposed surface water flows to the sewer.

## Design Principals

It is proposed to discharge the surface water from the development into the adjacent NWL surface water sewer. The discharge will be restricted to equivalent greenfield run off rate )discussed later within this chapter).

NWL's PDE response is included within App G, indicating their acceptance to accept the above flow rate into their SW sewer.

The surface water conveyance system will be designed to ensure no flooding during the 1 in 30 year event, ensuring no flooding from the 1 in 100 year, 6 Hour event leaves site.

In addition, if necessary the system will be designed as such to ensure that any flood volumes leaving site, from the critical 1 in 100 year design storm, are no greater than the equivalent pre development run off.

An allowance for the impact of climate change will be included for within the design. The Environment Agency generally advises that a lifespan of 100 years should be used for residential developments. The Technical Guidance to the NPPF states that for the time period 2070 to 2115, peak rainfall should be increased by 40% to account for the possible impacts of climate change.

Careful design of on site features and levels will be necessary to ensure that no property is at risk of damage during these events.

Surface water disposal will be managed through the incorporation of appropriate Sustainable Urban Drainage Systems (SuDS). There are many different SuDS components that can be used on a site. Each site will have unique characteristics and these should guide the selection of the most appropriate set of SuDS techniques.

Existing Greenfield Runoff rates

The existing 0.38 hectare site is currently occupied 100% be greenfield (farmland). The development site is within the catchment of the River Don, which lies approximately 300m to the north of the site.

The following existing greenfield run off rates have been calculated:

| Estimated Site Discharges | IH124 Results |
|---|---|
| Qbar (l/s) | 0.95 |
| 1 in 1 year (l/s) | 0.82 |
| 1 in 30 year (l/s) | 1.67 |
| 1 in 100 year (l/s) | 1.98 |

**Figure 7 - Existing Greenfield runoff rates**

(Full calculation can be found within the appendices)

Proposed Post Development Mitigation

It is proposed to limit the peak discharge from the site to the outfall of the receiving sewer to the equivalent greenfield runoff rates. However it is recognised that a minimum flow rate of 5 l/s should be applied to any site.. This would be achieved through the use of SUDs and flow control devices.

The drainage network, attenuation systems and site levels would be designed to accommodate a critical rainfall event of 1:100 year + 40% allowance for climate change.

The methodology outlined within EA/DEFRA R&D Technical Report W5-074 'Preliminary Rainfall Runoff Management for Developments' has been utilised in order to calculate the approximate post development surface water runoff volumes and thus the required storage volumes.

| Estimated Storage Volumes | Volume m3 |
|---|---|
| Interception Storage | 8.80 |
| Attenuation Storage | 91.85 |
| Long term storage | 0.00 |
| Total Storage | 100.65 |

Figure 8 - Estimated Storage Volumes

Note the above volumes are based on single calculation. Results may vary from the modelling of the actual network within software, such as Windes. The results of the Windes modelling may result in greater, or lesser, attenuation requirements.

This advice of the SUDS Manual (CIRIA C697) is that where applicable storage requirements are defined as Interception storage, Attenuation Storage, Long term storage.

**Interception storage ($m^3$)**

Interception storage is required in order to ensure that no run-off passes directly to the river for rainfall depths of 5mm or less. This is aimed at trying to replicate greenfield runoff response when no runoff is likely to take place for most small events. This type of storage is principally aimed at river water quality protection - polluted water is prevented from entering the water course for all small rainfall events. A 5mm rainfall threshold will reduce the number of runoff events into a receiving water body by at least 50%.

Interception of 5mm requires the use of vegetation based drainage systems, infiltration units or rainwater harvesting systems.

**Attenuation storage with/without Long Term Storage ($m^3$)**

Attenuation storage is provided to enable the rate of runoff from the site into the receiving water to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

Attenuation storage should preferably avoid using underground storage tanks which do not provide any form of treatment and have higher safety risks associated with any maintenance.

**Long term storage ($m^3$)**

Long term storage is similar to Attenuation storage, but aims to specifically address the additional volume of runoff caused by the development compared to pre-development runoff. Long-Term storage is specifically aimed at runoff from extreme events to limit flood impact downstream.

This volume difference should be infiltrated to the ground or, if this is not possible, discharged to the receiving water at very low flow rates (less than 2 l/s/ha) so as to minimise the risk of exacerbating river flooding. In this situation, the normal attenuation discharge limit should be adjusted (reduced) to take account of any discharge rate taking place from the Long Term Storage system.

Long Term Storage is calculated based on the difference between greenfield and development runoff volumes using the 100 year 6 hours rainfall event. This is a pragmatic criterion and avoids the need for complex analysis of extreme rainfall series.

Long Term Storage can be provided using a number of techniques:
- infrequent flooding of public open spaces- a minimum of 1 in 5 to 1 in 10 year frequency;
- flooding of an area adjacent to the pond which cannot drain back through the pond outfall;
- providing an equivalent volume in the form of infiltration units or rainwater harvesting where this is designed for stormwater control.
- storage with a very small outflow control orifice (2 L/s/ha), where there is minimal risk of blockage.

This methodology has been applied in order to determine the estimated surface water storage requirements for the post development site.

A copy of the preliminary Surface Water Drainage Strategy Plan and associated drainage calculations can been found within the appendices.

## Water Quality

Reference to the CIRIA C753, The SuDS Manual (2015), section 26.7, details the method to determine the SuDS pollution mitigation indices.

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type)

| Land Use | Pollution Hazard Levels | Total suspended solids (TSS) | Metals | Hydrocarbons |
|---|---|---|---|---|
| Other roofs (typically commercial) | Low | 0.3 | 0.4* | 0.05 |
| Non residential car parking with infrequent change | Low | 0.5 | 0.4 | 0.4 |

Figure 9 - Pollution hazard indices for different land use classifications

| Types of SuDS Component | TSS | Metals | Hydrocarbons |
|---|---|---|---|
| Bioretention System | 0.8 | 0.8 | 0.8 |

Figure 10 - Indicative SuDS Mitigation indices for discharges to surface waters (suitable components)

Reference to the Surface Water Drainage strategy will indicate that a combination of a pond and swale has been selected as an appropriate compliant treatment train. In addition this combination of components can be utilised to provide the attenuation requirements.

## SuDS Maintenance

A copy of the preliminary SuDS Maintenance responsibilities schedule has been provided within the appendices. (App F)

The maintenance of the SuDS feature would be undertaken by South Tyneside Homes.

# 6. Occupants & Users of the Development

## Pre Development site users

The current pre development site is greenfield and as such has no occupants. Site users would include the general public.

## Post Development site users

As a result of the development an increase in occupants will occur.

## Flood Risk management/evacuation plan

Due to the low risk of flooding to the site (from any source) there is unlikely to be any restrictions placed on the site design. (i.e. restrictions to accommodation on ground floor etc), similarly no specific restrictions will be imposed for the requirement of a dedicated flood evacuation route or plan.

Reference to the site plan indicates that the buildings are located at a higher elevation than the proposed SuDS features and that in the event of a critical event access to/from the development would not be restricted.

Emergency access is freely available from Tursdale Road, which itself does not suffer from any flooding issues in the locality.

# 7. Exception Test

In this instance as the proposed development is solely within Flood Zone 1 the exception test is not required.

# 8. Residual Risk

The only residual risks associated with flood risk relate the risk of blockage/damage to the proposed drainage network. To mitigate this risk all components will be specified and designed to current building regulations and guidance. A maintenance schedule has/will be produced to cover the SuDS features.

# Foul Water Drainage Strategy

The nearest suitable outfall for the foul drainage from the proposed development has been identified as the existing combined sewerage system within Salcombe Avenue the east of the site.

The developer has submitted a Pre Development Enquiry to NWL. A pre development enquiry was submitted to NWL in December 2016.

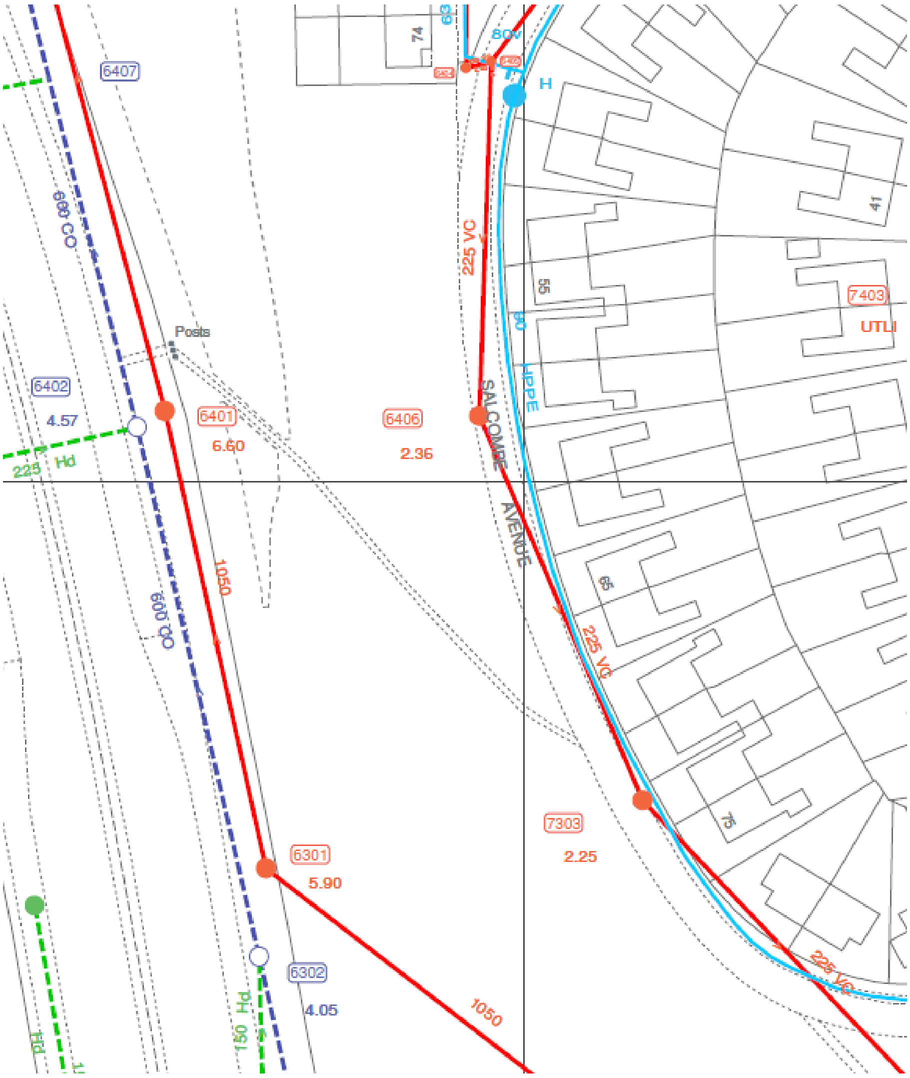



Figure 11 - Extract from NWL Sewer/Water Plan

# Appendix A

## Proposed Site Layout


| REVISION | DATE | DESCRIPTION | CHECKED |
|---|---|---|---|

CEAD
Community | Environment | Architecture | Delivery

JOB / CLIENT: South Tyneside Homes Porlock Green

DWG TITLE: Proposed Site Plan

| PROJECT NO. | DRAWING NO. | REVISION | STATUS |
|---|---|---|---|
| 16.28 | PG SP02 | A | D |

| DRAWN | CHECKED | SCALE | DATE |
|---|---|---|---|
| PM | RM | 1:250 | Dec 16 |


STATUS: D=Draft R=Review P=Planning T=Tender C=Construction B=As-Built

# Appendix B

## Greenfield Runoff Calculations

HR Wallingford
*Working with water*

# Greenfield runoff estimation for sites

| | |
|---|---|
| Site name: | Salcombe Avenue |
| Site location: | Jarrow |

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

## Site coordinates

| | |
|---|---|
| Latitude: | 54.97210° N |
| Longitude: | 1.47505° W |
| Reference: | gcybwrmgsy5j / 0.38 |
| Date: | 22 Dec 2016 |

## Site characteristics

| | | |
|---|---|---|
| Total site area | 0.38 | ha |
| Significant public open space | 0.16 | ha |
| Area positively drained | 0.22 | ha |

## Methodology

| | |
|---|---|
| Greenfield runoff method | IH124 |

| | |
|---|---|
| Qbar estimation method | Calculate from SPR and SAAR |
| SPR estimation method | Calculate from SOIL type |
| SOIL type | 4 |
| HOST class | N/A |
| SPR | 0.47 |

## Hydrological characteristics

| | Default | Edited | |
|---|---|---|---|
| SAAR | 638 | 638 | mm |
| M5-60 Rainfall Depth | 17 | 17 | mm |
| 'r' Ratio M5-60/M5-2 day | 0.3 | 0.3 | |
| FEH/FSR conversion factor | 0.92 | 0.92 | |
| Hydrological region | 3 | 3 | |
| Growth curve factor: 1 year | 0.86 | 0.86 | |
| Growth curve factor: 10 year | 1.45 | 1.45 | |
| Growth curve factor: 30 year | 1.75 | 1.75 | |
| Growth curve factor: 100 year | 2.08 | 2.08 | |

## Greenfield runoff rates

| | Default | Edited | |
|---|---|---|---|
| Qbar | 0.95 | 0.95 | l/s |
| 1 in 1 year | 0.82 | 0.82 | l/s |
| 1 in 30 years | 1.67 | 1.67 | l/s |
| 1 in 100 years | 1.98 | 1.98 | l/s |

*Please note that a minimum flow of 5 l/s applies to any site*

# Appendix C

## Surface Water Attenuation Calculations

# Surface water storage requirements for sites

HR Wallingford
*Working with water*

| | |
|---|---|
| Site name: | Salcombe Avenue |
| Site location: | Jarrow |

## Site coordinates

| | |
|---|---|
| Latitude: | 54.97198° N |
| Longitude: | 1.47511° W |
| Reference: | gcybwrmfgry3 / 0.22 |
| Date: | 22 Dec 2016 |

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

## Site characteristics

| | | |
|---|---|---|
| Total site area | 0.38 | ha |
| Significant public open space | 0.16 | ha |
| Area positively drained | 0.22 | ha |
| Impermeable area | 0.22 | ha |
| Percentage of drained area that is impermeable | 100 | % |
| Impervious area drained via infiltration | 0 | ha |
| Return period for infiltration system design | 10 | year |
| Impervious area drained to rainwater harvesting systems | 0 | ha |
| Return period for rainwater harvesting system design | 10 | year |
| Compliance factor for rainwater harvesting system design | 66 | % |
| Net site area for storage volume design | 0.22 | ha |

## Methodology

| | |
|---|---|
| Greenfield runoff method | IH124 |
| Volume control approach | Use Long Term Storage |

| | |
|---|---|
| Qbar estimation method | Calculate from SPR and SAAR |
| SPR estimation method | Calculate from SOIL type |
| SOIL type | 4 |
| HOST class | N/A |
| SPR | 0.47 |

## Hydrological characteristics

| | Default | Edited | |
|---|---|---|---|
| SAAR | 638 | 638 | mm |
| M5-60 Rainfall Depth | 17 | 17 | mm |
| 'r' Ratio M5-60/M5-2 day | 0.3 | 0.3 | |
| FEH/FSR conversion factor | 0.92 | 0.92 | |
| Hydrological region | 3 | 3 | |
| Growth curve factor: 1 year | 0.86 | 0.86 | |
| Growth curve factor: 10 year | 1.45 | 1.45 | |
| Growth curve factor: 30 year | 1.75 | 1.75 | |
| Growth curve factor: 100 year | 2.08 | 2.08 | |

## Design criteria

| | | |
|---|---|---|
| Climate change allowance factor | 1.3 | |
| Urban creep allowance factor | 1.1 | |
| Interception rainfall depth | 5 | mm |

## Greenfield runoff rates

| | Default | Edited | |
|---|---|---|---|
| Qbar | 0.95 | 0.95 | l/s |
| 1 in 1 year | 5.00 | 5.00 | l/s |
| 1 in 30 years | 5.00 | 5.00 | l/s |
| 1 in 100 years | 5.00 | 5.00 | l/s |

*Please note that a minimum flow of 5 l/s applies to any site*

## Estimated storage volumes

| | Default | Edited | |
|---|---|---|---|
| Interception storage | 8.80 | 8.80 | $m^3$ |
| Attenuation storage | 91.85 | 91.85 | $m^3$ |
| Long term storage | 0.00 | 0.00 | $m^3$ |
| Treatment storage | 26.40 | 26.40 | $m^3$ |
| Total storage | 100.65 | 100.65 | $m^3$ |

# Appendix D

## Proposed Drainage Strategy Plan

A1

**Standard Notes**

DO NOT USE THIS DRAWING IN ISOLATION

A. This drawing has been prepared as part of a set, and must therefore be read in conjunction with all other drawings. Any discrepancies or design queries must be reported to the engineer prior to completion of tender and commencement of works. Following completion of tender it is assumed that developer and contractor are in full agreement with the design drawings (with the exception of pre tender queries only).

B. Third party information is used to prepare the engineering design (including, architectural layout, ground investigation, existing utilities records, and specialist design items). The engineering design must therefore be read in conjunction with all third party information prior to commencing work. CK21 Ltd are not responsible for any third party information or details.

C. House type working drawings are to be used in conjunction with the plot setting out drawing.

D. Drawing status will remain preliminary until full technical approval is received from local authority and sewerage undertaker. Works commenced prior to technical approval are done so at risk and may be subject to change.

E. The contractor is expected to prepare appropriate construction method statements for all aspects of appointed work. This should include any temporary protection / works.

F. Land drainage is not permitted to discharge into the public sewer network. Any need for land drainage should be assessed by the ground worker and landscaper during construction and placement of gardens on an individual plot basis. If land drainage designs are required, they should be appointed prior to plot completion.

G. The contractor is expected to cross check all drainage inverts prior to commencing work, this may involve completion of trial holes if invert levels have been interpolated.

H. The contractor must monitor the “as build” progress of each construction stage (roads/sewers/plot works/to enable the next stages of construction to be checked before installation.

**Highways**

1. All highway works to be carried out in accordance with the current local authority design guide and specification.
2. All excavations below proposed and existing highways to be back filled with granular Type 1 sub base and well compacted in layers not exceeding 150mm, unless otherwise agreed.
3. Highway authority to be notified by the contractor prior to the commencement of works.

**Adoptable Drainage**

1. All adoptable drainage works to be in accordance with the water authorities publication "Sewers For Adoption 7th Edition" aswell as the approved drawings.
2. Precast concrete manhole rings to comply with the relevant provisions of BS5911: Part 200.
3. All brickwork to be Class B engineering complying with the relevant provisions of BS 3921. Concrete bricks maybe used if their specification is the same as Class B engineering bricks. Please seek approval from relevant water authority before using.
4. Manhole covers and frames shall comply with the relevant provisions of BS EN 124 and be of a non-rocking, non-ventilating design.
5. Ladders that are required in Type 1 manholes are to comply with "Sewers For Adoption 7th Edition".
6. Concrete must be either C20 sulphate resistant portland cement with high strength concrete topping to the benching or C35 ordinary portland cement.
7. 150mm Concrete surround is required around pipes where the depth from finished surface to soffit of pipe is less than 1200mm. This may be reduced to 900mm within open space.
8. The location of existing drainage that is within close proximity to the proposed site works, which is not to be diverted, should be confirmed by the contractor and reported to the developer to ensure it corresponds to that shown on the engineering layout and that no proposed works are affected. The position, line and diameter of all existing drainage apparatus should be confirmed on site prior to the commencement of the works. Any discrepancies must be reported to the engineer immediately. The connection of foul and surface water drainage to the existing public sewer system shall be subject to the approval of the local sewerage undertaker. The contractor is expected to apply for relevant permits prior to commencing the work.
9. Roads and sewers contractor must inform water authority prior to works commencing

**Existing Services**

Any existing services which may be affected by the proposed works should be located by means of a hand dig in close liaison with the statutory service authorities. The contractor shall inform the developer of any services that may affect the proposed design.

Contractor to notify statutory service authorities prior to commencement of work.

**As Constructed Information**

Refer to note H above. It is the contractors responsibility to provide the following as constructed drawings to the developer upon the completion of the works covered by the contract :

1. Position/coordinates of all adoptable manholes.
2. Invert and cover levels of all adoptable manholes.
3. New gully positions and connections.
4. Position and depth of service ducts for water, gas, electric, BT, cable and street lighting, stating size and number of ducts.

**Drawing Specific Notes**

1. General levels prepared for planning submission. Levels may be subject to some minor alteration during design development.
2. Topographic Survey shown in background in feint.

Discharge Rates

1. The pre development site is a greenfield site, measuring 0.38ha, with no obvious natural surface water outfall. the existing topography falls North/South and East/West. Existing overland flows are likely to run east into the wooded area and be blocked by the embankment of the adjacent A19.

2. Consideration of the surface water hierarchy has been undertaken.
- Review of the Site Investigation report, produced by Dunelm, Dec 16, confirms that the underlying strata is not suitable to accept infiltration.
- The closest natural watercourse is approx 300m to the north of the site, which considering the topography and existing built environment, is considered an unacceptable distance/level to connect to directly.
- A Pre development enquiry has been submitted to NWL, applying for consent to discharge into the surface water sewer that runs SOUTH/NORTH within the western boundary of the site.

3. It is proposed that the surface water run off generated by the proposed development will be attenuated on site and released to the receiving watercourse at equivalent greenfield runoff rates. The existing greenfield run off rates from the development area (excluding the non contributing soft landscaping areas) have been calculated as follows:

Methodology (IH124):
QBar = 0.95 l/s
1 in 1 year = 0.82 l/s
1 in 30 year = 1.67 l/s
1 in 100 year = 1.98 l/s

In accordance with best practice a minimum flow rate of 5 l/s will be applies to any site.Greenfield runoff calculations have been provided separately.

4. It is proposed to utilize SuDS in combination with a suitable flow control device to restrict and attenuate flows from site to the above rates.
A Bio-Retention basin has been selected as an appropriate method of SuDS to treat the proposed flows. Bioretention systems are shallow landscaped areas that can reduce runoff rates and volumes, and treat pollution through the use of engineered soils and vegetation. They are particularly effective in delivering interception and can also provide;
- attractive landscape features that are self irrigating and fertilizing
- habitat and biodiversity.

5. The system including the SuDS has been designed to accommodate the 100yr 360min storm event,without flooding, whilst ensuring that any flood volume from the critical 100 year event or as a result of system failure remains within the development boundary.

6. The SuDS Feature(s) will be maintained by the client (or management company) to ensure the performance of the drainage system is maintained throughout the design life of the development. A maintenance schedule will be provided separately.

7. The actual (at planning stage) calculated discharge rates into the receiving watercourse are as follows.

1 in 1 year = 4.2 l/s
1 in 30 year = 4.5 l/s
1 in 100 year = 4.5 l/s

These rates are derived from the Windes software model and include an allowance for 40% climate change. The windes calculations have been provided separately.

Treatment

Reference to the CIRIA C753, The SUDS Manual (2015), section 26.7, details the method to determine the SUDS pollution mitigation indices.

To deliver adequate treatment, the selected SUDS components should have a total pollution mitigation index (for each containment type) that equals or exceeds the pollution hazard index (for each containment type)

**Total SuDS mitigation index ≥ pollution hazard index**

| Table 1 | | | | |
|---|---|---|---|---|
| Land Use | Pollution Hazard Leve | Total Suspended Solids (TSS) | Metals | Hydrocarbons |
| Residential Roofs | Very Low | 0.2000 | 0.2000 | 0.0500 |
| Individual Property Driveways, residential car parks, low traffic roads | Very Low | 0.5000 | 0.4000 | 0.4000 |

*Table 1 - based on Table 26.2 - Pollution hazard indices for different land use classifications*

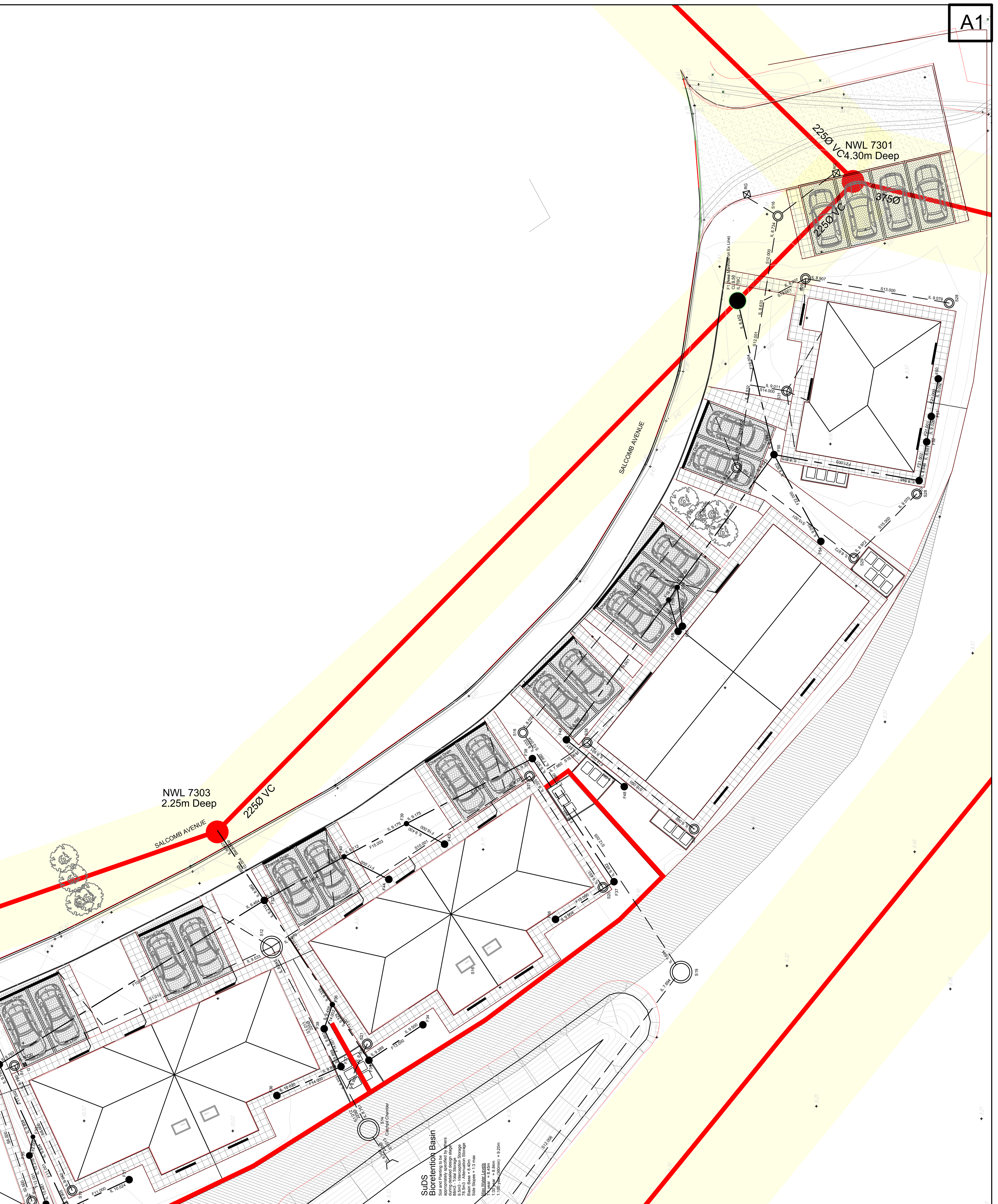
| Table 2<br>Mitigation Indices | | | |
|---|---|---|---|
| Types of SUDS Component | TSS | Metals | Hydrocarbons |
| Bio-retention Basin | 0.8 | 0.800 | 0.800 |
| Total | 0.8 | 0.800 | 0.800 |

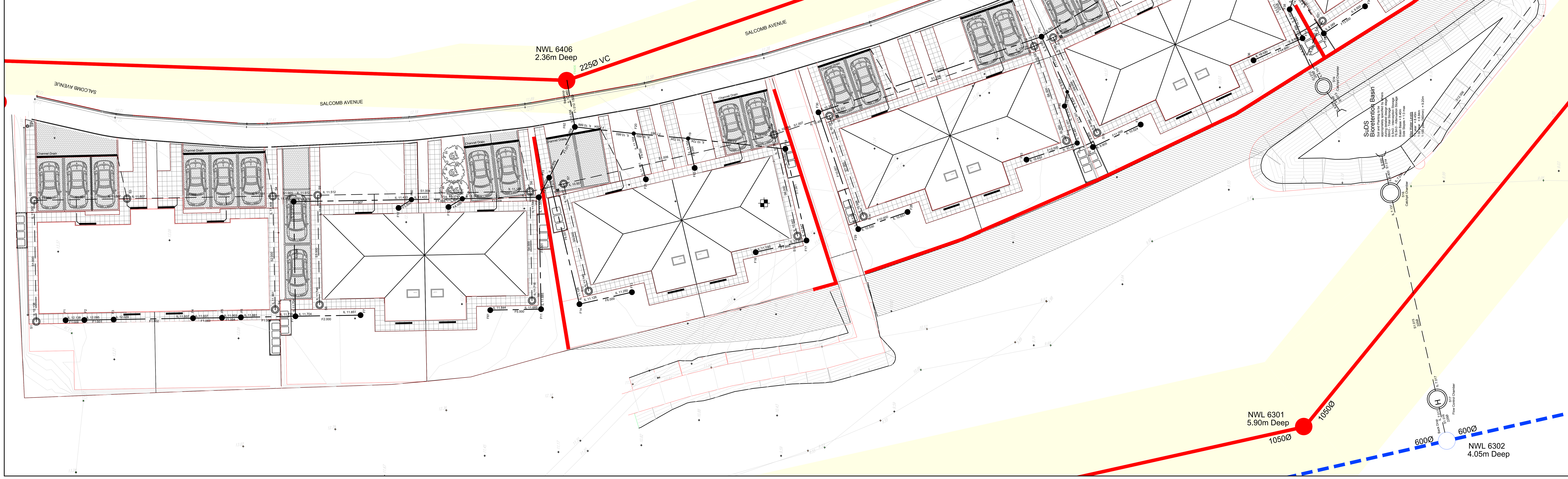
*Table 2 - based on Table 26.3 - Indicative SuDS mitigation indices for discharge to surface waters*

Conclusion:
Reference to the above criteria confirms that the BIO-RETENTION BASIN alone provides sufficient SUDS mitigation from the new build residential scheme. Treating all sources in compliance with the requirements of CIRIA C753, The SUDS Manual (2016), section 26.7.

Legend

| | |
|---|---|
| (thick solid line) | Existing NWL Combined Sewer |
| (blue dashed line) | Existing NWL Surface Water Sewer |
| (dashed line) | Proposed Private SW Drainage |
| (dash-dot line) | Proposed Private FW Drainage |
| ◎ ● | SW/FW Inspection Chambers (450Ø) |
| ◯ ● | SW/FW PCC Chambers (≥1200Ø) |
| H | Flow Control Device |
| G | Gully |
| RG | Road Gully |
| (shaded area) | Existing NWL Sewer Easement |




| Rev | Date | Description | Drawn | Chkd |
|---|---|---|---|---|

Project: SALCOMBE AVENUE, JARROW RESIDENTIAL DEVELOPMENT

Client: South Tyneside Homes

Architect: CEAD

Title: DRAINAGE ARRANGEMENT OVERVIEW

| Scale | Drawn | Date |
|---|---|---|
| 1:200 | DW | DEC 16 |
| **Job Number** | **Drawing Number** | **Rev.** |
| 16124 | C-GA-201 | P1 |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Status: PRELIMINARY

# Appendix E

**Surface Water Drainage Calculations**

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | Add Flow / Climate Change (%) | 0 |
| M5-60 (mm) | 17.100 | Minimum Backdrop Height (m) | 0.000 |
| Ratio R | 0.346 | Maximum Backdrop Height (m) | 4.000 |
| Maximum Rainfall (mm/hr) | 50 | Min Design Depth for Optimisation (m) | 0.600 |
| Maximum Time of Concentration (mins) | 30 | Min Vel for Auto Design only (m/s) | 1.00 |
| Foul Sewage (l/s/ha) | 0.000 | Min Slope for Optimisation (1:X) | 500 |
| Volumetric Runoff Coeff. | 0.750 | | |

Designed with Level Soffits

### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 10.973 | 0.188 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.001 | 8.413 | 0.144 | 58.5 | 0.004 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S1.002 | 13.174 | 0.225 | 58.5 | 0.008 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S2.000 | 10.657 | 0.182 | 58.5 | 0.005 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.003 | 4.039 | 0.069 | 58.5 | 0.011 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S3.000 | 9.884 | 0.169 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.004 | 19.193 | 0.328 | 58.5 | 0.007 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S4.000 | 9.862 | 0.175 | 56.4 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 50.00 | 1.18 | 12.138 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.001 | 50.00 | 1.32 | 11.950 | 0.009 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 1.2 |
| S1.002 | 50.00 | 1.54 | 11.807 | 0.016 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 2.2 |
| S2.000 | 50.00 | 1.18 | 11.991 | 0.005 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.003 | 50.00 | 1.60 | 11.581 | 0.032 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 4.3 |
| S3.000 | 50.00 | 1.16 | 11.746 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.004 | 50.00 | 1.92 | 11.512 | 0.043 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 5.9 |
| S4.000 | 50.00 | 1.16 | 11.718 | 0.004 | 0.0 | 0.0 | 0.0 | 1.03 | 8.1 | 0.6 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.005 | 3.115 | 0.055 | 56.4 | 0.008 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S5.000 | 9.896 | 0.169 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.006 | 19.524 | 0.197 | 99.3 | 0.009 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S6.000 | 9.927 | 0.170 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.007 | 5.268 | 0.239 | 22.1 | 0.008 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S7.000 | 9.576 | 0.164 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.008 | 19.540 | 0.197 | 99.2 | 0.008 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S8.000 | 9.519 | 0.163 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.009 | 1.890 | 0.271 | 7.0 | 0.008 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S9.000 | 9.454 | 0.162 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.010 | 19.547 | 0.197 | 99.0 | 0.008 | 0.00 | 0.0 | 0.600 | o | 150 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.005 | 50.00 | 1.97 | 11.184 | 0.056 | 0.0 | 0.0 | 0.0 | 1.03 | 8.1 | 7.6 |
| S5.000 | 50.00 | 1.16 | 11.146 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.006 | 50.00 | 2.29 | 10.927 | 0.069 | 0.0 | 0.0 | 0.0 | 1.01 | 17.8 | 9.4 |
| S6.000 | 50.00 | 1.16 | 10.951 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.007 | 50.00 | 2.34 | 10.730 | 0.081 | 0.0 | 0.0 | 0.0 | 2.15 | 38.0 | 11.0 |
| S7.000 | 50.00 | 1.16 | 10.544 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.008 | 50.00 | 2.66 | 10.331 | 0.094 | 0.0 | 0.0 | 0.0 | 1.01 | 17.8 | 12.7 |
| S8.000 | 50.00 | 1.16 | 10.500 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.009 | 50.00 | 2.67 | 10.134 | 0.106 | 0.0 | 0.0 | 0.0 | 3.84 | 67.8 | 14.4 |
| S9.000 | 50.00 | 1.16 | 9.942 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S1.010 | 50.00 | 2.99 | 9.730 | 0.119 | 0.0 | 0.0 | 0.0 | 1.01 | 17.8 | 16.1 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S10.000 | 9.236 | 0.158 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S10.001 | 21.354 | 0.365 | 58.5 | 0.008 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S1.011 | 10.912 | 0.073 | 150.0 | 0.016 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S11.000 | 3.440 | 0.070 | 48.8 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S1.012 | 3.168 | 0.021 | 150.0 | 0.004 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S1.013 | 6.685 | 0.051 | 131.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S1.014 | 4.851 | 0.029 | 168.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S12.000 | 5.925 | 0.101 | 58.5 | 0.017 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S13.000 | 10.069 | 0.172 | 58.5 | 0.002 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S13.001 | 3.184 | 0.054 | 58.5 | 0.003 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S12.001 | 5.925 | 0.101 | 58.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S14.000 | 2.525 | 0.132 | 19.2 | 0.001 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S12.002 | 5.739 | 0.098 | 58.7 | 0.000 | 0.00 | 0.0 | 0.600 | o | 100 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S10.000 | 50.00 | 1.15 | 9.493 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S10.001 | 50.00 | 1.51 | 9.335 | 0.012 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 1.7 |
| S1.011 | 50.00 | 3.16 | 8.845 | 0.148 | 0.0 | 0.0 | 0.0 | 1.07 | 42.4 | 20.0 |
| S11.000 | 50.00 | 1.05 | 9.500 | 0.004 | 0.0 | 0.0 | 0.0 | 1.11 | 8.7 | 0.6 |
| S1.012 | 50.00 | 3.21 | 8.772 | 0.157 | 0.0 | 0.0 | 0.0 | 1.07 | 42.4 | 21.2 |
| S1.013 | 50.00 | 3.31 | 8.751 | 0.157 | 0.0 | 0.0 | 0.0 | 1.14 | 45.3 | 21.2 |
| S1.014 | 50.00 | 3.39 | 8.400 | 0.157 | 0.0 | 0.0 | 0.0 | 1.00 | 39.9 | 21.2 |
| S12.000 | 50.00 | 1.10 | 8.734 | 0.017 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 2.4 |
| S13.000 | 50.00 | 1.17 | 9.079 | 0.002 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.3 |
| S13.001 | 50.00 | 1.22 | 8.907 | 0.005 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.7 |
| S12.001 | 50.00 | 1.32 | 8.633 | 0.023 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 3.0 |
| S14.000 | 50.00 | 1.02 | 9.011 | 0.001 | 0.0 | 0.0 | 0.0 | 1.77 | 13.9 | 0.2 |
| S12.002 | 50.00 | 1.41 | 8.532 | 0.024 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 3.2 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S15.000 | 5.694 | 0.097 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S15.001 | 10.212 | 0.175 | 58.5 | 0.004 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S12.003 | 23.511 | 0.402 | 58.5 | 0.007 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S12.004 | 3.033 | 0.052 | 58.5 | 0.011 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S16.000 | 9.442 | 0.161 | 58.5 | 0.004 | 1.00 | 0.0 | 0.600 | o | 100 | |
| S16.001 | 3.323 | 0.057 | 58.5 | 0.004 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S12.005 | 16.724 | 0.286 | 58.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S12.006 | 25.636 | 0.438 | 58.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 100 | |
| S1.015 | 19.075 | 0.113 | 168.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S1.016 | 3.173 | 0.019 | 168.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S15.000 | 50.00 | 1.09 | 9.070 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S15.001 | 50.00 | 1.26 | 8.972 | 0.008 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 1.1 |
| S12.003 | 50.00 | 1.80 | 8.434 | 0.039 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 5.3 |
| S12.004 | 50.00 | 1.85 | 8.032 | 0.050 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 6.8 |
| S16.000 | 50.00 | 1.16 | 9.092 | 0.004 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 0.6 |
| S16.001 | 50.00 | 1.21 | 8.931 | 0.008 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 1.1 |
| S12.005 | 50.00 | 2.13 | 7.980 | 0.058 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 7.8 |
| S12.006 | 50.00 | 2.55 | 7.694 | 0.058 | 0.0 | 0.0 | 0.0 | 1.01 | 7.9 | 7.8 |
| S1.015 | 50.00 | 3.70 | 7.131 | 0.214 | 0.0 | 0.0 | 0.0 | 1.00 | 39.9 | 29.0 |
| S1.016 | 50.00 | 3.76 | 7.017 | 0.214 | 0.0 | 0.0 | 0.0 | 1.00 | 39.9 | 29.0 |

## Manhole Schedules for Storm

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | PN | Pipe Out Invert Level (m) | Diameter (mm) | PN | Pipes In Invert Level (m) | Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 12.838 | 0.700 | Open Manhole | 450 | S1.000 | 12.138 | 100 | | | | |
| S2 | 12.806 | 0.856 | Open Manhole | 450 | S1.001 | 11.950 | 100 | S1.000 | 11.950 | 100 | |
| S3 | 12.833 | 1.026 | Open Manhole | 450 | S1.002 | 11.807 | 100 | S1.001 | 11.807 | 100 | |
| S4 | 12.691 | 0.700 | Open Manhole | 450 | S2.000 | 11.991 | 100 | | | | |
| S4 | 12.662 | 1.080 | Open Manhole | 450 | S1.003 | 11.581 | 100 | S1.002 | 11.581 | 100 | |
| | | | | | | | | S2.000 | 11.808 | 100 | 227 |
| S6 | 12.446 | 0.700 | Open Manhole | 450 | S3.000 | 11.746 | 100 | | | | |
| S5 | 12.443 | 0.931 | Open Manhole | 450 | S1.004 | 11.512 | 100 | S1.003 | 11.512 | 100 | |
| | | | | | | | | S3.000 | 11.577 | 100 | 65 |
| S8 | 12.418 | 0.700 | Open Manhole | 450 | S4.000 | 11.718 | 100 | | | | |
| S6 | 12.243 | 1.059 | Open Manhole | 450 | S1.005 | 11.184 | 100 | S1.004 | 11.184 | 100 | |
| | | | | | | | | S4.000 | 11.543 | 100 | 359 |
| S10 | 11.846 | 0.700 | Open Manhole | 450 | S5.000 | 11.146 | 100 | | | | |
| S7 | 11.852 | 0.926 | Open Manhole | 450 | S1.006 | 10.927 | 150 | S1.005 | 11.129 | 100 | 152 |
| | | | | | | | | S5.000 | 10.977 | 100 | |
| S12 | 11.651 | 0.700 | Open Manhole | 450 | S6.000 | 10.951 | 100 | | | | |
| S8 | 11.612 | 0.882 | Open Manhole | 450 | S1.007 | 10.730 | 150 | S1.006 | 10.730 | 150 | |
| | | | | | | | | S6.000 | 10.782 | 100 | 1 |
| S14 | 11.244 | 0.700 | Open Manhole | 450 | S7.000 | 10.544 | 100 | | | | |
| S9 | 11.242 | 0.911 | Open Manhole | 450 | S1.008 | 10.331 | 150 | S1.007 | 10.492 | 150 | 161 |
| | | | | | | | | S7.000 | 10.381 | 100 | |
| S16 | 11.200 | 0.700 | Open Manhole | 450 | S8.000 | 10.500 | 100 | | | | |
| S10 | 11.152 | 1.019 | Open Manhole | 450 | S1.009 | 10.134 | 150 | S1.008 | 10.134 | 150 | |
| | | | | | | | | S8.000 | 10.337 | 100 | 154 |
| S18 | 10.642 | 0.700 | Open Manhole | 450 | S9.000 | 9.942 | 100 | | | | |
| S11 | 10.613 | 0.883 | Open Manhole | 450 | S1.010 | 9.730 | 150 | S1.009 | 9.863 | 150 | 133 |
| | | | | | | | | S9.000 | 9.780 | 100 | |
| S20 | 10.193 | 0.700 | Open Manhole | 450 | S10.000 | 9.493 | 100 | | | | |
| S21 | 10.073 | 0.739 | Open Manhole | 450 | S10.001 | 9.335 | 100 | S10.000 | 9.335 | 100 | |
| S12 | 10.398 | 1.554 | Open Manhole | | S1.011 | 8.845 | 225 | S1.010 | 9.533 | 150 | 613 |
| | | | | | | | | S10.001 | 8.970 | 100 | |
| S21 | 10.200 | 0.700 | Open Manhole | | S11.000 | 9.500 | 100 | | | | |
| S13 | 10.647 | 1.875 | Junction | 0 | S1.012 | 8.772 | 225 | S1.011 | 8.772 | 225 | |
| | | | | | | | | S11.000 | 9.430 | 100 | 533 |
| S14 | 9.590 | 0.839 | Open Manhole | 1200 | S1.013 | 8.751 | 225 | S1.012 | 8.751 | 225 | |
| S15 | 9.100 | 0.700 | Open Manhole | 450 | S1.014 | 8.400 | 225 | S1.013 | 8.700 | 225 | 300 |
| S16 | 9.434 | 0.700 | Open Manhole | | S12.000 | 8.734 | 100 | | | | |
| S28 | 9.779 | 0.700 | Open Manhole | 450 | S13.000 | 9.079 | 100 | | | | |

## Manhole Schedules for Storm

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | PN | Pipe Out Invert Level (m) | Diameter (mm) | PN | Pipes In Invert Level (m) | Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S29 | 9.714 | 0.807 | Open Manhole | | S13.001 | 8.907 | 100 | S13.000 | 8.907 | 100 | |
| S28 | 9.661 | 1.028 | Junction | | S12.001 | 8.633 | 100 | S12.000 | 8.633 | 100 | |
| | | | | | | | | S13.001 | 8.853 | 100 | 220 |
| S31 | 9.711 | 0.700 | Open Manhole | | S14.000 | 9.011 | 100 | | | | |
| S32 | 9.579 | 1.047 | Junction | 0 | S12.002 | 8.532 | 100 | S12.001 | 8.532 | 100 | |
| | | | | | | | | S14.000 | 8.879 | 100 | 347 |
| S33 | 9.770 | 0.700 | Open Manhole | 450 | S15.000 | 9.070 | 100 | | | | |
| S34 | 9.786 | 0.813 | Open Manhole | 450 | S15.001 | 8.972 | 100 | S15.000 | 8.972 | 100 | |
| S35 | 9.674 | 1.240 | Open Manhole | 450 | S12.003 | 8.434 | 100 | S12.002 | 8.434 | 100 | |
| | | | | | | | | S15.001 | 8.798 | 100 | 364 |
| S36 | 9.890 | 1.858 | Open Manhole | | S12.004 | 8.032 | 100 | S12.003 | 8.032 | 100 | |
| S37 | 9.792 | 0.700 | Open Manhole | 450 | S16.000 | 9.092 | 100 | | | | |
| S38 | 9.791 | 0.860 | Open Manhole | | S16.001 | 8.931 | 100 | S16.000 | 8.931 | 100 | |
| S39 | 9.962 | 1.982 | Junction | 0 | S12.005 | 7.980 | 100 | S12.004 | 7.980 | 100 | |
| | | | | | | | | S16.001 | 8.874 | 100 | 894 |
| S40 | 9.375 | 1.681 | Open Manhole | 1200 | S12.006 | 7.694 | 100 | S12.005 | 7.694 | 100 | |
| S41 | 9.205 | 2.074 | Open Manhole | 1200 | S1.015 | 7.131 | 225 | S1.014 | 8.371 | 225 | 1241 |
| | | | | | | | | S12.006 | 7.256 | 100 | |
| S42 | 9.500 | 2.483 | Open Manhole | 1200 | S1.016 | 7.017 | 225 | S1.015 | 7.017 | 225 | |
| S6406 | 9.913 | 2.915 | Open Manhole | 1200 | | OUTFALL | | S1.016 | 6.999 | 225 | |

## PIPELINE SCHEDULES for Storm

### Upstream Manhole

| PN | Hyd Sect | Diam (mm) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S1.000 | o | 100 | S1 | 12.838 | 12.138 | 0.600 | Open Manhole | 450 |
| S1.001 | o | 100 | S2 | 12.806 | 11.950 | 0.756 | Open Manhole | 450 |
| S1.002 | o | 100 | S3 | 12.833 | 11.807 | 0.926 | Open Manhole | 450 |
| S2.000 | o | 100 | S4 | 12.691 | 11.991 | 0.600 | Open Manhole | 450 |
| S1.003 | o | 100 | S4 | 12.662 | 11.581 | 0.980 | Open Manhole | 450 |
| S3.000 | o | 100 | S6 | 12.446 | 11.746 | 0.600 | Open Manhole | 450 |
| S1.004 | o | 100 | S5 | 12.443 | 11.512 | 0.831 | Open Manhole | 450 |
| S4.000 | o | 100 | S8 | 12.418 | 11.718 | 0.600 | Open Manhole | 450 |
| S1.005 | o | 100 | S6 | 12.243 | 11.184 | 0.959 | Open Manhole | 450 |
| S5.000 | o | 100 | S10 | 11.846 | 11.146 | 0.600 | Open Manhole | 450 |
| S1.006 | o | 150 | S7 | 11.852 | 10.927 | 0.776 | Open Manhole | 450 |
| S6.000 | o | 100 | S12 | 11.651 | 10.951 | 0.600 | Open Manhole | 450 |

### Downstream Manhole

| PN | Length (m) | Slope (1:X) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S1.000 | 10.973 | 58.5 | S2 | 12.806 | 11.950 | 0.756 | Open Manhole | 450 |
| S1.001 | 8.413 | 58.5 | S3 | 12.833 | 11.807 | 0.926 | Open Manhole | 450 |
| S1.002 | 13.174 | 58.5 | S4 | 12.662 | 11.581 | 0.980 | Open Manhole | 450 |
| S2.000 | 10.657 | 58.5 | S4 | 12.662 | 11.808 | 0.753 | Open Manhole | 450 |
| S1.003 | 4.039 | 58.5 | S5 | 12.443 | 11.512 | 0.831 | Open Manhole | 450 |
| S3.000 | 9.884 | 58.5 | S5 | 12.443 | 11.577 | 0.766 | Open Manhole | 450 |
| S1.004 | 19.193 | 58.5 | S6 | 12.243 | 11.184 | 0.959 | Open Manhole | 450 |
| S4.000 | 9.862 | 56.4 | S6 | 12.243 | 11.543 | 0.600 | Open Manhole | 450 |
| S1.005 | 3.115 | 56.4 | S7 | 11.852 | 11.129 | 0.624 | Open Manhole | 450 |
| S5.000 | 9.896 | 58.5 | S7 | 11.852 | 10.977 | 0.776 | Open Manhole | 450 |
| S1.006 | 19.524 | 99.3 | S8 | 11.612 | 10.730 | 0.732 | Open Manhole | 450 |
| S6.000 | 9.927 | 58.5 | S8 | 11.612 | 10.782 | 0.731 | Open Manhole | 450 |

## PIPELINE SCHEDULES for Storm

### Upstream Manhole

| PN | Hyd Sect | Diam (mm) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S1.007 | o | 150 | S8 | 11.612 | 10.730 | 0.732 | Open Manhole | 450 |
| S7.000 | o | 100 | S14 | 11.244 | 10.544 | 0.600 | Open Manhole | 450 |
| S1.008 | o | 150 | S9 | 11.242 | 10.331 | 0.761 | Open Manhole | 450 |
| S8.000 | o | 100 | S16 | 11.200 | 10.500 | 0.600 | Open Manhole | 450 |
| S1.009 | o | 150 | S10 | 11.152 | 10.134 | 0.869 | Open Manhole | 450 |
| S9.000 | o | 100 | S18 | 10.642 | 9.942 | 0.600 | Open Manhole | 450 |
| S1.010 | o | 150 | S11 | 10.613 | 9.730 | 0.733 | Open Manhole | 450 |
| S10.000 | o | 100 | S20 | 10.193 | 9.493 | 0.600 | Open Manhole | 450 |
| S10.001 | o | 100 | S21 | 10.073 | 9.335 | 0.639 | Open Manhole | 450 |
| S1.011 | o | 225 | S12 | 10.398 | 8.845 | 1.329 | Open Manhole | 1200 |
| S11.000 | o | 100 | S21 | 10.200 | 9.500 | 0.600 | Open Manhole | 450 |

### Downstream Manhole

| PN | Length (m) | Slope (1:X) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S1.007 | 5.268 | 22.1 | S9 | 11.242 | 10.492 | 0.600 | Open Manhole | 450 |
| S7.000 | 9.576 | 58.5 | S9 | 11.242 | 10.381 | 0.761 | Open Manhole | 450 |
| S1.008 | 19.540 | 99.2 | S10 | 11.152 | 10.134 | 0.869 | Open Manhole | 450 |
| S8.000 | 9.519 | 58.5 | S10 | 11.152 | 10.337 | 0.715 | Open Manhole | 450 |
| S1.009 | 1.890 | 7.0 | S11 | 10.613 | 9.863 | 0.600 | Open Manhole | 450 |
| S9.000 | 9.454 | 58.5 | S11 | 10.613 | 9.780 | 0.733 | Open Manhole | 450 |
| S1.010 | 19.547 | 99.0 | S12 | 10.398 | 9.533 | 0.715 | Open Manhole | 1200 |
| S10.000 | 9.236 | 58.5 | S21 | 10.073 | 9.335 | 0.639 | Open Manhole | 450 |
| S10.001 | 21.354 | 58.5 | S12 | 10.398 | 8.970 | 1.329 | Open Manhole | 1200 |
| S1.011 | 10.912 | 150.0 | S13 | 10.647 | 8.772 | 1.650 | Junction | |
| S11.000 | 3.440 | 48.8 | S13 | 10.647 | 9.430 | 1.117 | Junction | |

## PIPELINE SCHEDULES for Storm

### Upstream Manhole

| PN | Hyd Sect | Diam (mm) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S1.012 | o | 225 | S13 | 10.647 | 8.772 | 1.650 | Junction | |
| S1.013 | o | 225 | S14 | 9.590 | 8.751 | 0.614 | Open Manhole | 1200 |
| S1.014 | o | 225 | S15 | 9.100 | 8.400 | 0.475 | Open Manhole | 450 |
| S12.000 | o | 100 | S16 | 9.434 | 8.734 | 0.600 | Open Manhole | 450 |
| S13.000 | o | 100 | S28 | 9.779 | 9.079 | 0.600 | Open Manhole | 450 |
| S13.001 | o | 100 | S29 | 9.714 | 8.907 | 0.707 | Open Manhole | 450 |
| S12.001 | o | 100 | S28 | 9.661 | 8.633 | 0.928 | Junction | |
| S14.000 | o | 100 | S31 | 9.711 | 9.011 | 0.600 | Open Manhole | 450 |
| S12.002 | o | 100 | S32 | 9.579 | 8.532 | 0.947 | Junction | |
| S15.000 | o | 100 | S33 | 9.770 | 9.070 | 0.600 | Open Manhole | 450 |
| S15.001 | o | 100 | S34 | 9.786 | 8.972 | 0.713 | Open Manhole | 450 |
| S12.003 | o | 100 | S35 | 9.674 | 8.434 | 1.140 | Open Manhole | 450 |
| S12.004 | o | 100 | S36 | 9.890 | 8.032 | 1.758 | Open Manhole | 450 |

### Downstream Manhole

| PN | Length (m) | Slope (1:X) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S1.012 | 3.168 | 150.0 | S14 | 9.590 | 8.751 | 0.614 | Open Manhole | 1200 |
| S1.013 | 6.685 | 131.1 | S15 | 9.100 | 8.700 | 0.175 | Open Manhole | 450 |
| S1.014 | 4.851 | 168.4 | S41 | 9.205 | 8.371 | 0.609 | Open Manhole | 1200 |
| S12.000 | 5.925 | 58.5 | S28 | 9.661 | 8.633 | 0.928 | Junction | |
| S13.000 | 10.069 | 58.5 | S29 | 9.714 | 8.907 | 0.707 | Open Manhole | 450 |
| S13.001 | 3.184 | 58.5 | S28 | 9.661 | 8.853 | 0.709 | Junction | |
| S12.001 | 5.925 | 58.5 | S32 | 9.579 | 8.532 | 0.947 | Junction | |
| S14.000 | 2.525 | 19.2 | S32 | 9.579 | 8.879 | 0.600 | Junction | |
| S12.002 | 5.739 | 58.7 | S35 | 9.674 | 8.434 | 1.140 | Open Manhole | 450 |
| S15.000 | 5.694 | 58.5 | S34 | 9.786 | 8.972 | 0.713 | Open Manhole | 450 |
| S15.001 | 10.212 | 58.5 | S35 | 9.674 | 8.798 | 0.776 | Open Manhole | 450 |
| S12.003 | 23.511 | 58.5 | S36 | 9.890 | 8.032 | 1.758 | Open Manhole | 450 |
| S12.004 | 3.033 | 58.5 | S39 | 9.962 | 7.980 | 1.882 | Junction | |

## PIPELINE SCHEDULES for Storm

### Upstream Manhole

| PN | Hyd Sect | Diam (mm) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S16.000 | o | 100 | S37 | 9.792 | 9.092 | 0.600 | Open Manhole | 450 |
| S16.001 | o | 100 | S38 | 9.791 | 8.931 | 0.760 | Open Manhole | 450 |
| S12.005 | o | 100 | S39 | 9.962 | 7.980 | 1.882 | Junction | |
| S12.006 | o | 100 | S40 | 9.375 | 7.694 | 1.581 | Open Manhole | 1200 |
| S1.015 | o | 225 | S41 | 9.205 | 7.131 | 1.849 | Open Manhole | 1200 |
| S1.016 | o | 225 | S42 | 9.500 | 7.017 | 2.258 | Open Manhole | 1200 |

### Downstream Manhole

| PN | Length (m) | Slope (1:X) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| S16.000 | 9.442 | 58.5 | S38 | 9.791 | 8.931 | 0.760 | Open Manhole | 450 |
| S16.001 | 3.323 | 58.5 | S39 | 9.962 | 8.874 | 0.988 | Junction | |
| S12.005 | 16.724 | 58.5 | S40 | 9.375 | 7.694 | 1.581 | Open Manhole | 1200 |
| S12.006 | 25.636 | 58.5 | S41 | 9.205 | 7.256 | 1.849 | Open Manhole | 1200 |
| S1.015 | 19.075 | 168.4 | S42 | 9.500 | 7.017 | 2.258 | Open Manhole | 1200 |
| S1.016 | 3.173 | 168.4 | S6406 | 9.913 | 6.999 | 2.690 | Open Manhole | 1200 |

## Area Summary for Storm

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.001 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.002 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 2.000 | User | - | 100 | 0.005 | 0.005 | 0.005 |
| 1.003 | User | - | 100 | 0.011 | 0.011 | 0.011 |
| 3.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.004 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| | User | - | 100 | 0.004 | 0.004 | 0.007 |
| 4.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.005 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 5.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.006 | User | - | 100 | 0.009 | 0.009 | 0.009 |
| 6.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.007 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 7.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.008 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 8.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.009 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 9.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.010 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 10.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 10.001 | User | - | 100 | 0.008 | 0.008 | 0.008 |
| 1.011 | User | - | 100 | 0.009 | 0.009 | 0.009 |
| | User | - | 100 | 0.008 | 0.008 | 0.016 |
| 11.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.012 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 1.013 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.014 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 12.000 | User | - | 100 | 0.017 | 0.017 | 0.017 |
| 13.000 | User | - | 100 | 0.002 | 0.002 | 0.002 |
| 13.001 | User | - | 100 | 0.003 | 0.003 | 0.003 |
| 12.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 14.000 | User | - | 100 | 0.001 | 0.001 | 0.001 |
| 12.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 15.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 15.001 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 12.003 | User | - | 100 | 0.003 | 0.003 | 0.003 |
| | User | - | 100 | 0.004 | 0.004 | 0.007 |
| 12.004 | User | - | 100 | 0.006 | 0.006 | 0.006 |
| | User | - | 100 | 0.004 | 0.004 | 0.011 |
| 16.000 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 16.001 | User | - | 100 | 0.004 | 0.004 | 0.004 |
| 12.005 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 12.006 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.015 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.016 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total<br>0.214 | Total<br>0.214 | Total<br>0.214 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| S1.016 | S6406 | 9.913 | 6.999 | 0.000 | 1200 | 0 |

## Simulation Criteria for Storm

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.840 | Additional Flow - % of Total Flow | 0.000 |
| Areal Reduction Factor | 1.000 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start (mins) | 0 | Inlet Coeffiecient | 0.800 |
| Hot Start Level (mm) | 0 | Flow per Person per Day (l/per/day) | 0.000 |
| Manhole Headloss Coeff (Global) | 0.500 | Run Time (mins) | 60 |
| Foul Sewage per hectare (l/s) | 0.000 | Output Interval (mins) | 1 |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Winter |
| Return Period (years) | 1 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 17.100 | Storm Duration (mins) | 15 |
| Ratio R | 0.346 | | |

## Online Controls for Storm

### Hydro-Brake Optimum® Manhole: S42, DS/PN: S1.016, Volume ($m^3$): 3.5

| | |
|---|---|
| Unit Reference | MD-SHE-0090-5000-2100-5000 |
| Design Head (m) | 2.100 |
| Design Flow (l/s) | 5.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 90 |
| Invert Level (m) | 7.017 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 2.100 | 5.0 |
| Flush-Flo™ | 0.397 | 4.0 |
| Kick-Flo® | 0.808 | 3.2 |
| Mean Flow over Head Range | - | 3.9 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 2.8 | 1.200 | 3.8 | 3.000 | 5.9 | 7.000 | 8.8 |
| 0.200 | 3.7 | 1.400 | 4.1 | 3.500 | 6.3 | 7.500 | 9.1 |
| 0.300 | 4.0 | 1.600 | 4.4 | 4.000 | 6.8 | 8.000 | 9.4 |
| 0.400 | 4.0 | 1.800 | 4.6 | 4.500 | 7.1 | 8.500 | 9.6 |
| 0.500 | 4.0 | 2.000 | 4.9 | 5.000 | 7.5 | 9.000 | 9.9 |
| 0.600 | 3.9 | 2.200 | 5.1 | 5.500 | 7.8 | 9.500 | 10.2 |
| 0.800 | 3.3 | 2.400 | 5.3 | 6.000 | 8.2 | | |
| 1.000 | 3.5 | 2.600 | 5.5 | 6.500 | 8.5 | | |

## Storage Structures for Storm

### Tank or Pond Manhole: S15, DS/PN: S1.014

Invert Level (m) 8.400

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 64.2 | 0.300 | 120.1 | 0.600 | 157.5 |
| 0.100 | 97.8 | 0.400 | 132.0 | 0.700 | 171.1 |
| 0.200 | 108.6 | 0.500 | 144.5 | 0.701 | 171.3 |

## 1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

| | | | |
|---|---|---|---|
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 0.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Inlet Coeffiecient | 0.800 |
| Manhole Headloss Coeff (Global) | 0.500 | Flow per Person per Day (l/per/day) | 0.000 |
| Foul Sewage per hectare (l/s) | 0.000 | | |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Ratio R | 0.345 |
| Region | England and Wales | Cv (Summer) | 0.750 |
| M5-60 (mm) | 17.200 | Cv (Winter) | 0.840 |

| | | | |
|---|---|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 | DVD Status | OFF |
| Analysis Timestep | Fine | Inertia Status | ON |
| DTS Status | ON | | |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720 |
| Return Period(s) (years) | 1, 30, 100 |
| Climate Change (%) | 0, 0, 40 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S1.001 | S2 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S1.002 | S3 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S2.000 | S4 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S1.003 | S4 | 15 Summer | 1 | +0% | 30/15 Summer | 100/15 Summer | | |
| S3.000 | S6 | 15 Summer | 1 | +0% | 30/15 Summer | 100/15 Summer | | |
| S1.004 | S5 | 15 Summer | 1 | +0% | 30/15 Summer | 100/15 Winter | | |
| S4.000 | S8 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S1.005 | S6 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S5.000 | S10 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S1.006 | S7 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S6.000 | S12 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S1.007 | S8 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S7.000 | S14 | 15 Summer | 1 | +0% | 30/15 Summer | 100/15 Summer | | |
| S1.008 | S9 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S8.000 | S16 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S1.009 | S10 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| S9.000 | S18 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S1.010 | S11 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| S10.000 | S20 | 15 Summer | 1 | +0% | | | | |
| S10.001 | S21 | 15 Summer | 1 | +0% | 100/15 Summer | | | |

## 1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 12.160 | -0.078 | 0.000 | 0.10 | | 0.8 | OK | |
| S1.001 | S2 | 11.977 | -0.074 | 0.000 | 0.14 | | 1.0 | OK | |
| S1.002 | S3 | 11.839 | -0.068 | 0.000 | 0.23 | | 1.7 | OK | |
| S2.000 | S4 | 12.013 | -0.077 | 0.000 | 0.11 | | 0.8 | OK | |
| S1.003 | S4 | 11.631 | -0.050 | 0.000 | 0.50 | | 3.4 | OK | 2 |
| S3.000 | S6 | 11.768 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | 4 |
| S1.004 | S5 | 11.568 | -0.044 | 0.000 | 0.60 | | 4.5 | OK | 1 |
| S4.000 | S8 | 11.739 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S1.005 | S6 | 11.257 | -0.027 | 0.000 | 0.88 | | 5.8 | OK | |
| S5.000 | S10 | 11.168 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S1.006 | S7 | 10.995 | -0.082 | 0.000 | 0.41 | | 6.9 | OK | |
| S6.000 | S12 | 10.973 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S1.007 | S8 | 10.783 | -0.097 | 0.000 | 0.27 | | 8.1 | OK | |
| S7.000 | S14 | 10.566 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | 2 |
| S1.008 | S9 | 10.412 | -0.069 | 0.000 | 0.56 | | 9.3 | OK | |
| S8.000 | S16 | 10.522 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S1.009 | S10 | 10.192 | -0.091 | 0.000 | 0.32 | | 10.5 | OK | |
| S9.000 | S18 | 9.964 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S1.010 | S11 | 9.824 | -0.057 | 0.000 | 0.69 | | 11.6 | OK | |
| S10.000 | S20 | 9.515 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S10.001 | S21 | 9.364 | -0.071 | 0.000 | 0.18 | | 1.4 | OK | |

## 1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.011 | S12 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| S11.000 | S21 | 15 Summer | 1 | +0% | | | | |
| S1.012 | S13 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| S1.013 | S14 | 15 Winter | 1 | +0% | 30/15 Summer | | | |
| S1.014 | S15 | 30 Winter | 1 | +0% | 30/30 Winter | | | |
| S12.000 | S16 | 15 Summer | 1 | +0% | 30/15 Summer | 100/15 Summer | | |
| S13.000 | S28 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S13.001 | S29 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S12.001 | S28 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S14.000 | S31 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S12.002 | S32 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S15.000 | S33 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S15.001 | S34 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S12.003 | S35 | 15 Summer | 1 | +0% | 30/15 Summer | | | |
| S12.004 | S36 | 60 Winter | 1 | +0% | 1/30 Summer | | | |
| S16.000 | S37 | 15 Summer | 1 | +0% | 100/15 Winter | | | |
| S16.001 | S38 | 15 Summer | 1 | +0% | 100/15 Summer | | | |
| S12.005 | S39 | 60 Winter | 1 | +0% | 1/30 Summer | | | |
| S12.006 | S40 | 60 Winter | 1 | +0% | 1/15 Summer | | | |
| S1.015 | S41 | 60 Winter | 1 | +0% | 1/15 Summer | 100/120 Winter | | |
| S1.016 | S42 | 60 Winter | 1 | +0% | 1/15 Summer | 100/180 Summer | | |

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.011 | S12 | 8.945 | -0.125 | 0.000 | 0.40 | | 14.5 | OK | |
| S11.000 | S21 | 9.522 | -0.078 | 0.000 | 0.10 | | 0.8 | OK | |
| S1.012 | S13 | 8.887 | -0.110 | 0.000 | 0.51 | | 15.3 | OK* | |
| S1.013 | S14 | 8.860 | -0.116 | 0.000 | 0.48 | | 15.3 | OK | |
| S1.014 | S15 | 8.475 | -0.150 | 0.000 | 0.25 | | 7.1 | OK | |
| S12.000 | S16 | 8.782 | -0.053 | 0.000 | 0.42 | | 2.9 | OK | 10 |
| S13.000 | S28 | 9.094 | -0.085 | 0.000 | 0.05 | | 0.4 | OK | |
| S13.001 | S29 | 8.928 | -0.079 | 0.000 | 0.09 | | 0.6 | OK | |
| S12.001 | S28 | 8.683 | -0.050 | 0.000 | 0.43 | | 3.4 | OK* | |
| S14.000 | S31 | 9.020 | -0.090 | 0.000 | 0.02 | | 0.2 | OK | |
| S12.002 | S32 | 8.582 | -0.050 | 0.000 | 0.48 | | 3.8 | OK* | |
| S15.000 | S33 | 9.092 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S15.001 | S34 | 8.998 | -0.075 | 0.000 | 0.13 | | 1.0 | OK | |
| S12.003 | S35 | 8.493 | -0.041 | 0.000 | 0.67 | | 5.1 | OK | |
| S12.004 | S36 | 8.470 | 0.339 | 0.000 | 0.48 | | 3.0 | SURCHARGED | |
| S16.000 | S37 | 9.114 | -0.078 | 0.000 | 0.10 | | 0.7 | OK | |
| S16.001 | S38 | 8.958 | -0.073 | 0.000 | 0.15 | | 1.0 | OK | |
| S12.005 | S39 | 8.468 | 0.388 | 0.000 | 0.44 | | 3.5 | SURCHARGED* | |
| S12.006 | S40 | 8.461 | 0.667 | 0.000 | 0.46 | | 3.5 | SURCHARGED | |
| S1.015 | S41 | 8.453 | 1.097 | 0.000 | 0.17 | | 6.2 | SURCHARGED | 7 |
| S1.016 | S42 | 8.444 | 1.202 | 0.000 | 0.16 | | 4.2 | SURCHARGED | 7 |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.345
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 17.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S1.001 | S2 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S1.002 | S3 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S2.000 | S4 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| S1.003 | S4 | 15 Winter | 30 | +0% | 30/15 Summer | 100/15 Summer | | |
| S3.000 | S6 | 15 Winter | 30 | +0% | 30/15 Summer | 100/15 Summer | | |
| S1.004 | S5 | 15 Winter | 30 | +0% | 30/15 Summer | 100/15 Winter | | |
| S4.000 | S8 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S1.005 | S6 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S5.000 | S10 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S1.006 | S7 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| S6.000 | S12 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S1.007 | S8 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| S7.000 | S14 | 15 Winter | 30 | +0% | 30/15 Summer | 100/15 Summer | | |
| S1.008 | S9 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S8.000 | S16 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S1.009 | S10 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S9.000 | S18 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S1.010 | S11 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S10.000 | S20 | 15 Summer | 30 | +0% | | | | |
| S10.001 | S21 | 15 Summer | 30 | +0% | 100/15 Summer | | | |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 12.173 | -0.065 | 0.000 | 0.25 | | 1.9 | OK | |
| S1.001 | S2 | 12.094 | 0.044 | 0.000 | 0.34 | | 2.5 | SURCHARGED | |
| S1.002 | S3 | 12.081 | 0.175 | 0.000 | 0.53 | | 3.9 | SURCHARGED | |
| S2.000 | S4 | 12.037 | -0.053 | 0.000 | 0.22 | | 1.6 | OK | |
| S1.003 | S4 | 12.031 | 0.350 | 0.000 | 1.06 | | 7.2 | SURCHARGED | 2 |
| S3.000 | S6 | 11.963 | 0.116 | 0.000 | 0.20 | | 1.4 | SURCHARGED | 4 |
| S1.004 | S5 | 11.957 | 0.344 | 0.000 | 1.26 | | 9.6 | SURCHARGED | 1 |
| S4.000 | S8 | 11.752 | -0.066 | 0.000 | 0.24 | | 1.8 | OK | |
| S1.005 | S6 | 11.434 | 0.150 | 0.000 | 1.93 | | 12.6 | SURCHARGED | |
| S5.000 | S10 | 11.180 | -0.066 | 0.000 | 0.24 | | 1.8 | OK | |
| S1.006 | S7 | 11.044 | -0.033 | 0.000 | 0.96 | | 16.1 | OK | |
| S6.000 | S12 | 10.986 | -0.065 | 0.000 | 0.25 | | 1.8 | OK | |
| S1.007 | S8 | 10.817 | -0.063 | 0.000 | 0.64 | | 19.4 | OK | |
| S7.000 | S14 | 10.680 | 0.035 | 0.000 | 0.20 | | 1.5 | SURCHARGED | 2 |
| S1.008 | S9 | 10.674 | 0.194 | 0.000 | 1.30 | | 21.8 | SURCHARGED | |
| S8.000 | S16 | 10.535 | -0.065 | 0.000 | 0.25 | | 1.8 | OK | |
| S1.009 | S10 | 10.341 | 0.057 | 0.000 | 0.75 | | 24.3 | SURCHARGED | |
| S9.000 | S18 | 10.195 | 0.153 | 0.000 | 0.17 | | 1.2 | SURCHARGED | |
| S1.010 | S11 | 10.190 | 0.310 | 0.000 | 1.61 | | 26.9 | SURCHARGED | |
| S10.000 | S20 | 9.528 | -0.065 | 0.000 | 0.25 | | 1.8 | OK | |
| S10.001 | S21 | 9.386 | -0.049 | 0.000 | 0.51 | | 3.9 | OK | |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.011 | S12 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S11.000 | S21 | 15 Summer | 30 | +0% | | | | |
| S1.012 | S13 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S1.013 | S14 | 15 Summer | 30 | +0% | 30/15 Summer | | | |
| S1.014 | S15 | 120 Winter | 30 | +0% | 30/30 Winter | | | |
| S12.000 | S16 | 60 Winter | 30 | +0% | 30/15 Summer | 100/15 Summer | | |
| S13.000 | S28 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S13.001 | S29 | 60 Winter | 30 | +0% | 100/15 Summer | | | |
| S12.001 | S28 | 30 Winter | 30 | +0% | 30/15 Summer | | | |
| S14.000 | S31 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S12.002 | S32 | 60 Winter | 30 | +0% | 30/15 Summer | | | |
| S15.000 | S33 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S15.001 | S34 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S12.003 | S35 | 60 Winter | 30 | +0% | 30/15 Summer | | | |
| S12.004 | S36 | 60 Winter | 30 | +0% | 1/30 Summer | | | |
| S16.000 | S37 | 15 Summer | 30 | +0% | 100/15 Winter | | | |
| S16.001 | S38 | 15 Summer | 30 | +0% | 100/15 Summer | | | |
| S12.005 | S39 | 60 Winter | 30 | +0% | 1/30 Summer | | | |
| S12.006 | S40 | 60 Winter | 30 | +0% | 1/15 Summer | | | |
| S1.015 | S41 | 180 Winter | 30 | +0% | 1/15 Summer | 100/120 Winter | | |
| S1.016 | S42 | 180 Winter | 30 | +0% | 1/15 Summer | 100/180 Summer | | |

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.011 | S12 | 9.114 | 0.045 | 0.000 | 0.96 | | 34.2 | SURCHARGED | |
| S11.000 | S21 | 9.536 | -0.064 | 0.000 | 0.26 | | 1.9 | OK | |
| S1.012 | S13 | 9.049 | 0.052 | 0.000 | 1.21 | | 36.0 | SURCHARGED* | |
| S1.013 | S14 | 8.981 | 0.005 | 0.000 | 1.10 | | 34.9 | SURCHARGED | |
| S1.014 | S15 | 8.684 | 0.059 | 0.000 | 0.26 | | 7.7 | SURCHARGED | |
| S12.000 | S16 | 9.008 | 0.174 | 0.000 | 0.37 | | 2.6 | SURCHARGED | 10 |
| S13.000 | S28 | 9.104 | -0.075 | 0.000 | 0.13 | | 0.9 | OK | |
| S13.001 | S29 | 9.001 | -0.006 | 0.000 | 0.12 | | 0.8 | OK | |
| S12.001 | S28 | 8.953 | 0.220 | 0.000 | 0.63 | | 5.0 | SURCHARGED* | |
| S14.000 | S31 | 9.025 | -0.086 | 0.000 | 0.05 | | 0.5 | OK | |
| S12.002 | S32 | 8.979 | 0.347 | 0.000 | 0.39 | | 3.1 | SURCHARGED* | |
| S15.000 | S33 | 9.105 | -0.065 | 0.000 | 0.25 | | 1.7 | OK | |
| S15.001 | S34 | 9.016 | -0.057 | 0.000 | 0.36 | | 2.7 | OK | |
| S12.003 | S35 | 8.979 | 0.446 | 0.000 | 0.65 | | 5.0 | SURCHARGED | |
| S12.004 | S36 | 8.910 | 0.779 | 0.000 | 0.89 | | 5.6 | SURCHARGED | |
| S16.000 | S37 | 9.127 | -0.066 | 0.000 | 0.24 | | 1.8 | OK | |
| S16.001 | S38 | 8.977 | -0.054 | 0.000 | 0.40 | | 2.6 | OK | |
| S12.005 | S39 | 8.888 | 0.808 | 0.000 | 0.76 | | 6.0 | SURCHARGED* | |
| S12.006 | S40 | 8.801 | 1.007 | 0.000 | 0.65 | | 5.0 | SURCHARGED | |
| S1.015 | S41 | 8.844 | 1.488 | 0.000 | 0.26 | | 9.4 | SURCHARGED | 7 |
| S1.016 | S42 | 8.974 | 1.731 | 0.000 | 0.17 | | 4.5 | SURCHARGED | 7 |

# Appendix F

## SuDS Maintenance Plan

# SuDS, Bio-retention/Detention Basin, Maintenance and Management Plan

## Salcombe Avenue

## South Tyneside Homes

Mar 17

CK21 Consulting LLP, 1 Mosley Street, Newcastle upon Tyne
T 0191 2616312 F 0191 2617774 www.ck21.co.uk

# Document Validation

# Revision History

| Revision Ref | Issue Date | Purpose of issue / description of revision |
|---|---|---|
| A | 31/03/2017 | For Planning |
| | | |
| | | |
| | | |

### Quality Assurance

| | Purpose of issue / description of revision / version "Reason for Issue" | | | |
|---|---|---|---|---|
| | | **Prepared by** | **Checked by** | **Approved by** |
| | Name | David Webb | Mark Bryden | Iain Hush |
| | Signature | | | |

This report has been prepared by CK21 Ltd with all reasonable skill, care and diligence, within the terms of the Contract with the Client. The report is confidential to the Client and CK21 Ltd accepts no responsibility of whatever nature to third parties to whom this report may be made known.

# Contents



# Surface Water Drainage Overview

### Drainage Overview

Surface water discharge from the site , to the NWL surface water sewer, is restricted by a Hydrobrake Vortex control(s) to a rate of 5 l/s. Attenuation and water treatment is provided by the incorporation of a Bio retention Basin, upstream of the flow control.

South Tyneside Homes are the organisation responsible for the basin. With the maintenance of such undertaken by themselves or a direct sub contractor.

The purpose of this report is to set out the maintenance and management of the drainage, SuDS, culvert and watercourse relating to the proposed residential development by Story Homes.

The Maintenance Plan should be considered as a live document with items tailored to reflect the requirements of the particular site.

# Bio-Retention/Detention Basin

The basin is located to the west of the development, within an area of amenity space, under the ownership of South Tyneside Homes. The sides of the basin are sloped at a gradient of 1:4, with a flat bottom of approximately 60m2. The planting proposals will include for a mix of 'Wildflower Grass: WFG15', 'Eco Species Rich Lawn: WFG20' and 'Amenity Grass: A22' as well as water compatible planting to the base of the basin. To be appropriately specified by a landscape architect, during the detailed design stage.

### Technique Overview

Detention basins are surface storage basins or facilities that provide flow control through attenuation of stormwater runoff. They also facilitate some settling of particulate pollutants. Detention basins are normally dry and in certain situations the land may also function as a recreational facility.

Detention basins are dry basins that attenuate stormwater runoff by providing temporary storage and controlled release of detained runoff. They are normally vegetated depressions that are mainly dry, except during and immediately after storm events. They may be designed with a small permanent pool at the outlet to help prevent re-suspension of sediment particles by high intensity storms and to provide enhanced water quality treatment for frequent events.

### Operation & Maintenance Requirements

Regular inspection and maintenance is important for the effective operation of detention basins as designed. Maintenance responsibility will be placed with the appointed Management Company for the site.

Regular mowing in and around detention basins is required only along maintenance access routes, amenity areas (eg footpaths), across embankments and across the main storage area. The remaining areas can be managed as "meadow", unless additional management is required for landscaping purposes.

Adequate access will be available to the detention basin for inspection and maintenance, including for appropriate equipment and vehicles, eg mowing equipment. Operation and maintenance requirements for detention basins are described in Table 1

Many of the maintenance activities for detention basins can be undertaken as part of landscape maintenance and should have marginal cost implications.

## 1.1. Maintenance Plan Overview – Bio-Retention/Detention basin

**Table 1 – Detention Basin - Maintenance Schedule**

| Maintenance Schedule | Required Action | Frequency |
|---|---|---|
| Regular Maintenance | Litter, debris and trash removal | Monthly (or as required) |
| | Grass Cutting – for landscaped areas and access routes | See Landscaping Management Plan |
| | Grass Cutting – meadow grass in and around basin | See Landscaping Management Plan |
| | Manage other vegetation and remove nuisance plants | See Landscaping Management Plan |
| | Tidy all dead growth before start of growing season | See Landscaping Management Plan |
| | | |
| Occasional Maintenance | Re-seed areas of poor vegetation growth | See Landscaping Management Plan |
| | Prune & trim trees and remove cuttings | See Landscaping Management Plan |
| Remedial Actions | Repair of erosion or other damage by re-seeding or re-turfing | As required |
| | Remove silt build up and restore basin to design contours | 7-10 years as required |
| | Repair/Replace inlet/outlet structures | As required |
| | Rehabilitate infiltration surface using scarifying and spiking techniques if performance deteriorates | 1 per 5 years or As required |
| Monitoring | Inspect inlet/outlet and downstream catchpit for blockages, and clear if required | Bi Monthly/after large storms |
| | Inspect banksides, inlet/outlet for damage | Bi Monthly/after large storms |
| | Inspect Hydrobrake chamber for blockage, and clear if required | Bi Monthly/after large storms |

### 1.1.1 Regular Maintenance

Inspections & Reporting

Regular Drainage scheme inspections will:

- help determine optimum future maintenance activities
- confirm hydraulic, water quality, amenity and ecological performance
- Allow identification of potential system failures, e.g. blockage, poor infiltration, poor water quality etc.

Inspections can generally be required at Bi monthly site visits (e.g. for grass cutting) for little additional cost, and should, therefore, be subsumed into regular maintenance requirements. During the first year of operation, inspections should ideally be carried out after every significant storm event to ensure proper functioning, but in practice this may be difficult or impractical to arrange.

Typical routine inspection questions that will indicate when occasional or remedial maintenance activities are required, and/or when water quality requires investigation include:

_ are inlets or outlets blocked?

_ does any part of the system appear to be leaking (especially ponds and wetlands)?

_ is the vegetation healthy?

_ is there evidence of poor water quality (e.g. algae, oils, milky froth, odour, unusual colourings)?

_ is there evidence of sediment build-up?

_ is there evidence of ponding above an infiltration surface?

_ is there any evidence of structural damage that requires repair?

_ are there areas of erosion or channelling over vegetated surfaces?

It is recommended that an annual maintenance report and record should be prepared by the maintenance contractor which should be retained with the owner's manual. The report should provide the following information:

- observations resulting from inspections
- measured sediment depths (where appropriate)
- monitoring results, if flow or water quality monitoring was undertaken
- maintenance and operation activities undertaken during the year
- Recommendations for inspection and maintenance programme for the following year.

Litter/debris removal

This is an integral part of SUDS maintenance and reduces the risks of inlet and outlet blockages, retains amenity value and minimises pollution risks.

Grass cutting

It is recommended that grass cutting be minimised around SUDS facilities. In general, allowing grass to grow tends to enhance water quality performance.

Grass cutting is an activity undertaken primarily to enhance the perceived aesthetics of the facility. The frequency of cutting will tend to depend on surrounding land uses, and public requirements. Therefore, grass cutting should be done as infrequently as possible, recognising the aesthetic concerns of local residents. However, grass around inlet and outlet infrastructure should be strimmed closely to reduce risks to system performance. If a manicured, parkland effect is required, then cutting will need to be undertaken more regularly than for meadow type grass areas, which aim to maximise habitat and biodiversity potential.

Weed/invasive plant control

Weeds are generally defined as vegetation types that are unwanted in a particular area. For SUDS, weeds are often alien or invasive species, which do not enhance the technical performance or aesthetic value of the system, or non-native species and the spread of which is undesirable.

In some places, weeding has to be done by hand to prevent the destruction of surrounding vegetation (hand weeding should generally be required only during the first year, ie during plant establishment). However, over grassed surfaces, mowing can be an effective management measure. The use of herbicides and pesticides should be prohibited since they cause water quality deterioration. The use of fertilisers should also be limited or prohibited to minimise nutrient loadings which are damaging to water bodies.

Shrub management

Shrubs tend to be densely planted and are likely to require weeding at the base, especially during the first year to ensure that they get enough water. Shrubs should be selected so they can grow to their maximum natural height without pruning.

### 1.1.2 Occasional Maintenance

Sediment Removal

To ensure long-term effectiveness, the sediment that accumulates in feature should be removed periodically. The required frequency of sediment removal is dependent on many factors including:

- design of upstream drainage system
- type of system
- design storage volume
- Characteristics of upstream catchment area (e.g. land use, level of imperviousness, upstream construction activities, erosion control management and effectiveness of upstream pre-treatment).

Sediment accumulation will typically be rapid for the entire construction period (including time required for the building, turfing and landscaping of all upstream development plots). Once a catchment is completely developed and all vegetation is well-established, sediment mobility and accumulation is likely to drop significantly.

Vegetation/plant replacement

Some replacement of plants may be required in the first 12 months after installation, especially after storm events. Dead or damaged plants should be removed and replaced to restore the prescribed number of living plants per hectare.

Inspection programmes should identify areas of filtration, or infiltration surfaces where vegetation growth is poor and likely to cause a reduced level of system performance. Such areas can then be rehabilitated and plant growth repaired.

### 1.1.3 Remedial Maintenance

Structure Rehabilitation/repair
Headwall inlet/outlets and associated fittings may require repair/replacement in the long term. These features should be monitored for determination/vandalism.

### 1.1.4 Construction Requirements

The bottom and side slopes of the basin should be carefully prepared to ensure that they are structurally sound and checks should be made that any embankment structures meet their design criteria. The preparation should also ensure that the basin will satisfactorily retain the surface water runoff without significant erosion damage.

Backfilling against inlet and outlet structures needs to be controlled to minimise settlement and erosion. The soils used to finish the side slopes need to be suitably fertile, porous and of sufficient depth to ensure healthy vegetation growth. If an impermeable liner is used, care should be taken to ensure that it is not damaged during construction.

During the establishment phase, runoff from bare soils should be minimised.

For example:

- vegetative on slopes should be rapidly established
- base-of-slope trenches should be introduced to retain the inevitable runoff of sediments

Construction should be timed to avoid autumn and winter when high runoff rates are to be expected.

## 2.1. References

Woods-Ballard, B, Kellagher, R Martin, P, Jefferies, C, Bray, R, Shaffer, P

The SUDs Manual

CIRIA (2015)

# Appendix G

## NWL Pre Development Enquiry Response & Plans

NORTHUMBRIAN WATER living water

T: +44 (0) 345 609 4639
F: +44 (0) 191 419 6510
www.nwl.co.uk

Leat House
Pattinson Road
Washington
NE38 8LB

Ext: 36603
Direct Line: 0191 419 6603
Email: niki.mather@nwl.co.uk
Our Ref: 17NO456E24
Your Ref:

Friday, 03 February 2017

CK21
18 Shakespeare Street
Newcastle
NE1 6AQ

Dear Mr. David Webb,

**Re: Pre-Development Enquiry – Salcombe Avenue, Jarrow**

Further to receiving the Pre-Development Enquiry for the above site, received 9th January 2017, we are now able to provide the following response.

We have based our response on the information in your application and accompanying correspondence. Therefore, should any of the information now be different, then you must ensure that you inform us of any changes as further Network Modelling may be required and our response may also change, leading to this response being invalid.

Northumbrian Water assesses the impact of the proposed development on our assets and assesses the capacity within our network's to accommodate and treat the anticipated flows arising from the development. We do not therefore offer comment on aspects of planning applications that are outside of our area of control.

Enclosed for your information is a scaled extract showing the approximate position of our water and wastewater networks and associated assets. Please note that the actual position of any of our assets shown on the plan must be established by taking trial holes in all cases.

An appropriate risk assessment and method statement (RAMS) must be provided to us prior to gaining approval for any trial hole investigations, at least 5 working days in advance of starting any work onsite.

Also enclosed is our extract showing locations within the approximate vicinity of this site that have, from our records, experienced flooding. This has been provided to demonstrate the known flood risks within the vicinity which have been considered as part of our assessment on this enquiry.

We have also carried out a review of your application and can confirm the following:

**<u>Sewerage and Sewerage Treatment</u>**

Northumbrian Water would ask that you separate the foul and surface water flows in accordance with Part H of the Building Regulations prior to the final connection to the public sewer.

All new connections to the public sewerage system must first be approved through the Section 106 of the Water Industry Act 1991 process prior to construction.

Should you decide to proceed with this development, a fully completed Sewer Connection application form will be required. These are available to download from the following link:

https://www.nwl.co.uk/developers/new-connections.aspx

- Foul Water Discharge

The foul flows can discharge without restriction into the 225mm diameter combined public sewer within Salcombe Avenue, as follows:

1. Manhole 6406 - 0.5 l/sec
2. Manhole 7303 - 0.3 l/sec
3. Manhole's 7303 to 7301 - 0.3. l/sec

- Surface Water Discharge

In applying for planning permission you will be required to demonstrate to the Local Planning Authority through your flood risk appraisal that you have considered the 3 alternative options for the management of surface water which are listed within Part H of the Building Regulations 2010:

*(a) an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,*

*(b) a watercourse; or, where that is not reasonably practicable,*

*(c) a sewer.*

If the more sustainable options prove to be unfeasible, a restricted surface water flow of 5 l/sec would be permitted to discharge into the 600mm diameter surface water sewer via manhole 6302. Any excess in flows must be attenuated on site.

- Protection of Existing Sewerage Assets

We wish to draw your attention to the existing sewer's which pass through the site. These sewer's could be diverted, protected or accommodated within your site layout with an appropriate easement.

Part H of the Building Regulations also details the reasons why Northumbrian Water does not permit buildings to be built over or near to its sewerage network:

- Undue risk in the event of failure of the drain or sewer
- Maintaining access
- Protection of the drain or sewer during construction
- Protection form settlement
- Protection against piling

To discuss the diversion of this asset in further detail, please contact:

Mr. Roger Perkins
0191 419 6621
roger.perkins@nwl.co.uk

- Sewage Treatment Capacity

The Sewage Treatment Works to which this development finally discharges to is able to accept the additional flows.

**Water Efficiency Information**

Water efficiency information can be found on our website by following the web link below:

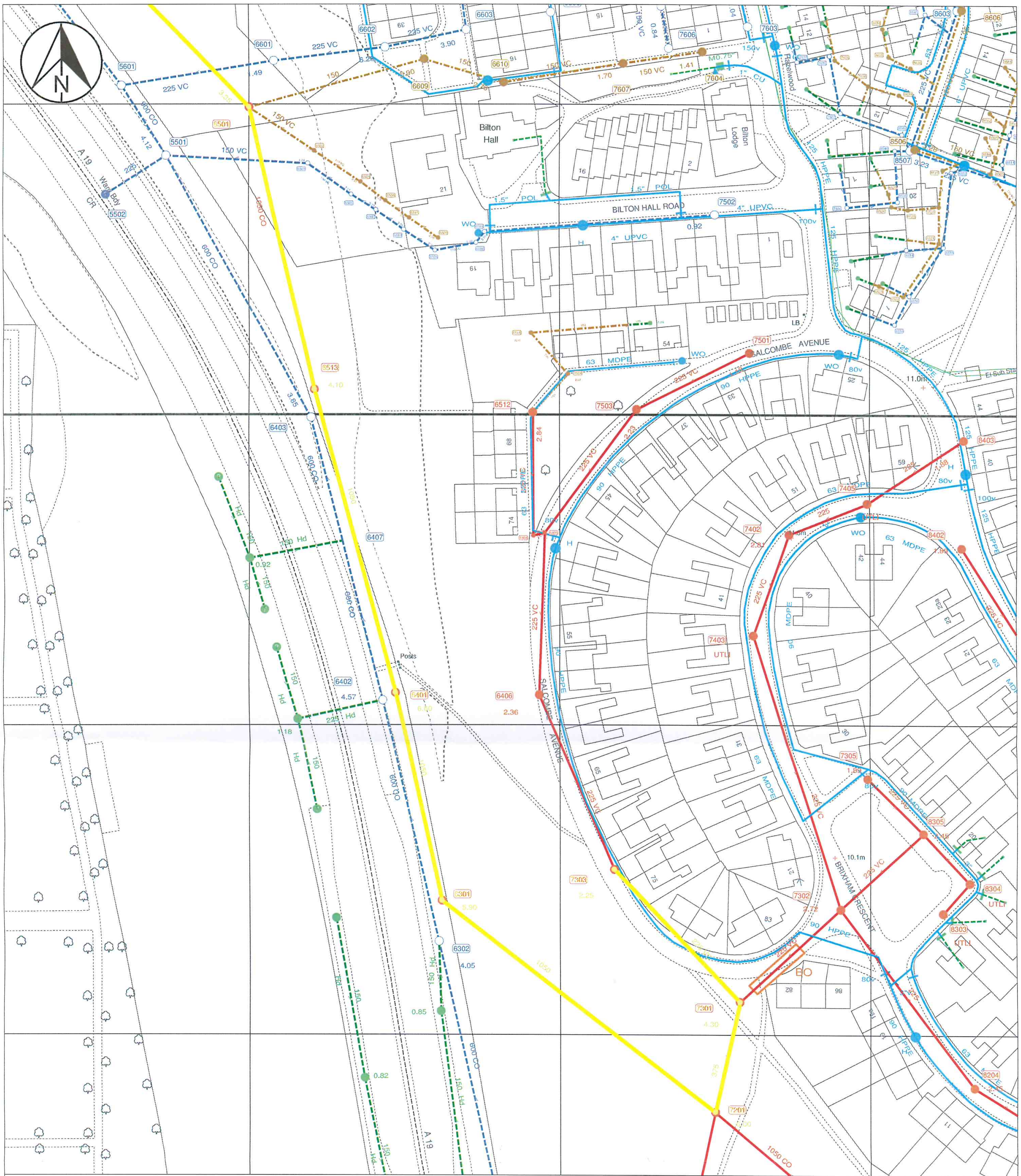
https://www.nwl.co.uk/your-home/saving-water/why-save-water.aspx

Please note that this response is valid for 1 year only and you should resubmit your proposals should this period lapse prior to your development beginning.

Should you require any further assistance or information, then please do not hesitate to contact me via niki.mather@nwl.co.uk or alternatively on 0191 419 6603, please quote our reference number above in any future correspondence.

Yours sincerely,

Mr. Niki Mather
Technical Support Advisor
Asset Protection - New Development




| Waste Water - NWL Responsibility | Private/Non NWL | Proposed | Water Network - Network Types | |
|---|---|---|---|---|
| Combined | Combined | Combined | Distribution | AB Asbestos |
| Foul | Foul | Foul | Treated | Abandoned |
| Surface | Surface | Surface | Raw | Out of Comm |
| Treated Eff | Trade Eff | | Fire | |
| Untreated Eff | Watercourse | | Supply | |
| Overflow | | | Private | |

NORTHUMBRIAN WATER living water

User : BOWMS

Title :

Centre Point : 433684,564443

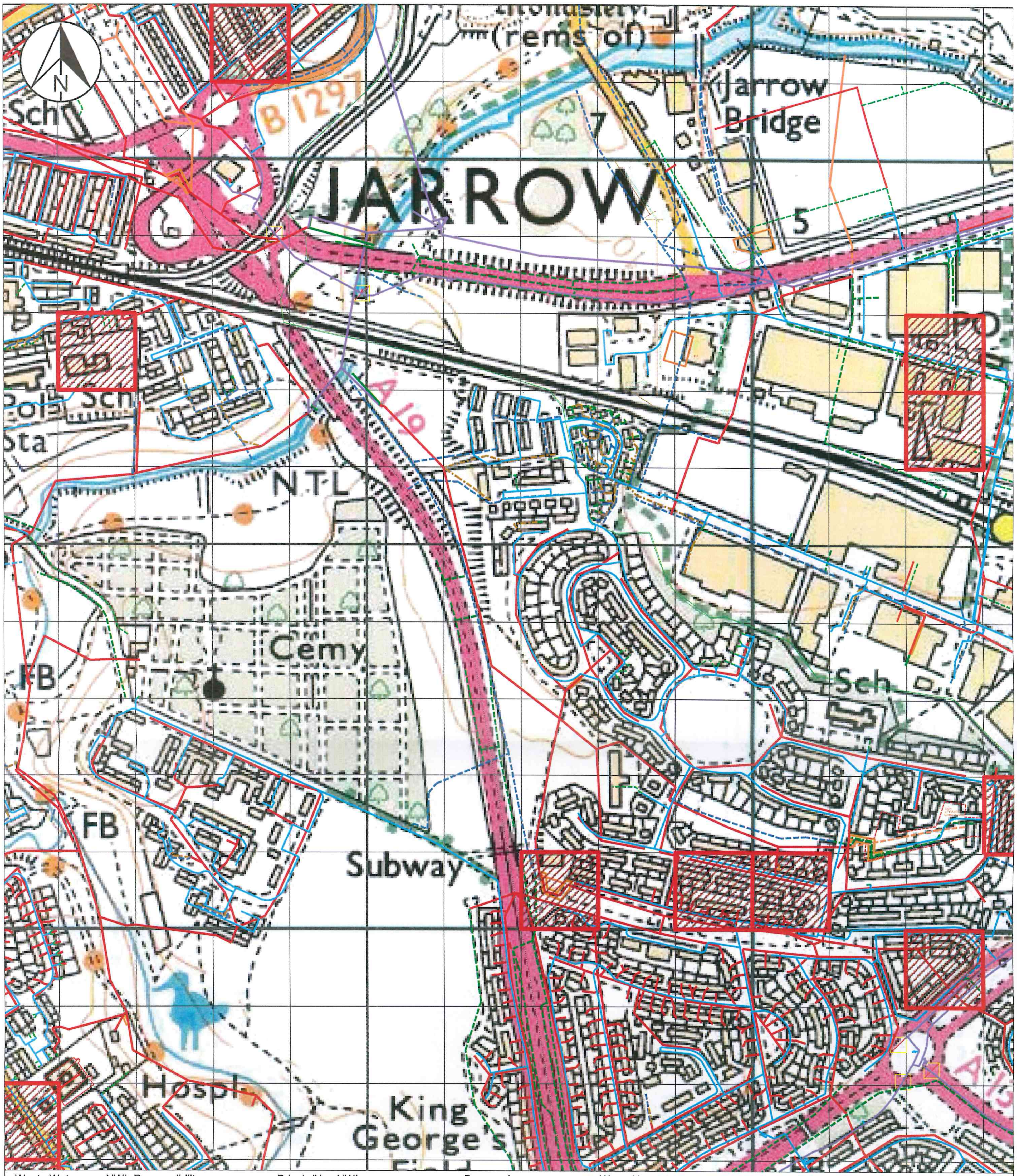
Date : 12/01/2017 12:46:00

Map Sheet : NZ3364SE

Paper / Scale : A3@1:1250


The information shown on this plan should be regarded as approximate and is intended for guidance only. No Liability of any kind whatsoever is accepted by Northumbrian Water, it's servants or agents for any omission. The actual position of any water mains or sewers shown on the plan must be established by taking trial holes in all cases. In the case of water mains Northumbrian Water must be given two working days notice of their intention to excavate trial holes. With effect from 1 October 2011, private lateral drains and sewers automatically transferred to Northumbrian Water under a scheme made by the Secretary of State pursuant to section 105A Water Industry Act 1991. These former private drains and sewers together with existing private connections may not be shown but their presence should be anticipated. WARNING...Where indicated on the plan there could be abandoned asbestos cement materials or shards of pipe. If excavating in the vicinity of these abandoned asbestos cement materials, the appropriate Health & Safety precautions should be taken. Northumbrian Water accepts no liability in respect of claims, costs, losses or other liabilities which arise as the result of the presence of the pipes or any failure to take adequate precautions.
Emergency Telephone Number: 0345 717 1100

10 m




Waste Water - NWL Responsibility: Combined, Foul, Surface, Treated Eff, Untreated Eff, Overflow

Private/Non NWL: Combined, Foul, Surface, Trade Eff, Watercourse

Proposed: Combined, Foul, Surface

Water Network - Network Types: Distribution, Treated, Raw, Fire, Supply, Private

AB Asbestos, Abandoned, Out of Comm

**NORTHUMBRIAN WATER** *living water*

User : BOWMS

Title :

Centre Point : 433684,564443

Date : 12/01/2017 13:15:47

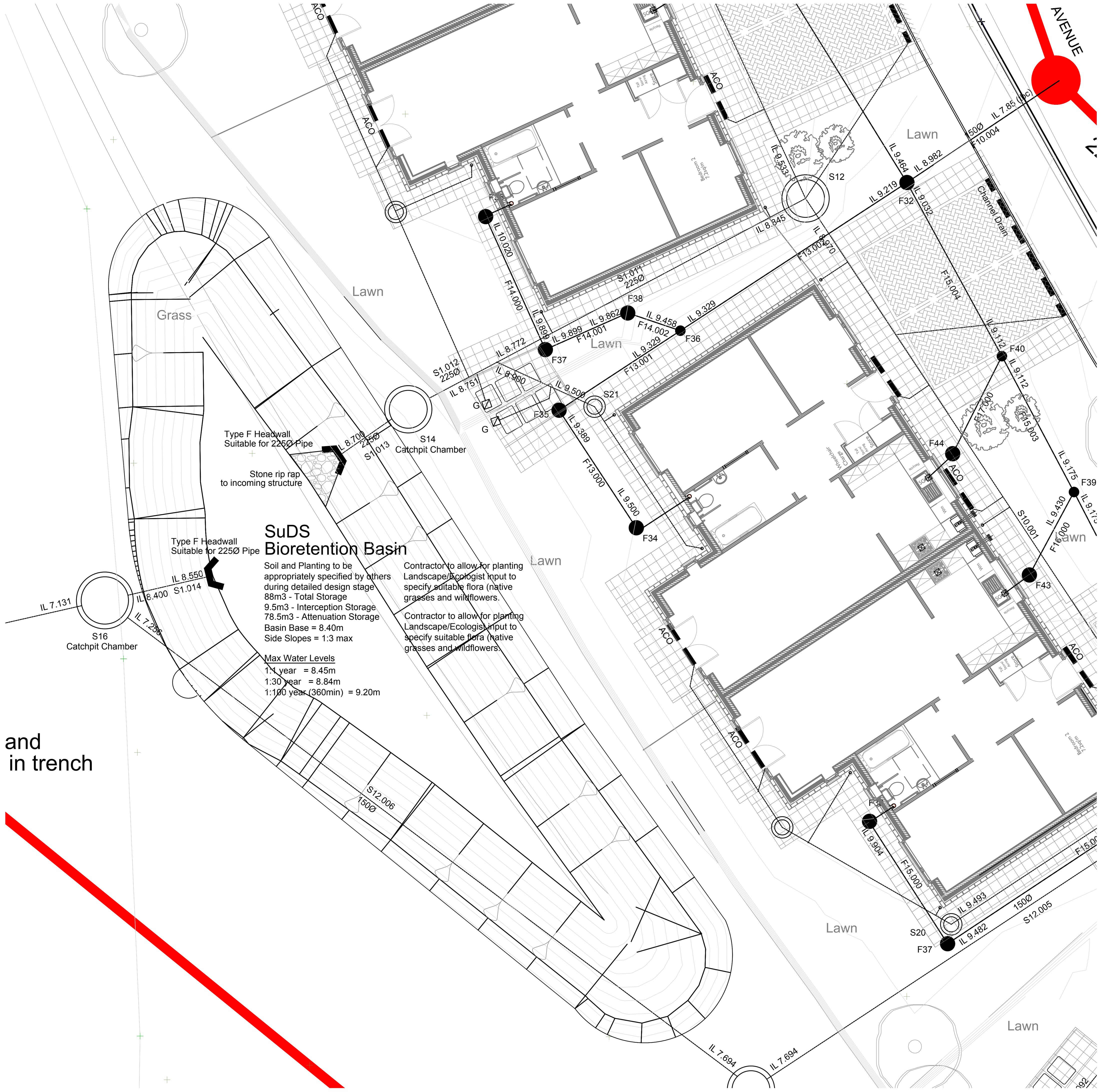
Map Sheet : NZ3364

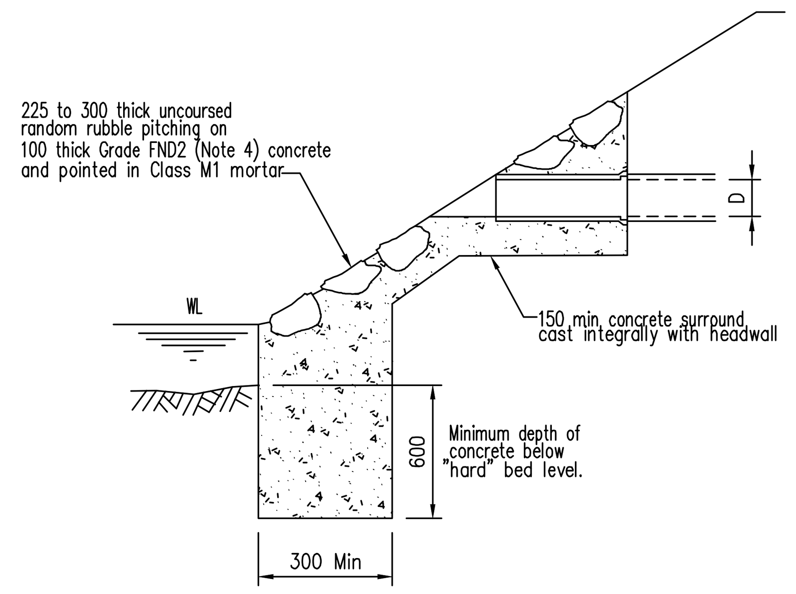
Paper / Scale : A3@1:5015

# Appendix H

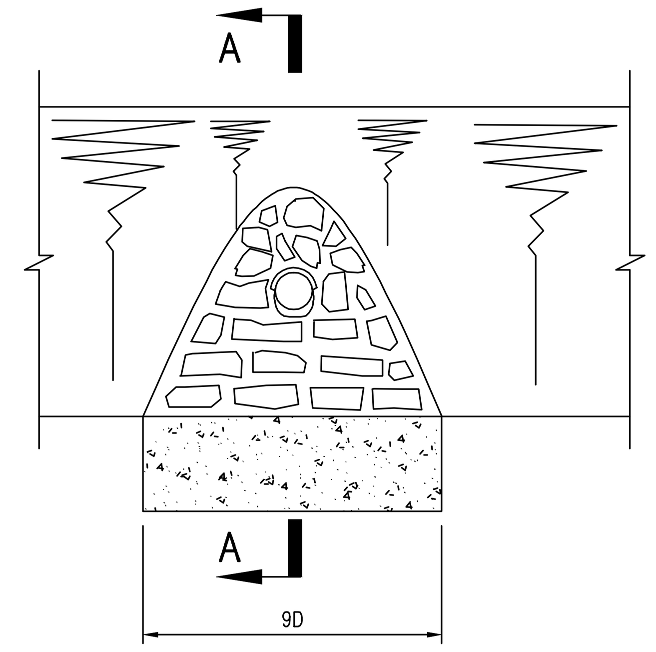
**SuDS Detail Drg**

A1



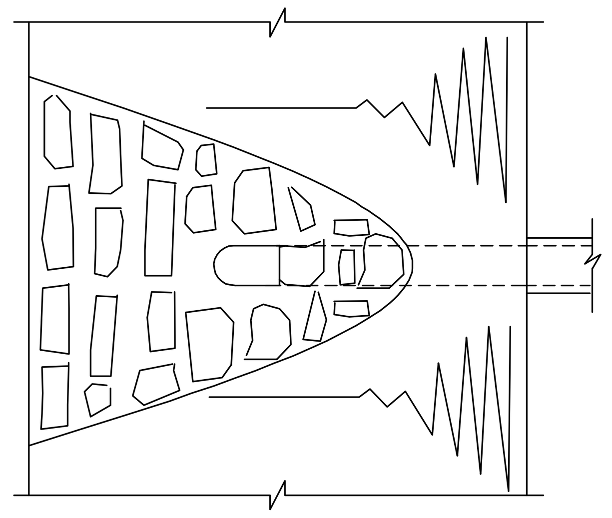




SECTIONAL ELEVATION A-A

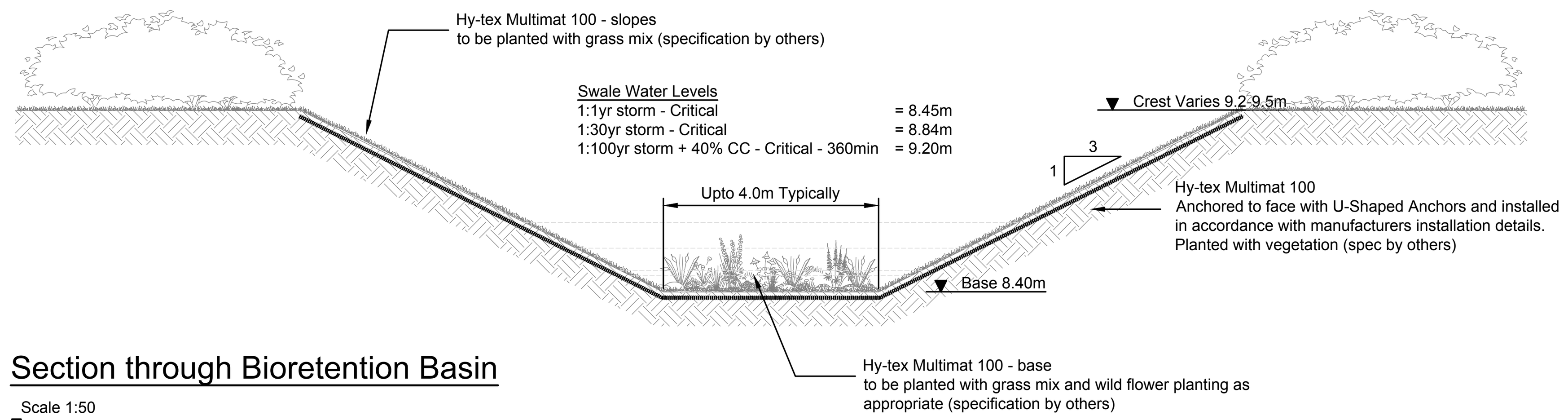



SECTION A-A

TYPICAL DETAIL F
TYPICAL OUTFALL DETAIL TYPE 3
(MAXIMUM PIPE SIZE 225mm)
Formerly Drg No 0000/261/W105 Version D



PLAN




Section through Bioretention Basin
Scale 1:50

| T1 | 030217 | Issued for Tender | KS | DW |
|---|---|---|---|---|
| Rev | Date | Description | Drawn | Chkd |

| | |
|---|---|
| Project | SALCOMBE AVENUE, JARROW RESIDENTIAL DEVELOPMENT |
| Client | SOUTH TYNESIDE HOUSING VENTURES |
| Architect | CEAD |
| Title | DRAINAGE DETAILS SHEET 3 |

| Scale | Drawn | Date |
|---|---|---|
| 1:100 | DW | FEB 17 |
| **Job Number** | **Drawing Number** | **Rev.** |
| 16124 | C-GA-206 | T1 |

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Status
TENDER