



**Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG
Surface and Foul Water Drainage Assessment**

For Cathy Bolton

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Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG

Project	Surface and Foul Water Drainage Assessment
Client	Cathy Bolton
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EXECUTIVE SUMMARY

The purpose of this report is to assess the potential for disposing of foul and surface water. This Surface and Foul Water Drainage Assessment demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The proposed development will considerably reduce the flood risk posed to the site and to off-site locations due to the adoption of a SUDS Strategy.

The development should not therefore be precluded on the grounds of flood risk or drainage.

1.0 INTRODUCTION

1.1 Background

This Surface and Foul Water Drainage Assessment has been prepared by KRS Environmental Limited at the request of Cathy Bolton to support a planning application for the proposed development on Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG.

It is recognised that developments that are designed without regards to the surface and foul water runoff are likely to result in increased impact on existing off site service provision and may leads to an increase in flood risk.

1.2 Purpose

This Surface and Foul Water Drainage Assessment complies with the principles of SUDS presented in the new Defra non-statutory technical standards for SUDS¹, and the National Planning Policy Framework (NPPF)². A Surface and Foul Water Drainage Assessment is presented with reference to the hydrological and hydrogeological context of the development.

The report findings are based upon professional judgement and are summarised below with detailed recommendations provided at the end of the report. The report includes baseline data on: flood risk from the Environment Agency, rainfall data from the Flood Estimation Handbook (FEH) and hydrogeological information from the British Geological Survey (BGS). The assessment will summarise and refer to these datasets in the text.

1.3 Surface Water Management Overview

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A SUDS Strategy for the site proposals has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development unless specific off-site arrangements are made and result in the same net effect.

¹ Department for Environment, Food and Rural Affairs (2015) Non-statutory technical standards for SUDS (March 2015).

² Department for Communities and Local Government (2012) National Planning Policy Framework (NPPF).

1.4 What are SUDS?

A Sustainable Drainage System (SUDS) is designed to replicate, as closely as possible, the natural drainage from the site (before development) to ensure that the flood risk downstream of the Site does not increase as a result of the land being developed. SUDS can also significantly improve the quality of water leaving the Site and can enhance the amenity and biodiversity that a site has to offer.

There are a range of SUDS options available to provide effective surface water management that intercept and store excess run-off. The standards set out appropriate design criteria based on four main parameters:

1. Runoff Destination (in order of preference)
 - a. To ground;
 - b. To surface water body;
 - c. To road drain or surface water sewer;
 - d. To combined sewer
2. Peak flow rate and volume (pre-and post-development)
3. Water Quality (based on potential hazards arising from development and sensitivity of the runoff destination)
4. Function (design; flood risk; operation and maintenance)

These parameters are then used to develop a drainage strategy based on the following six principles;

1. Manage surface runoff at source
2. Manage on the surface
3. Utilise public space and integrate into the drainage design
4. Effective operation and maintenance
5. Account for climate change and changes in impermeable area
6. Affordability

This report aims identify the most practicable runoff destination and drainage parameters for each site. A surface water drainage assessment is presented with reference to the hydrological and hydrogeological context of the development.

1.5 Report Structure

This Surface and Foul Water Drainage Assessment has the following report structure:

- Section 2 details the sources of information that have been consulted;
- Section 3 details the location & development description;
- Section 4 details the possible foul water discharge destinations;
- Section 5 details the possible surface water discharge destinations;
- Section 6 outlines the surface water drainage for the site;
- Section 7 discusses water quality;

- Section 8 outlines the SUDS Strategy: and
- Section 9 presents a summary and conclusions.

2.0 SOURCES OF INFORMATION

2.1 Discussion with Regulators

Consultation and discussions with the relevant regulators have been undertaken during this FRA including the Environment Agency, the Local Planning Authority (LPA), the Lead Local Flood Authority (LLFA), and Sewerage Undertakers.

2.1.1 Environment Agency

The Flood and Water Management Act 2010 gives the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is the statutory consultee with regards to flood risk and planning.

Environment Agency Standing Advice and the NPPF has been consulted and reviewed during this FRA. This has confirmed the level of FRA required and that a surface water drainage assessment is to be undertaken. Information regarding the current flood risk at the application site, local flood defences and flood water levels has been obtained from the Environment Agency (see Appendix 1).

2.1.2 Lancashire County Council

Lancashire County Council is the LLFA and has responsibilities for 'local flood risk', which includes surface runoff, groundwater and ordinary watercourse. Planning guidance written by Lancashire County Council regarding flood risk was consulted to assess the mitigation policies in place. The Lancashire County Council Preliminary Flood Risk Assessment (PFRA) which covers the site has been reviewed.

Correspondence has been received from Helen Lord Flood Risk Technical Support Officer at Lancashire County Council. It was confirmed that the LLFA would not be providing pre-planning advice for this site. (see Appendix 2).

2.1.3 Ribble Valley Borough Council

Ribble Valley Brough Council is the LPA. Planning guidance written by Ribble Valley Borough Council regarding flood risk was consulted to assess the mitigation policies in place. These documents include the Local Development Framework and the Local Plan. The Ribble Valley Borough Council Strategic Flood Risk Assessment (SFRA) which covers the site has been reviewed.

2.1.4 United Utilities

United Utilities is responsible for the disposal of waste water and supply of clean water for this area. Information with regards to sewer and water main flooding contained within the Ribble Valley Borough SFRA and the Lancashire County Council PFRA have been consulted as part of this FRA. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.

A Pre-Planning Sewerage Enquiry has been undertaken with United Utilities to ascertain their views on the availability of the public sewer network and any restrictions which would be imposed on the proposed development and includes a sewer plan (see Appendix 3). United Utilities have made the following comments:

'We have carried out an assessment of your application which is based on the information provided; this pre development advice will be valid for 12 months.'

Foul

Foul will be allowed to drain to the public combined/ foul sewer network. Our preferred point of discharge would be to the 225mm combined sewer crossing the site at an unrestricted rate.

Surface Water

Surface water from this site must drain to soak away or some other form of infiltration system but if ground conditions confirm that this is not a viable solution all surface water can drain to the 225mm surface water sewer on Clitheroe Road at a maximum pass forward flow of 5 l/s.

Connection Application

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

<http://www.unitedutilities.com/connecting-public-sewer.aspx>

Sewer Adoption Agreement

You may wish to offer the proposed new sewers for adoption. United Utilities assess adoption application based on Sewers adoption 6th Edition and for any pumping stations our company addenda document. Please refer to link below to obtain further guidance and application pack:

<http://www.unitedutilities.com/sewer-adoption.aspx>

Existing Sewers Crossing the Site

A public sewer crosses this site and we will require unrestricted access to the sewer for maintenance purposes, we would ask that you maintain a minimum clearance of 6m which is measured 3m from the centre line of the pipe. If you cannot achieve this then you may wish to consider diverting the public sewer.

I suspect that the sewer will interfere with plot 3 on the site and a diversion may be necessary

Please refer to the link below to obtain full details of the processes involved in sewer diversion.

<http://www.unitedutilities.com/sewer-diversion.aspx>

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

Please note, if you intend to put forward your wastewater assets for adoption by United Utilities, the proposed detail design will be subject to a technical appraisal by an Adoption Engineer as we need to be sure that the proposals meets the requirements of Sewers for adoption and United Utilities Asset Standards. The proposed design should give consideration to long term operability and give United Utilities a cost effective proposal for the life of the assets. Therefore, further to this enquiry should you wish to progress a Section 104 agreement, we strongly recommend that no construction commences until the detailed drainage design, submitted as part of the Section 104 agreement, has been assessed and accepted in writing by United Utilities. Any works carried out prior to the technical assessment being approved is done entirely at the developers own risk and could be subject to change'.

3.0 LOCATION & DEVELOPMENT DESCRIPTION

3.1 Site Location

The site is located on Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG (see Figure 1). The National Grid Reference (NGR) of the site is 373508, 436556.

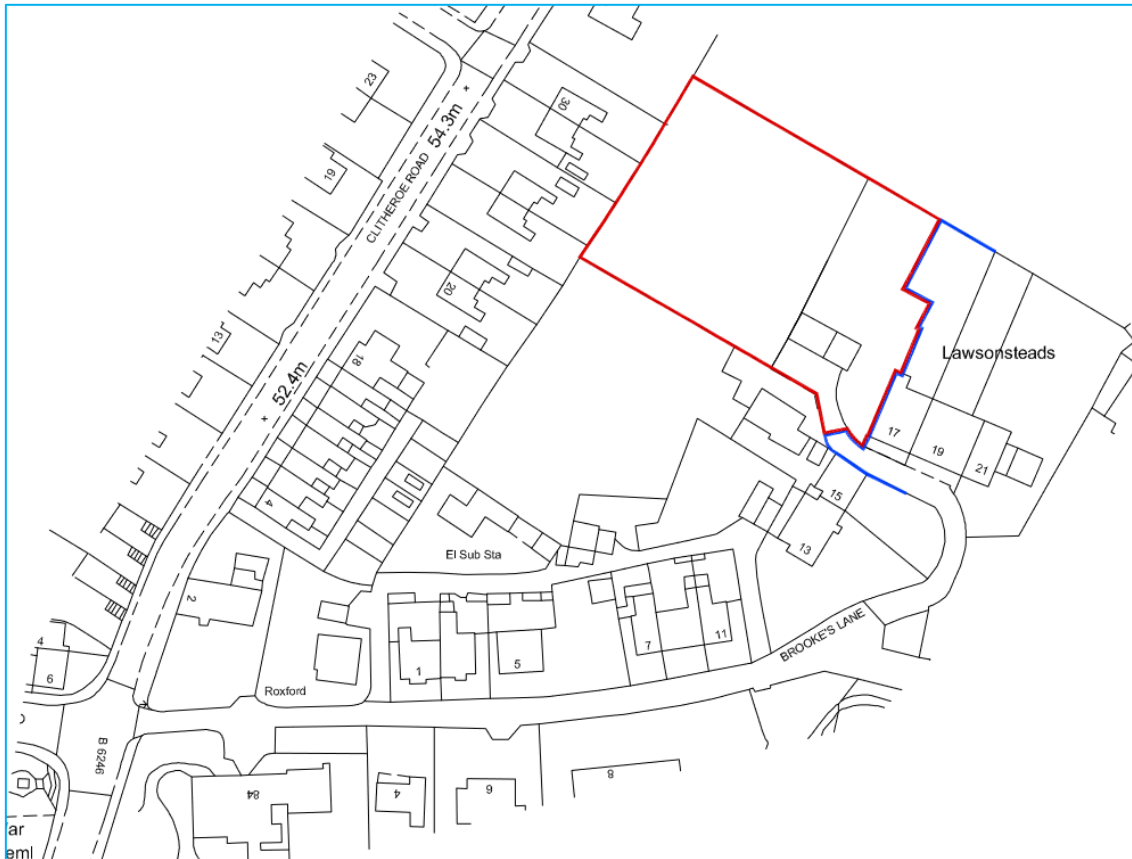


Figure 1 - Site Location

3.2 Existing Development

The site comprises a greenfield development and is currently vacant land.

3.3 Proposed Development

It is understood that the proposals are for a residential development of 3 units with gardens (see Appendix 4). Further details with regard to the proposed development can be found in the accompanying information submitted with the planning application.

3.4 Topographic Survey

A site topographic survey was undertaken in April 2018 (see Appendix 5). The site is reasonably flat. The minimum ground level is 53.38 above Ordnance Datum (mAOD) and the maximum ground level is 55.75mAOD.

3.5 Catchment Hydrology

A small drainage ditch is located approximately 60m to the north east of the site. There are no other watercourses located on, or within, the vicinity of the site.

3.6 Public Sewers

United Utilities public combined sewers are located to the west of the site (see Figure 2). United Utilities has no duty to keep records of private sewers, and there are no comprehensive records kept elsewhere.

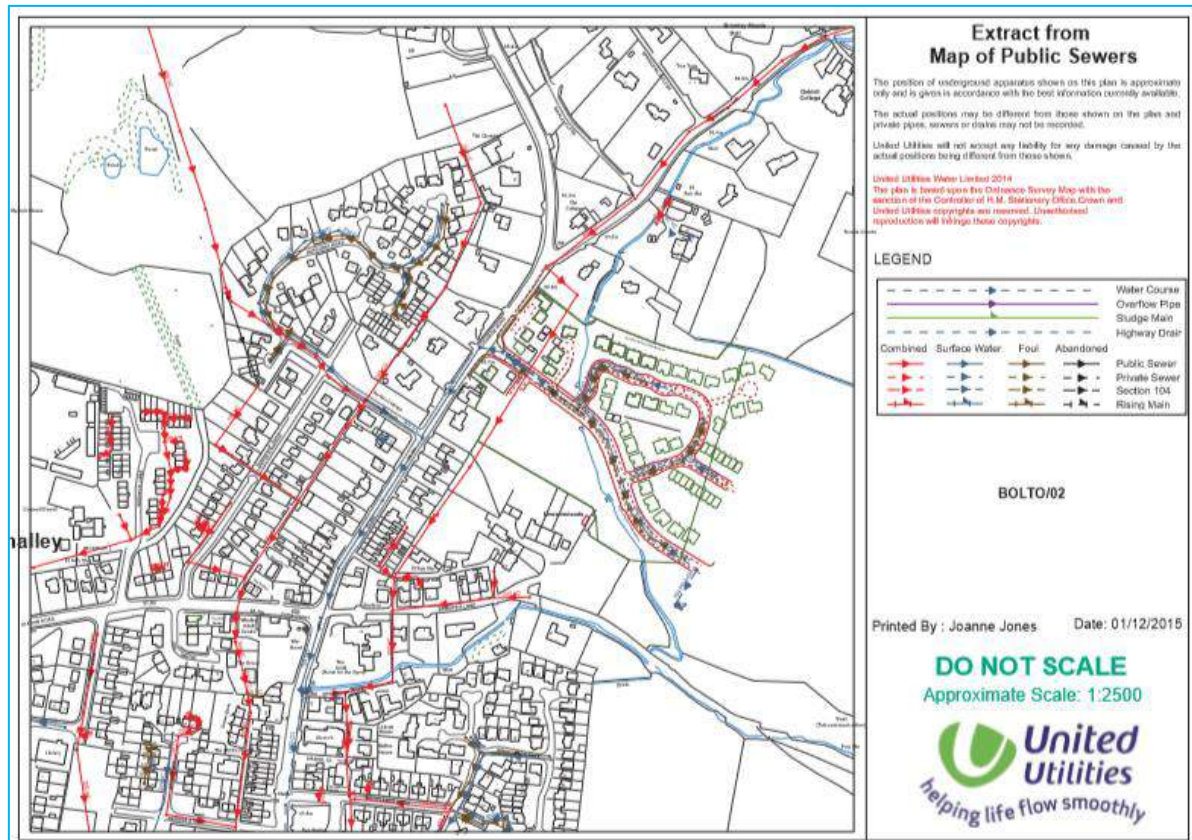


Figure 2 - United Utilities Public Sewer Map

3.7 Geology

The British Geological Survey (BGS) Map indicates that the bedrock underlying the site consists of the Bowland Shale Formation - mudstone. Sedimentary Bedrock formed approximately 319 to 337 million years ago in the Carboniferous Period in local environment previously dominated by open seas with pelagite deposits.

The superficial deposits consist of Till, Devensian - diamicton. Superficial deposits formed up to 2 million years ago in the Quaternary Period in a local environment previously dominated by ice age conditions (U).

3.8 Groundwater

The Environment Agency aquifer designation data shows that the bedrock and superficial deposits are designated as Secondary Undifferentiated: In cases where it has not been possible to attribute either category A or B to a rock type.

During site investigations groundwater was not found in any of the trial pits to a depth of 2.00m Below Ground Level (mBGL). Groundwater is likely to be more than 3.00mBGL and has confirmed that the groundwater is not expected to be especially vulnerable to contamination. Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.

3.9 Groundwater Source Protection Zones

The site is not located within an Environment Agency Groundwater Source Protection Zone.

3.10 Soil

Information from the National Soil Resource Institute³ details the site area as being situated on slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage. The Flood Studies Report WRAP soil map classification is type 4: clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

3.11 Contaminated Land

We are not aware of any historical industrial land use. Further investigation would be required to confirm this. The client has not provided information to suggest the potential for contamination within the site boundary from past land uses.

3.12 Ground stability

Dissolution, sand liquefaction and landslides could be enhanced by SUDS infiltration and lead to unstable ground. Dissolution risk is low since the site does not appear to be directly underlain by chalk or other soluble rocks. Sand liquefaction risk is low since the site is not located on unconsolidated superficial sand deposits. Landslide risk is low since there are no records of landslides close to the site according to the BGS.

The BGS data does not indicate any very significant geological hazards (soluble rock; landslide hazard; shallow mining; or made ground) within the site. Increased infiltration is unlikely to result in increased geological hazards.

3.13 Permeability/Infiltration Rate

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. Soakaway tests in accordance with BRE Digest 365 Guidelines have been undertaken at the site. The soakaway tests were undertaken in sunny dry weather but following periods of rainfall during the previous weeks. Three trial test pits were dug in the vicinity of the proposed soakaways and soakaway tests were carried out in each test pit.

No standing groundwater was encountered and no seepage of groundwater into the trial pits with it remaining dry until the commencement of the test. The soakaway test results are shown in Table 1 (see Appendix 6).

³ <https://www.landis.org.uk/soilscapes/>

The site ground conditions, based on the geology and soils, suggest that the infiltration rate at the site will be good. The infiltration rates obtained during the site investigation were found to be good. It is therefore suggested that soakaways will provide a suitable means of surface water discharge from the site. Therefore, based on the information provided and reviewed, it has been concluded that there will be infiltration drainage within the soils and bedrock at the site. SUDS methods such as soakaways will work at the site. An average infiltration rates of 3.16×10^{-5} m/s has been used with this report.

Table 1 - Soakaway Test Results

Location	Soil Description	Infiltration Rate (m/s)	Drainage Characteristics
TP1	TOPSOIL, ash fill, dark brown CLAY	2.54×10^{-5}	Good
		2.54×10^{-5}	Good
TP2	TOPSOIL, stony CLAY, dark brown CLAY	2.18×10^{-5}	Good
TP3	TOPSOIL, stony CLAY, shale	4.44×10^{-5}	Good
		4.73×10^{-5}	Good
		2.18×10^{-5}	Good

4.0 FOUL WATER DRAINAGE

4.1 Foul Water Drainage Strategy

In relation to foul drainage, pre-application discussions were undertaken with United Utilities. Development of the site will take place with separate systems for foul and surface water drainage. The separate system will extend to the public sewer. Foul will be allowed to drain to the public combined/ foul sewer network. United Utilities preferred point of discharge would be to the 225mm combined sewer crossing the site at an unrestricted rate.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage is possible. However, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer. The proposed foul water drainage layout is shown in Appendix 7.

4.2 Conditions

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage can be connected/discharged to the public sewer.

At a last resort, highway drainage may be accepted under certain circumstances. If SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharge to the public sewer network may be permitted. In this event, the developer may be required to enter into a formal agreement with Yorkshire Water under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

Foul water from kitchens and/or food preparation areas of any restaurants and/or canteens etc. must pass through a fat and grease trap of adequate design before any discharge to the public sewer network.

4.3 Application to make connections

The developer will write to United Utilities requesting an application form that will be duly completed and returned. No works on the public sewer will be carried out until a letter of consent is received from United Utilities.

4.4 Adoption Agreements

Prospective adoptable sewers and pumping stations will be designed and in constructed in accordance with 'Sewers for Adoption' 7th Edition as supplemented by United Utilities requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site.

4.5 Easements

An easement (an area over and to either side of the sewer on which no buildings or other permanent structures are permitted) is required where sewers are laid in land other than highway. The minimum dimension of a sewer easement is 6 metres (3 metres either side of the centre line of the sewer) but

may be more depending on the size and depth of the sewer. No information has been provided by United Utilities on the depth of sewers within the vicinity of the site. Easements are not required where the sewers are in the public highway. If sewers are shown as being present on the site this will be discussed further with United Utilities.

5.0 SURFACE WATER RUNOFF DESTINATION

5.1 Opportunities for Discharge of Surface Water

Possible receptors for runoff generated onsite have been assessed in line with the prioritisation set onsite out in the Defra non-statutory technical standards for SUDS. There are four possible options to discharge the surface water. The Runoff Destination is (in order of preference):

- a) To ground;
- b) To surface water body;
- c) To road drain or surface water sewer;
- d) To combined sewer

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

5.2 Discharge to Ground

The ground conditions suggest infiltration SUDS techniques such as soakaways will work and will provide a suitable option at the site. An average infiltration rates of 3.16×10^{-5} m/s has been used with this report. At this stage, it is proposed that the surface water runoff from the site will discharge via infiltration SUDS methods such as soakaways.

5.3 Discharge to Surface Water Body

Should infiltration be found to be unsuitable, the next option is discharge to a surface water body. The drainage ditch is located approximately 60m to the north east of the site. There are no other watercourses evident either on, or within the vicinity of the site.

It has been determined that surface water runoff from the site cannot practicably be discharged to a surface water body, for the following reasons:

1. The distance from the point of discharge from the site to the surface water body is significantly greater than to the proposed alternative receiving public sewer, and this constraint outweighs any negative impacts resulting from discharging to the alternative location.
2. Access over 3rd party land between the site and the receiving surface water body cannot be secured.

Therefore, discharge to a water body will not be possible.

5.4 Discharge to Road Drain or Surface Water Sewer

There are no road drains or public surface water sewers located within the vicinity of the site (see Figure 2).

5.5 Discharge to a Combined Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to the public sewer would be possible. All surface water runoff that cannot

be discharged via infiltration will be managed on site and discharged to a surface water sewer. United Utilities has confirmed that:

‘Surface water from this site must drain to soak away or some other form of infiltration system but if ground conditions confirm that this is not a viable solution all surface water can drain to the 225mm surface water sewer on Clitheroe Road at a maximum pass forward flow of 5 l/s’.

It would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer. A gravity connection to the sewers would be made at a location/s adjacent to the site. If so, it would be possible to discharge to the public sewers, at a point adjacent to the site. However, at this stage, it is proposed that the surface water runoff from the site will discharge via infiltration SUDS methods.

6.0 SURFACE WATER PEAK FLOW AND VOLUME

6.1 Climate change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRA. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF⁴.

Table 2 shows the anticipated changes in extreme rainfall intensity in small and urban catchments.

Table 2 - Peak Rainfall Intensity Allowance in Small and Urban Catchment (use 1961 to 1990 baseline)

Parameter	2010 to 2039	2040 to 2059	2060 to 2115
Upper end	+10%	+20%	+40%
Central	+5%	+10%	+20%

6.2 Site Areas

The site comprises a greenfield development and is currently vacant land. It is understood that the proposals are for a residential development with 3 units with gardens. The incorporation of gardens and landscaped areas will allow a proportion of the rainfall to infiltrate into the soil substrate.

The impermeable areas within the proposed development will cover an area of approximately 2,046m², the increase in impermeable areas will lead to an increase in surface water runoff rate and volumes. If the surface water runoff from the developed site is not attenuated this would generate higher surface water runoff post-development. If uncontrolled, this could in turn increase the risk of flooding to the site and off-site locations. The required attenuation storage could be provided by a variety of means these are discussed below.

6.3 Greenfield Runoff Rates

An estimation of surface water runoff is required to permit effective site water management and prevent any increase in flood risk to off-site receptors. In accordance with The SUDS Manual, the Greenfield runoff from the site has been calculated using the IoH124 method. Table 3 shows the IoH 124 method Greenfield run off rates for the proposed impermeable area of 2,046m² (see Appendix 8). QBAR has been calculated to be 1.24 litres/second.

The method used for calculating the runoff complies with the NPPF, as well as the new Defra non-statutory technical standards for SUDS and assumes that the excess runoff associated with the proposed development (plus an allowance for future climate change) will need to be managed by the proposed SUDS Strategy.

⁴ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances>.

Table 3 - IoH 124 Method Greenfield Runoff Rates

Return Period (yrs)	Runoff Rate (l/s)
1	1.24
QBAR	1.46
30	2.45
100	3.07

7.0 SURFACE WATER QUALITY

7.1 SUDS and Water Quality

A key requirement of any SUDS system is that it protects the receiving water body from the risk of pollution and this is particularly true for surface water courses. This can be effectively managed by an appropriate “train” or sequence of SUDS components that are connected in series. The frequent and short duration rainfall events or the initial phase of longer duration events are those that are mostly loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10mm of rainfall (first flush) should be adequately treated with SUDS that are most effective in removing these potential contaminants (infiltration to the ground, filtration through a parking area sub-base, detention and sedimentation through storage in ponds and swales).

Proposed SUDS must account for a sufficient number of treatment stages to protect the receiving waterbody. The minimum number of treatment stages will depend of the sensitivity of the receiving groundwater body and the potential hazard associated with the proposed development.

Current guidance promotes sustainable water management through the use of SUDS. SUDS measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.

One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and bio-diversity. Systems incorporating these features are often termed SUDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

A hierarchy of techniques is identified⁵:

1. **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving, soakaways and/or green roofs).
3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site, swales and/or infiltration trenches).
4. **Regional Control** – management of runoff from several sites, typically in a detention pond, basins, tanks and/or wetland.

It is generally accepted that the implementation of SUDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;


⁵ CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

The most appropriate attenuation system will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity.

The application of the SUDS Manual⁶ requires that the runoff from sites is not only restricted to meet the Greenfield runoff characteristics but also that SUDS systems are utilised to improve the quality of the runoff prior to outfall to watercourses. The SUDS Manual and Environment Agency guidance applies a sustainability hierarchy to the various types of SUDS systems, this is summarised in Table 4.

Table 4 - Sustainability Hierarchy

Most Sustainable	SUDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife
	Living Roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration Devices - Soakaways	✓	✓	✓
	Permeable Surfaces and Filter Drains - Gravelled areas - Solid paving blocks - Permeable paving	✓	✓	
	Tanked systems - Over-sized pipes/tanks - Cellular storage	✓		
	Least Sustainable			

Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and at this stage it is not possible to guide the development towards a particular strategy.

The usual approach is to consider the 'SUDS train' where each of the above options are considered in turn until a suitable solution is found. Thus, source control techniques such as soakaways, rainwater harvesting and/or infiltration trenches, if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds.

⁶ CIRIA C697 SUDS Manual, 2007.

According to the Defra Draft National Standards (see Table 5), the proposed development is a combination of low (roof water) to medium hazard (runoff from car parking and road).

Table 5 - Level of hazard

Hazard	Source of Hazard
Low	Roof drainage
Medium	Residential, amenity, commercial, industrial uses including car parking spaces and roads
High	Areas used for handling and storage of chemicals and fuels, handling of storage and waste (incl. scrap-yards).

Table 6 has been extrapolated from the Defra Draft National Standards and indicates in green the stages of treatment suggested for the different runoff waters identified for the proposed development. It is noted that if the site is on clay and does not discharge to the aquifer then less treatment is required.

Table 6 - Minimum number of treatment stages for groundwater

Sensitivity of the groundwater below the site	Hazard			Consult with the Environment Agency
	Low	Medium	High	
SPZ 1; within 50 m of an existing well, a spring or a borehole that supplies potable water	1	3		
Discharge into or immediately adjacent to a sensitive receptor that could be influenced by infiltrated water. Includes designated nature conservation, heritage and landscape sites – including Biodiversity Action Plan (BAP) habitats and Protected Species	1	3		
SPZ 2 or SPZ 3 or Principal Aquifer	1	3		
Secondary Aquifer	1	2		

7.2 Source Control

(i) Soakaways

Soakaways are buried rings or tanks filled with rubble or stone and allow gradual infiltration of collected runoff from impermeable areas into the surrounding soil. They require relatively permeable strata below a site to allow percolation and the reduction in runoff is achieved by the volume of percolation and the available storage volume. An assessment of their suitability requires the characteristics of the sub-soils or the geology to confirm the infiltration rate or vertical permeability.

The depth of any soakaway should not normally exceed 2.00m and will not intersect the water table. A minimum of 1.00m unsaturated zone will be maintained between the base of any soakaway and the maximum seasonal water table. Whilst the permeability and infiltration rate of the site should ideally be confirmed by a site investigation into the hydrogeology of the site, the ground conditions suggest infiltration techniques such as soakaways may work and may provide a suitable option at the site.

At this stage, it is proposed that the roof drainage from the site could discharge to house soakaways. The soakaways would be sized according to on site infiltration rates obtained during infiltration/soakaway tests. If the soakaways are sized for example the 1 in 10 year event an overflow

would discharge water to another SUDS feature (e.g. permeable paving) during events larger than the 1 in 10 year event. An average infiltration rates of 3.16×10^{-5} m/s has been used with this report.

Table 7 shows the BRE365 calculation procedure for a concrete ring soakaway with a void ratio of 65% within the Masterdrain Drainage Software was used to demonstrate that the proposed surface water runoff volumes can be viably accommodated on site and drained by infiltration during the 10, 30, and 100 year storms with a 40% allowance for climate change assuming a roof area of 200m² per plots 1, 2 and 3 (see Appendix 9). The required half emptying time of 24 hours for each of the design storms is met and therefore this method of storm water disposal is appropriate for use on this site.

Table 8 shows the BRE365 calculation procedure for a concrete ring soakaway with a void ratio of 65% within the Masterdrain Drainage Software was used to demonstrate that the proposed surface water runoff volumes can be viably accommodated on site and drained by infiltration during the 10, 30, and 100 year storms with a 40% allowance for climate change assuming a roof area of 50m² per garage for no. 17 and 19 (see Appendix 9). The required half emptying time of 24 hours for each of the design storms is met and therefore this method of storm water disposal is appropriate for use on this site.

The concrete ring soakaways will be installed within a square pit, with side lengths of twice the ring diameter which allows the total excavation volume below the inlet invert to be used in the design storage volume and void ratio⁷. The excavation will be backfilled with suitable permeable material such as Type 3 filter material, pea gravel or 4/40 aggregate in accordance with BS 7533-13:2009.

Concrete ring soakaways are commonly used for sites of smaller impermeable areas (generally less than 500m²). Precast concrete rings are commonly available in sizes 650, 900, 1050, 1200, 1350, 1500, 1800, 2100, 2400 and 2700mm in diameter. This variety of soakaway is produced with slots in the outer wall to provide easy filtration of water to the surrounding soil.

All working areas within the soakaway excavations will be backfilled with clean stone and the soakaway will be fed from a 100mm diameter porous pipe originating from a collection chamber receiving flows from the delivery pipework from around the proposed dwellings.

Table 7 - BRE365 Concrete Ring Soakaway Calculations per Plots 1, 2 and 3 (SW1, SW2 and SW5)

Return Period (years)	Impermeable Area (m ²)	Ring Diameter (mm)	Side Length (m)	Depth (m)	Void Ratio (%)	Required Volume (m ³)	Actual Volume (m ³)	Half Emptying Time
10 + 40%	200	1800	3.60	2.40	65	13.60	22.40	Ok
30 + 40%						17.20	22.40	Ok
100 + 40%						22.40	22.40	Ok

⁷ BRE (1991) Soakaway design, BRE Digest 365, Building Research Establishment, Bracknell, UK.

Table 8 - BRE365 Concrete Ring Soakaway Calculations per garages for no. 17 and 19 (SW3 and SW4)

Return Period (years)	Impermeable Area (m ²)	Ring Diameter (mm)	Side Length (m)	Depth (m)	Void Ratio (%)	Required Volume (m ³)	Actual Volume (m ³)	Half Emptying Time
10 + 40%	50	1000	1.80	2.50	65	3.30	6.00	Ok
30 + 40%						4.20	6.00	Ok
100 + 40%						5.50	6.00	Ok

(ii) Permeable Paving

The use of permeable paving can often be considered for pedestrian or car parking areas but not for heavy traffic areas such as roadways where the heavy loading could damage the paving infrastructure. It is also possible to provide plot-by-plot systems connecting in to a site wide system. There may be scope to apply these features on a plot-by-plot basis as the layout develops further. These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the run-off.

Permeable paving also depends on having permeable underlying strata. The permeable paving can either discharge via infiltration or discharge to cellular storage. Land take is reduced as storage is located under car parks and access roads. However, maintenance is potentially a long-term issue and the possibility of the paving being damaged, dug up and not properly reinstated or not regularly swept could lead to compromising the future capacity of the system.

This system will negate the need for a separate collection system such as kerbs and gullies. It will also assist in reducing the flood profile of the site by significantly attenuating the run-off from the development within the sub base material. There is no specific amenity provided by the system other than enabling other areas to be utilised for development rather than potentially sterilizing areas with an easement for a sewer or stand-off for a basin.

Permeable paving will provide storage for the first 5mm (interception storage) as a minimum. It should be noted that any permeable paving system to be installed by a developer must have an infiltration rate of at least 30mm/hr (0.03m/hr) to avoid ponding on the surface before it reaches the natural soil (permeable paving systems generally would have an infiltration rate in excess of 30mm/hr).

These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the runoff. Treatment processes that occur within the surface structure and the geotextile layers include:

- Filtration
- Absorption
- Biodegradation
- Sedimentation

The ground conditions suggest infiltration techniques such as permeable paving may work and may provide a suitable option at the site.

Permeable paving will be utilised within the car parking, patio and footpath areas of the site. Provided that this is laid onto a thick open-graded sub-base, this provide sufficient storage for the runoff before discharge via infiltration such that the 1 in 100 year (+40%) event can be fully discharged (see Table 9 and Appendix 10). This is based on an infiltration rate of 3.16×10^{-5} m/s and a total impermeable area of 1446m², which covers the hardstanding areas.

Table 9 - Permeable Paving 1 in 100 Year (+40%) Event

Return Period (years)	Impermeable Area (m ²)	Void Ratio (%)	Mean Rain Intensity (mm/hr)	Total Rainfall Volume (m ³)	Total Runoff Volume (m ³)	Mean Discharge Rate (l/s)	Infiltration Volume (m ³)	Storage Balance Required (m ³)	Storage Depth Required (m)
100 + 40% 6 hour	1446	30	15.50	134.28	127.56	0.013	0.274	130.48	0.30

(iii) Rainwater Harvesting

The reuse of water from roofed areas to provide grey (non-potable) water for flushing WCs within buildings can reduce storm runoff without the need for treatment or oil separators since the risk of spillage or contamination is low. Such a facility could be practical depending on the available water volumes. Rain water is held in off-line storage tanks at or about roof level from where a gravity feed is used to supplement the standard water supply. This would not include the hard standing areas at ground level such as roads and car parking areas which would require a pumped system to return water to roof level and this is considered impractical. Over the course of a year a grey water system will reduce the volume of water entering the storm water disposal system and could be considered.

Such a system would require one or more tanks at roof level and under optimum conditions these would be kept as near as full as possible to ensure a reliable water supply. For the purposes of a worst-case design scenario it is assumed that the tanks would be full at the start of an extreme rainfall event and hence all storm rainfall would enter the surface water drainage system rather than grey water storage. Whilst there may be merit in including such a scheme in the overall designs these are not considered appropriate in the SUDS assessment.

(iv) Water Butts

Water butts are the most common means of harvesting rainwater for garden use. They are small, off-line storage devices that are designed to capture and store roof runoff. They are a simple water conservation technique that can contribute to sustainable water management for developed areas. In general water butts, do not provide water quality treatment.

A water butt collects rainwater from roofs via an inlet that is connected to the roof down-pipe. Water butts are manufactured in a wide variety of sizes and can consist of inter-connectable units. During wet periods, water butts are often full, resulting in little or no attenuation or reduction in outflow rates or volumes. However, water butts can be designed to attenuate runoff by using a throttled overflow system with excess water discharge to the drainage system or soakaway.

Water butts will be used to provide betterment but not as the primary system and have therefore not been included within any storage volume calculations. Normal sized water butts can provide between 0.20m³ and 0.35m³ of water storage.

(iv) Green Roofs/Brown Roofs

A green/brown roof is a multi-layered system that covers the top of a building with soil and vegetation and which can provide a degree of rain storm attenuation and a reduction in site runoff. These can either be extensive roofs which are low maintenance with a 25-125mm soil layer in which a variety of hardy drought tolerant low plants are grown, or intensive roofs with trees and planters which impose a greater load on the roof structure but are more suitable in certain circumstances. Green/brown roofs can be used to reduce the volume and rate of runoff so that other SUDS techniques in the scheme can be significantly reduced in size.

As the buildings, will not have flat roofs and the application of green roofs in a domestic scenario is limited due to on-going cost, maintenance and access requirements of any system therefore, this is not a practical option and is therefore not considered further.

7.3 Site Control - Permeable Conveyance Systems

Permeable conveyance systems can take the form of infiltration trenches, swales or filter strips at road margins where surface runoff from roads, car parking areas and also roof drainage can be directed. Other options include canals and rills. Used to collect water directly from linear systems, percolate the flow, attenuate and then discharge the flow to either a traditional system or a secondary SUDS device.

The use of these systems is more suited to linear applications such as roads as the typical cross section is relatively small and longer runs are required to provide attenuation volume. Land take can be relatively small in comparison to other systems and both types perform well in improving water quality. They are also ideally suited for disposal of water via secondary infiltration. Due to the small size of the site it has been concluded that these are not a practical option and is therefore not considered further.

8.0 SUSTAINABLE DRAINAGE SYSTEMS

8.1 SUDS Strategy

The objective of this SUDS Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The proposed SUDS Strategy is designed to attenuate surface water runoff up to and including the 1 in 100 year (+40%) event. The downstream discharge to the public sewers will be restricted to (or similar to) the existing runoff rate for all events up to and including the 1 in 100 year (+40%) event. The SUDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. It is therefore recommended that the site provides its own attenuation. This will be in the form of:

- Water Butts for each dwelling.
- Permeable paving of all driveways, patios, footpaths and car parking areas.
- House soakaway/s.
- For larger events in other areas such as car-parking and landscaping, provided that it will not cause damage or prevent access.

The precise nature and form of the SUDS system will be influenced by the type of the dwellings on the site, so some flexibility should be offered, providing proposals are robust and adequate plans for their maintenance made. Each plot may discharge into the drainage system. A SUDS Strategy for the site is shown in Appendix 7.

The remainder of the site that is not formally drained, i.e. gardens and areas of open space, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

Where SUDS are to be used, it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems with a maintenance schedule or the lifetime of the facility and these issues should be considered at the

detailed design stage. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

Quantity

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, the surface water will be discharged by infiltration methods (e.g. soakaways, permeable paving etc.) however; if this is not possible 10.40m³ of attenuation storage will be incorporated into the site layout.

This volume may be reduced when moderate infiltration is taken into account. The volume is dependent on the values assumed for infiltration. Local site specific investigations and testing will improve this estimate and refine the volumes for infiltration.

The size of this infiltration methods has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate a 100 year (+40%) storm event.

This restriction will provide significant flood mitigation benefits to existing third party property and land downstream of the site that may be potentially at risk from flooding.

Amenity Benefits

SUDS features may be integrated into the landscape forming a harmonious whole, which will have a visually pleasing affect. Paths may be constructed to enable access for both maintenance and recreation, with surface finishes that are durable, and in keeping with the surroundings.

Biodiversity Benefits

Planting should use a variety of native species of local provenance to ensure opportunities for biodiversity and sustain habitat within the development. Features should aim to mimic equivalent natural features, following natural drainage paths and fitting in with site contours, with natural elongated sinuous forms where possible. SUDS features may also be managed for wildlife for example by encouraging flowering plants, changing mowing regimes to allow plants to set seeds, and leaving them over winter as a food source. Carrying out grass cuts, and removing from site may also improve biodiversity of landscaped areas. However, such management regimes are likely to differ from normal regimes and may need additional equipment, training and agreement from the maintaining authority to implement.

'Traditional' Drainage

More traditional or conventional drainage structures are likely to be required as part of the proposed development: collecting runoff where source control is not practical, conveying water within the site, or providing additional attenuation storage underground.

In certain areas within the proposed development, gullies or linear drains may be the most practical option, when whole-life issues are considered: such as operation, maintenance, and change of use.

If the SUDS described above cannot provide the total attenuation volume required in order to mimic pre-development conditions, other storage systems may need to be provided, such as oversized pipes, cellular storage or underground tanks. These are unlikely to meet water quality or amenity objectives and should be used in conjunction with other SUDS where possible, particularly source control.

All drainage elements should be designed appropriately and considered as part of the overall site strategy.

8.2 Designing for Local Drainage System Failure/Design Exceedance

When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SUDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it is not possible to completely remove the risk. This section of the FRA is therefore associated with the way the residual risk is managed.

As part of the SUDS Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground⁸.

The attenuation requirements have been designed to accommodate the 1 in 100 year storm event plus climate change (+40%). The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the sewers and lateral drains connecting the properties to the underground storage areas. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the sewers would not affect the proposed buildings because the finished floor level will be raised above surrounding ground levels, ensuring any exceedance flooding would not affect the buildings. Exceedance flows would be contained within the highways adjacent to the site and within the site and would flow to the lower ground levels where the public open space is located. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

In particular, the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+40%) event, there is safety, even under the design event conditions. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this (i.e. within the manholes, pipework etc.). If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

The above manages and mitigates the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

8.3 Operation and Maintenance Requirements

The following maintenance schedules are based on The SUDS Manual, for standard maintenance regimes. However, planting and maintenance regimes may be changed to enhance bio-diversity. In order for any surface water drainage system to operate as originally intended, it is necessary to ensure

⁸ CIRIA (2006) Designing for exceedance in urban drainage – good practice.

that it is adequately maintained throughout its lifetime. For residential developments, this is generally taken as 100 years. Therefore, over the lifetime of a development there is strong possibility that the system could either fail or its performance be reduced if it is not correctly maintained. This is even more important when SUDS form part of the SUDS Strategy compared to traditional piped networks.

The surface water drainage scheme will be installed and fully operational before occupation of the site occurs. The surface water drainage scheme will be regularly maintained. The key maintenance requirements are regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris as required.

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Maintenance responsibility for the system will be placed with the owner of the dwellings who will employ responsible organisations when required. Specific maintenance needs of the system will be monitored, and maintenance schedules adjusted to suit requirements.

Preventative measures will be taken rather than corrective measures. Preventative maintenance ensures both the condition monitoring and life-extending tasks are carried out at scheduled regular intervals, ensuring failure and regular repair of the system is avoided.

The operational and maintenance requirements are shown in Table 10.

Table 10 - Operational and maintenance requirements

Maintenance Schedule	Required action	Frequency
Soakaways		
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor or inspection tube or chamber and inside of concrete manhole rings	As required, based on inspection
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deterioration or failure occurs	As required
	Replacement or clogged geotextiles	As required

Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the 1st year and then annually
	Check soakaway to ensure emptying is occurring	Annually
Permeable Paving		
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole pavement)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site specific observations of clogging or manufacturers recommendations – pay particular attention to areas where water runs onto permeable surface from adjacent impermeable areas as this area is most likely to collect most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weed	As required – once per year on less frequency used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users	As required
	Rehabilitation of surface and upper sub-structure	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required take remedial action	3 monthly, 48 hours after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

9.0 SUMMARY AND CONCLUSIONS

9.1 Introduction

This report presents a Surface and Foul Water Drainage Assessment for the proposed development on Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG.

9.2 Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. It is proposed that foul water will discharge to the public combined foul water sewer in Senior Road, at a point adjacent to the site.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage will be possible; however, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

9.3 SUDS Strategy

This SUDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The proposed SUDS Strategy is designed to attenuate surface water runoff up to and including the 1 in 100 year (+40%) event. The downstream discharge to the public sewers will be restricted to (or similar to) the existing runoff rate for all events up to and including the 1 in 100 year (+40%) event. The SUDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. It is therefore recommended that the site provides its own attenuation. This will be in the form of:

- Water Butts for each dwelling.
- Permeable paving of all driveways, patios, footpaths and car parking areas.
- House soakaway/s.
- For larger events in other areas such as car-parking and landscaping, provided that it will not cause damage or prevent access.

The precise nature and form of the SUDS system will be influenced by the type of the dwellings on the site, so some flexibility should be offered, providing proposals are robust and adequate plans for their maintenance made. Each plot may discharge into the drainage system. A SUDS Strategy for the site is shown in Appendix 7.

The remainder of the site that is not formally drained, i.e. gardens and areas of open space, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

Where SUDS are to be used, it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems with a maintenance schedule or the lifetime of the facility and these issues should be considered at the detailed design stage. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

Quantity

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, the surface water will be discharged by infiltration methods (e.g. soakaways, permeable paving etc.) however; if this is not possible 10.40m³ of attenuation storage will be incorporated into the site layout.

This volume may be reduced when moderate infiltration is taken into account. The volume is dependent on the values assumed for infiltration. Local site specific investigations and testing will improve this estimate and refine the volumes for infiltration.

The size of this infiltration methods has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate a 100 year (+40%) storm event.

This restriction will provide significant flood mitigation benefits to existing third party property and land downstream of the site that may be potentially at risk from flooding.

Amenity Benefits

SUDS features may be integrated into the landscape forming a harmonious whole, which will have a visually pleasing affect. Paths may be constructed to enable access for both maintenance and recreation, with surface finishes that are durable, and in keeping with the surroundings.

Biodiversity Benefits

Planting should use a variety of native species of local provenance to ensure opportunities for biodiversity and sustain habitat within the development. Features should aim to mimic equivalent natural features, following natural drainage paths and fitting in with site contours, with natural elongated sinuous forms where possible. SUDS features may also be managed for wildlife for example by encouraging flowering plants, changing mowing regimes to allow plants to set seeds, and leaving them over winter as a food source. Carrying out grass cuts and removing from site may also improve biodiversity of landscaped areas. However, such management regimes are likely to differ from normal

regimes and may need additional equipment, training and agreement from the maintaining authority to implement.

'Traditional' Drainage

More traditional or conventional drainage structures are likely to be required as part of the proposed development: collecting runoff where source control is not practical, conveying water within the site, or providing additional attenuation storage underground.

In certain areas within the proposed development, gullies or linear drains may be the most practical option, when whole-life issues are considered: such as operation, maintenance, and change of use.

If the SUDS described above cannot provide the total attenuation volume required in order to mimic pre-development conditions, other storage systems may need to be provided, such as oversized pipes, cellular storage or underground tanks. These are unlikely to meet water quality or amenity objectives and should be used in conjunction with other SUDS where possible, particularly source control.

All drainage elements should be designed appropriately and considered as part of the overall site strategy.

9.4 Conclusion

This Surface and Foul Water Drainage Assessment demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The proposed development will considerably reduce the flood risk posed to the site and to off-site locations due to the adoption of a SUDS Strategy.

The development should not therefore be precluded on the grounds of flood risk or drainage.

APPENDIX 1 – Environment Agency Correspondence

Flood Zones Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

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NGR: 373,545 436,516

Key

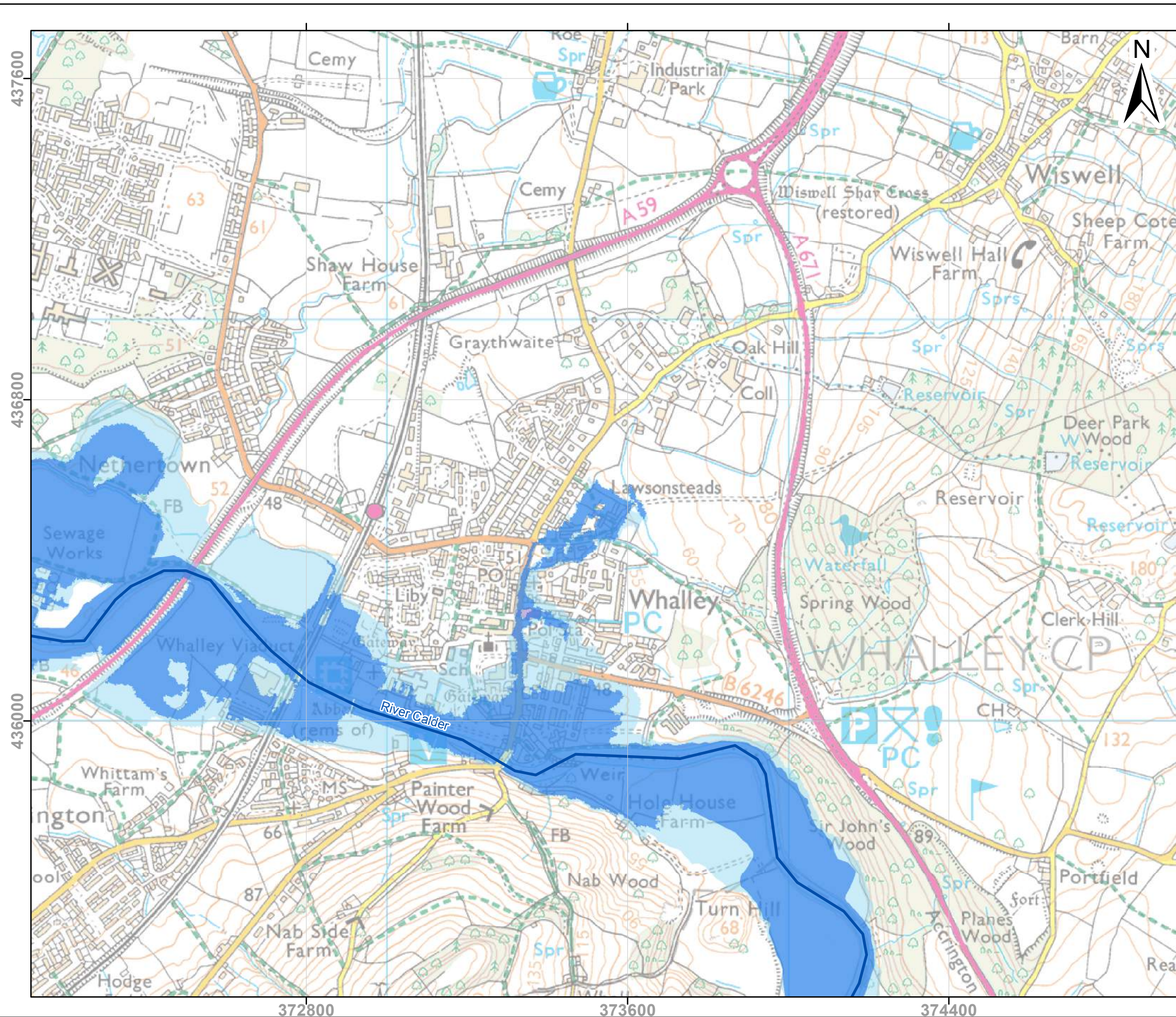
-  Main River
-  Areas Benefitting from Defences
-  Flood Zone 3
-  Flood Zone 2

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefitting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

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Historic Flooding Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

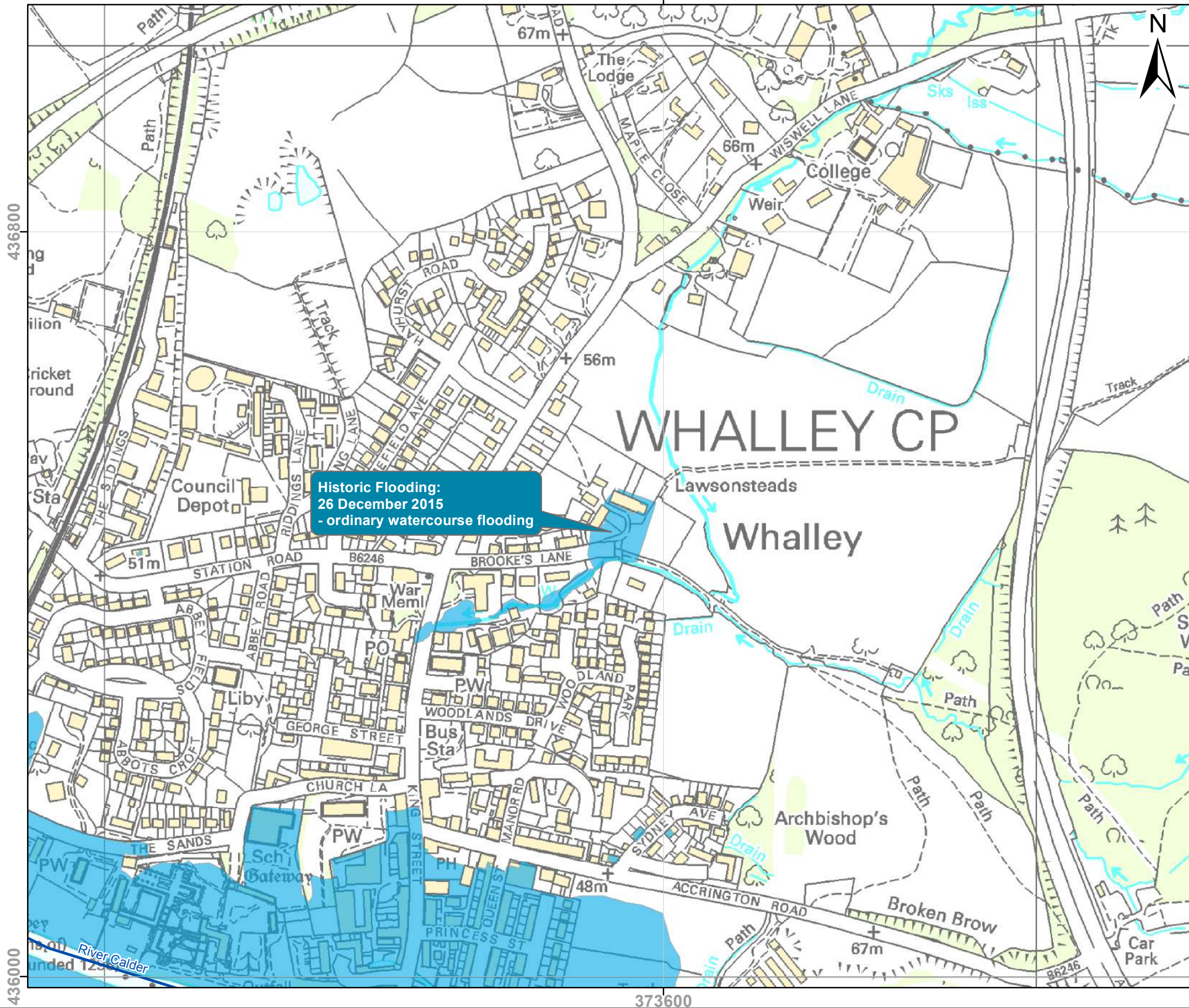
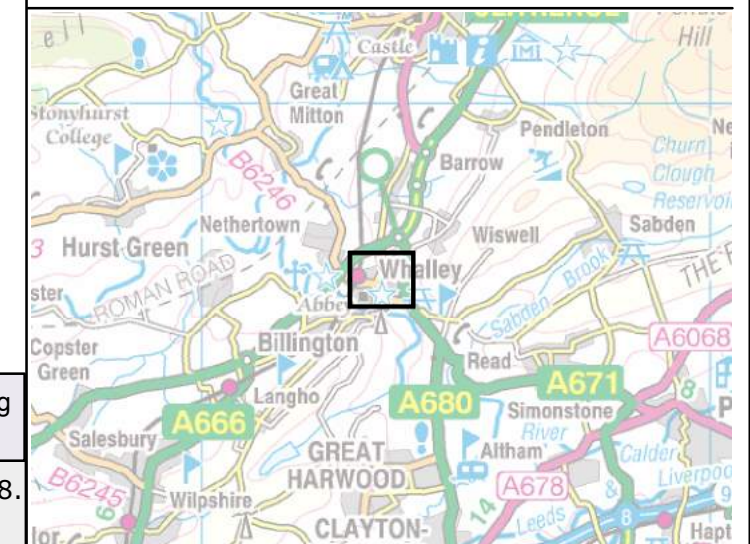
-  Main River
-  26 December 2015

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

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ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Historic Flooding:
26 December 2015
- ordinary watercourse flooding

Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

Produced: 13 April 2018
 Our Ref: CL82099
 NGR: 373,545 436,516

Key

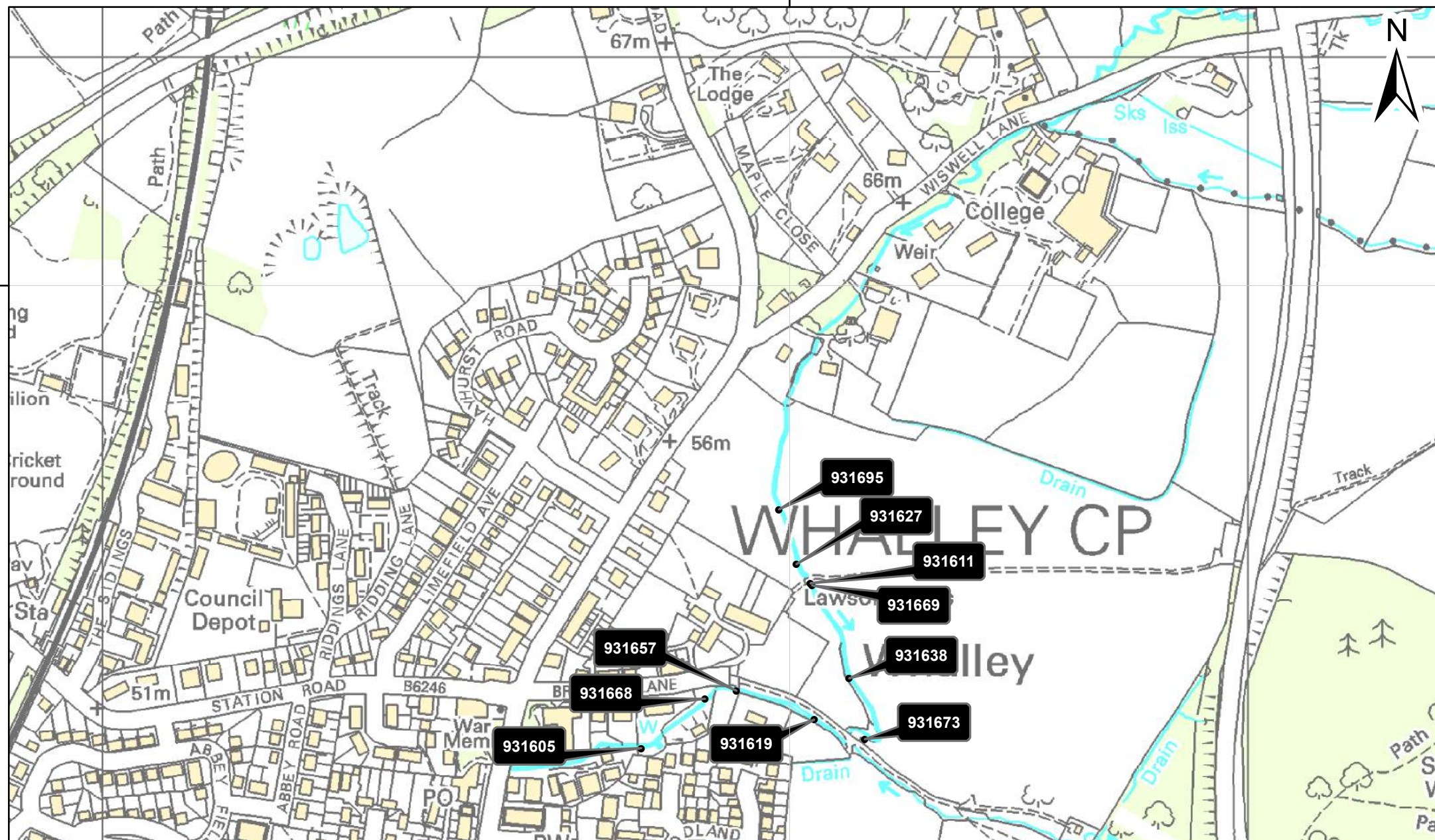
- Node Points

Flood Zone 3 shows the area that could be affected by flooding:

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Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

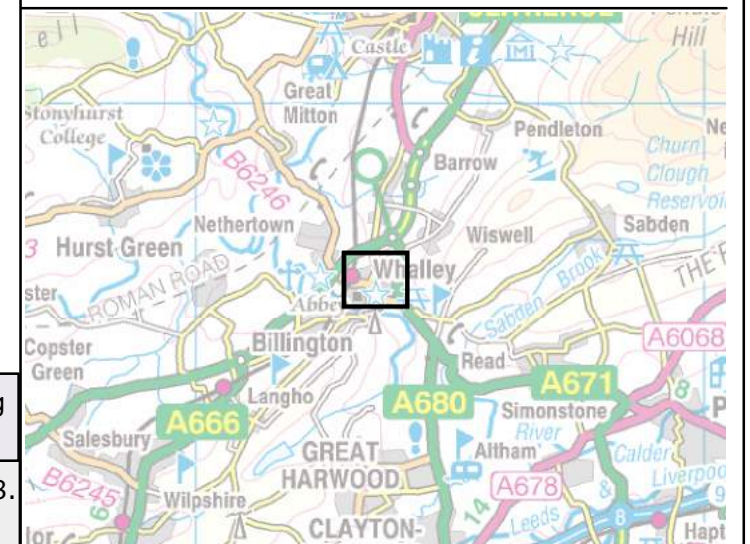
ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Flood Flow ($m^3 s^{-1}$) and Level (mAOD) data for a range of annual probability of flooding

Node Point	0.1%		0.5%		1.0%		4.0%									
	Defended		Undefended		Defended		Undefended									
	Level	Flow	Level	Flow	Level	Flow	Level	Flow								
EA ID	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
931695	58.65	3.00	58.65	3.00	58.55	2.10	58.55	2.10	58.50	1.80	58.50	1.80	58.40	1.30	58.40	1.30
931627	58.10	2.66	58.10	2.66	58.05	2.04	58.05	2.04	58.03	1.76	58.03	1.76	57.99	1.30	57.99	1.30
931611	58.00	1.71	58.00	1.71	57.95	1.45	57.95	1.45	57.92	1.31	57.92	1.31	57.86	1.07	57.86	1.07
931669	57.87	1.71	57.87	1.71	57.81	1.45	57.81	1.45	57.77	1.31	57.77	1.31	57.71	1.07	57.71	1.07
931638	55.89	1.93	55.89	1.93	55.79	1.49	55.79	1.49	55.75	1.33	55.75	1.33	55.68	1.07	55.68	1.07
931673	54.26	1.94	54.26	1.94	54.17	1.49	54.17	1.49	54.13	1.34	54.13	1.34	54.07	1.07	54.07	1.07
931619	53.37	1.93	53.38	1.93	53.31	1.49	53.31	1.49	53.29	1.33	53.29	1.33	53.24	1.07	53.24	1.07
931657	52.67	1.95	52.67	1.95	52.47	1.49	52.47	1.49	52.40	1.34	52.40	1.34	52.30	1.07	52.30	1.07
931668	52.43	4.26	52.43	4.25	52.28	2.92	52.28	2.93	52.20	2.55	52.20	2.54	52.08	1.97	52.08	1.97
931605	51.25	4.00	51.24	3.99	50.79	3.30	50.79	3.34	50.70	2.85	50.70	2.86	50.52	2.14	50.52	2.15

Level data in mAOD (metres above ordnance datum). Flow data in m^3 per second
 Data taken from Wider Calder Review 2017



Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.


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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

Produced: 13 April 2018
 Our Ref: CL82099
 NGR: 373,545 436,516

Key

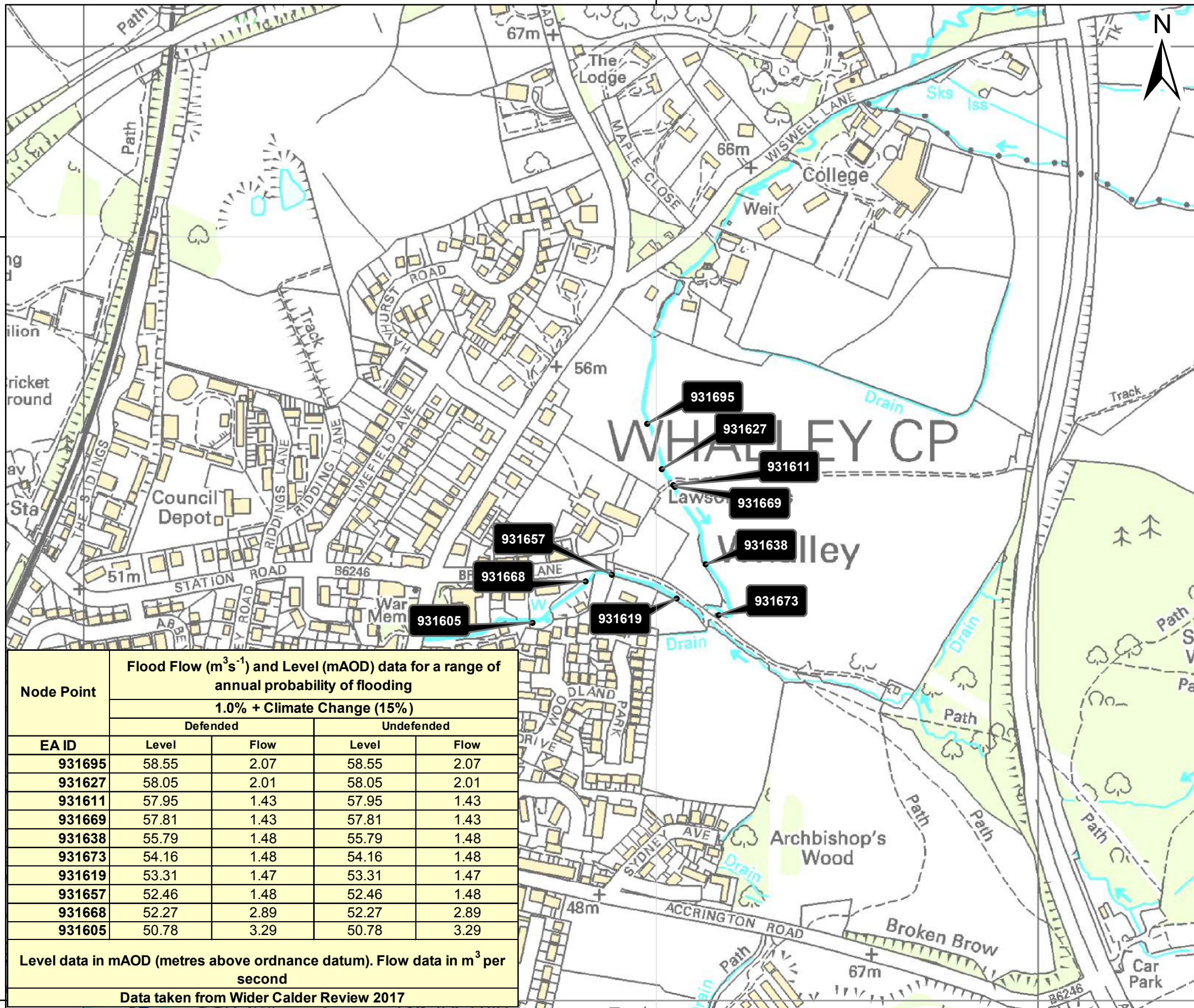
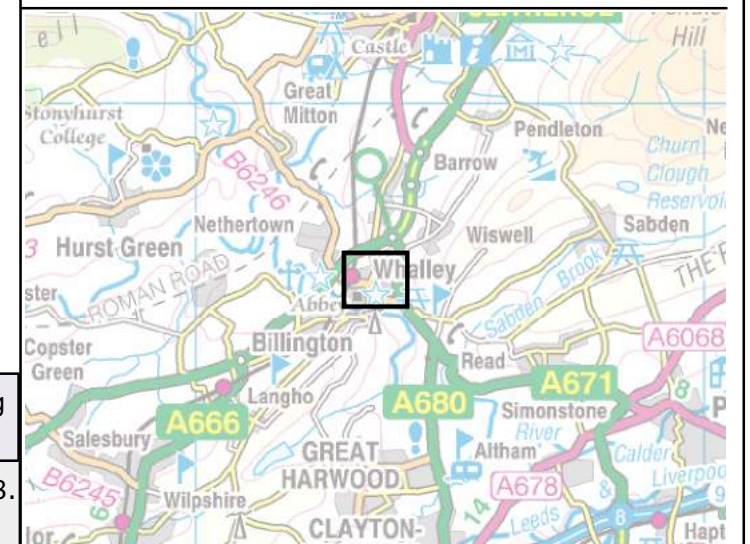
- Node Points
-  Main River

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Node Point	Flood Flow (m ³ s ⁻¹) and Level (mAOD) data for a range of annual probability of flooding				
	1.0% + Climate Change (15%)				
		Defended		Undefended	
EA ID	Level	Flow	Level	Flow	
931695	58.55	2.07	58.55	2.07	
931627	58.05	2.01	58.05	2.01	
931611	57.95	1.43	57.95	1.43	
931669	57.81	1.43	57.81	1.43	
931638	55.79	1.48	55.79	1.48	
931673	54.16	1.48	54.16	1.48	
931619	53.31	1.47	53.31	1.47	
931657	52.46	1.48	52.46	1.48	
931668	52.27	2.89	52.27	2.89	
931605	50.78	3.29	50.78	3.29	

Level data in mAOD (metres above ordnance datum). Flow data in m³ per second
 Data taken from Wider Calder Review 2017

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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

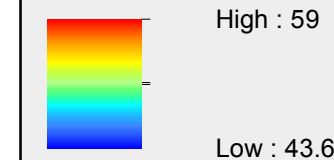
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

 Main River

Fluvial Defended Scenario 4.0% Annual Probability of Flooding

mAOD

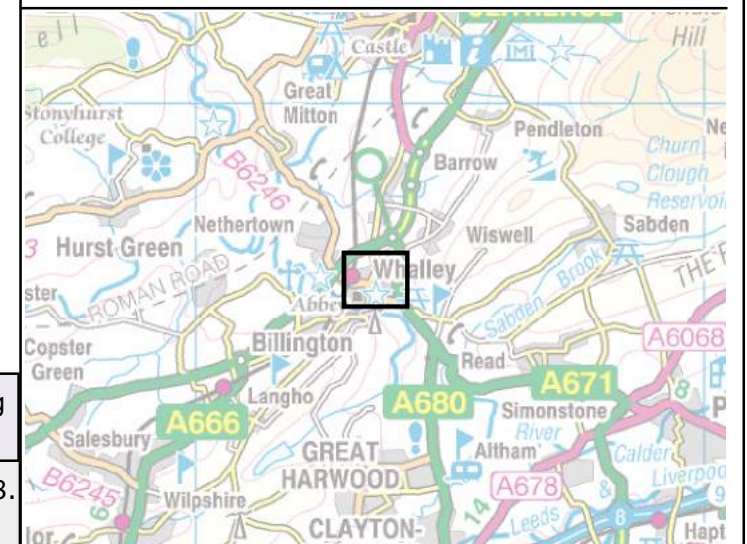


Flood Zone 3 shows the area that could be affected by flooding:

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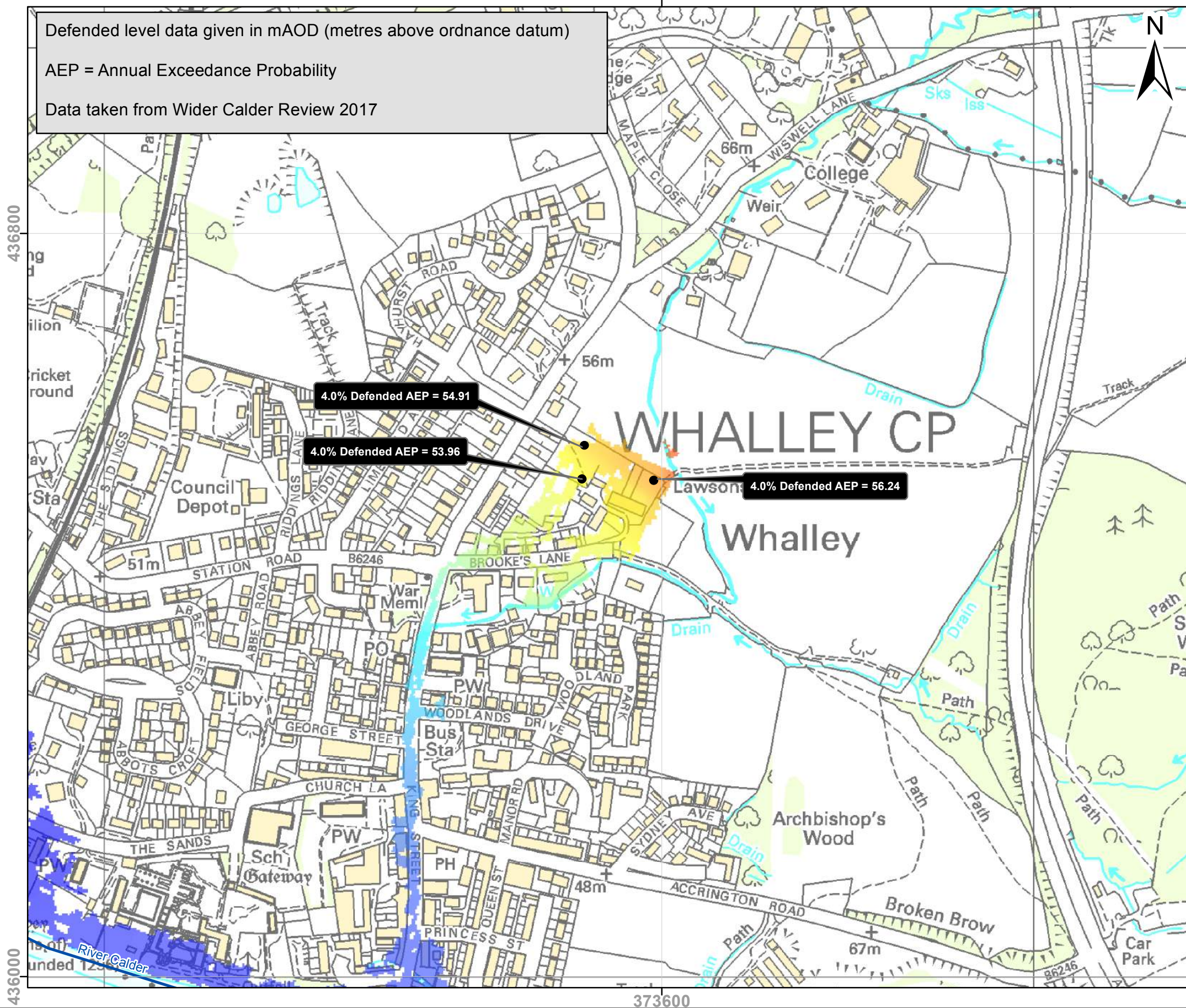
ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Defended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

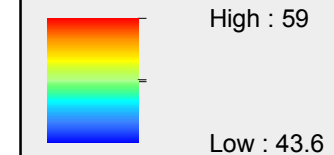
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

 Main River

Fluvial Defended Scenario 1.0% Annual Probability of Flooding

mAOD

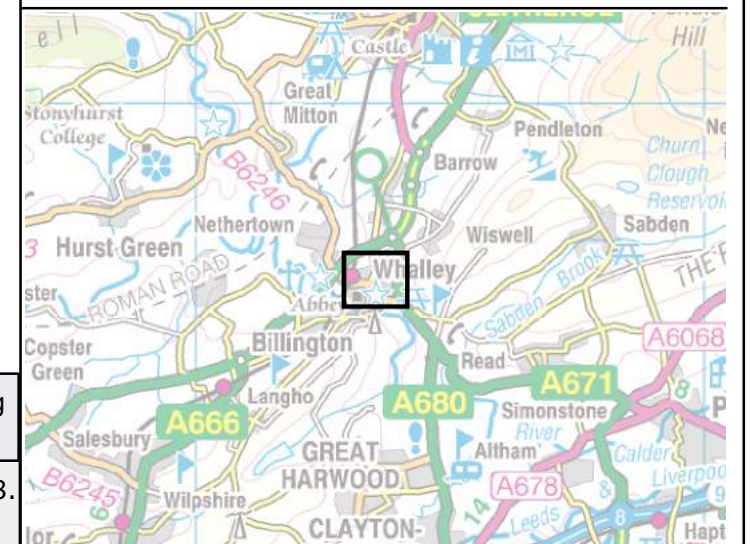


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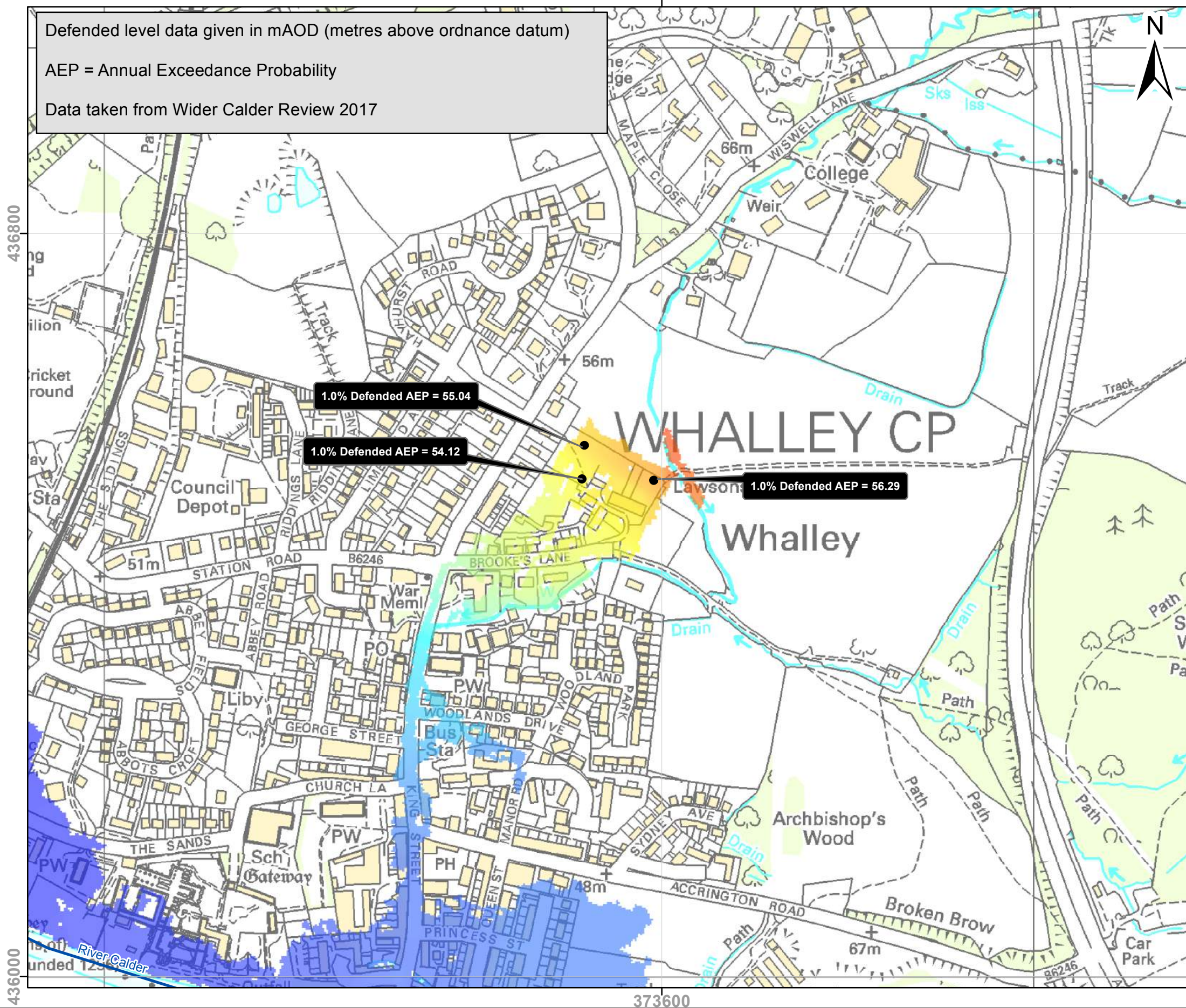
ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.



Defended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



1.0% Defended AEP = 55.04

1.0% Defended AEP = 54.12

1.0% Defended AEP = 56.29

Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.


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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

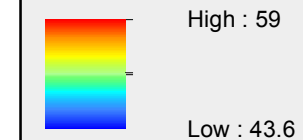
Produced: 16 April 2018
 Our Ref: CL82099
 NGR: 373,302 436,516

Key

 Main River

Fluvial Defended Climate Change (+15%) Scenario 1.0% Annual Probability of Flooding

mAOD



Flood Zone 3 shows the area that could be affected by flooding:

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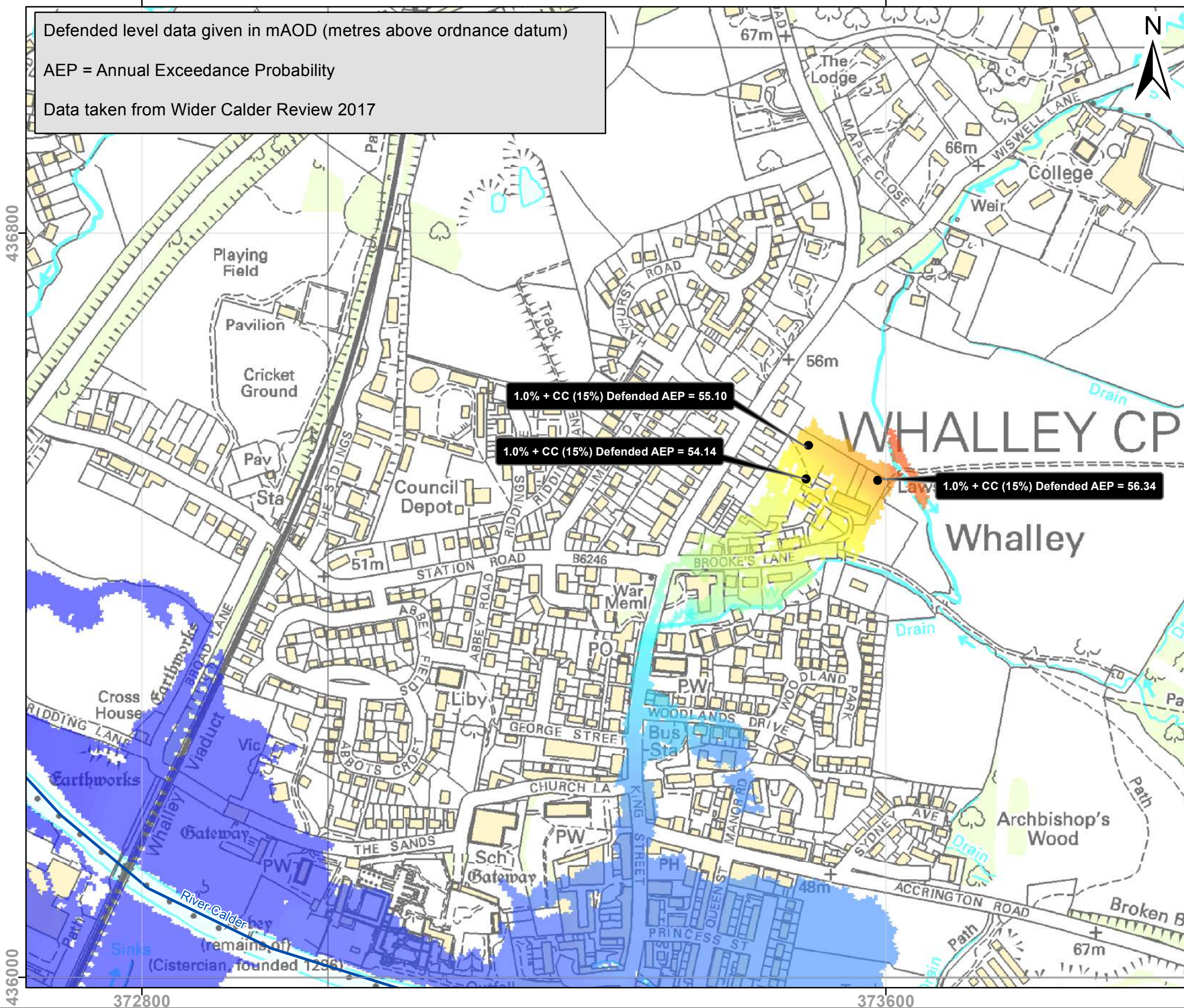
Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.

Defended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

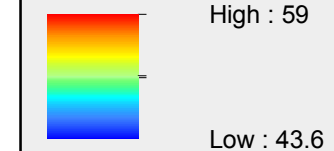
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

 Main River

Fluvial Defended Scenario 0.5% Annual Probability of Flooding

mAOD



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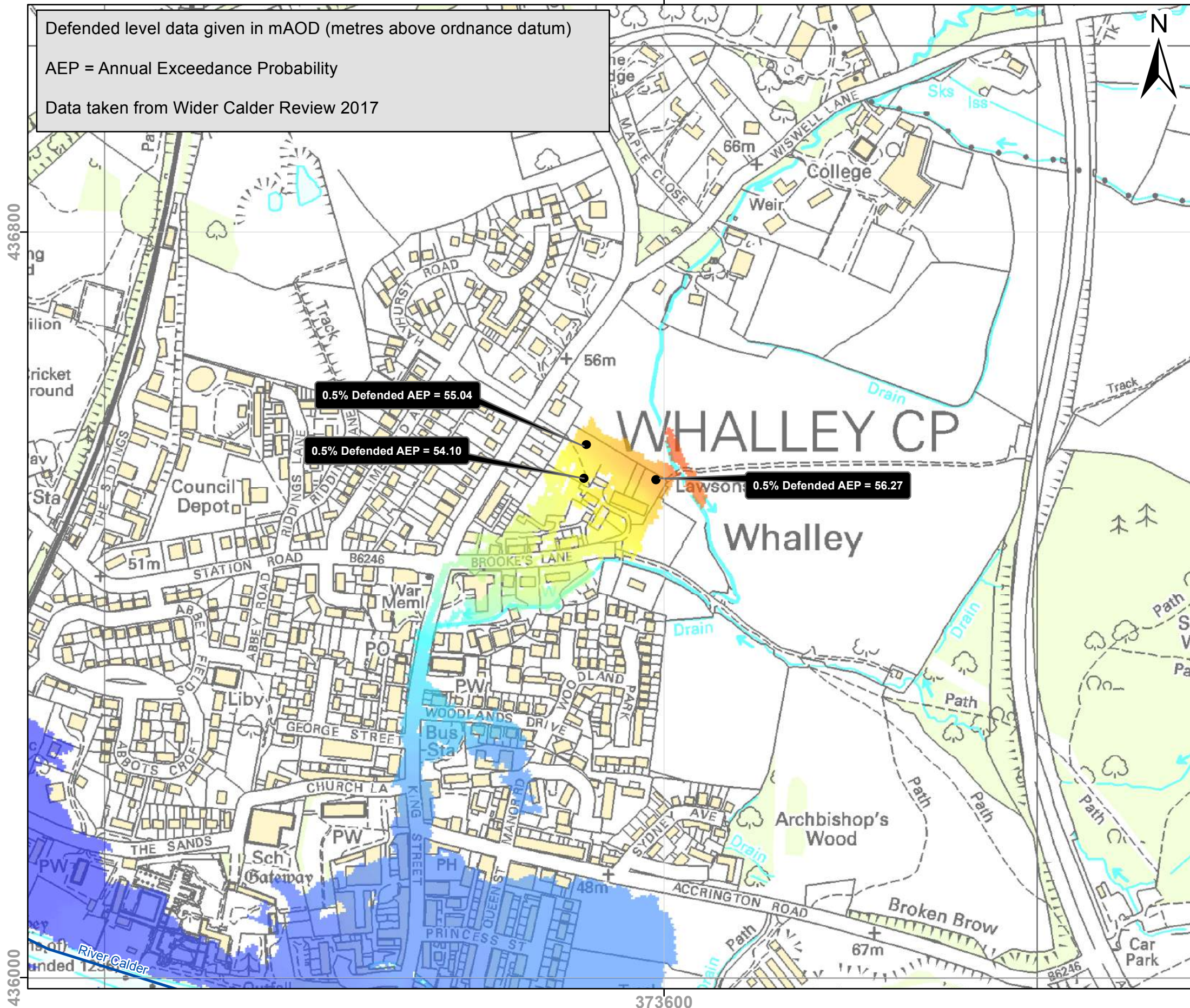
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Defended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



0.5% Defended AEP = 55.04

0.5% Defended AEP = 54.10

0.5% Defended AEP = 56.27

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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

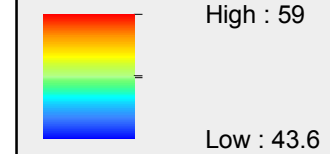
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

 Main River

Fluvial Defended Scenario 0.1% Annual Probability of Flooding

mAOD

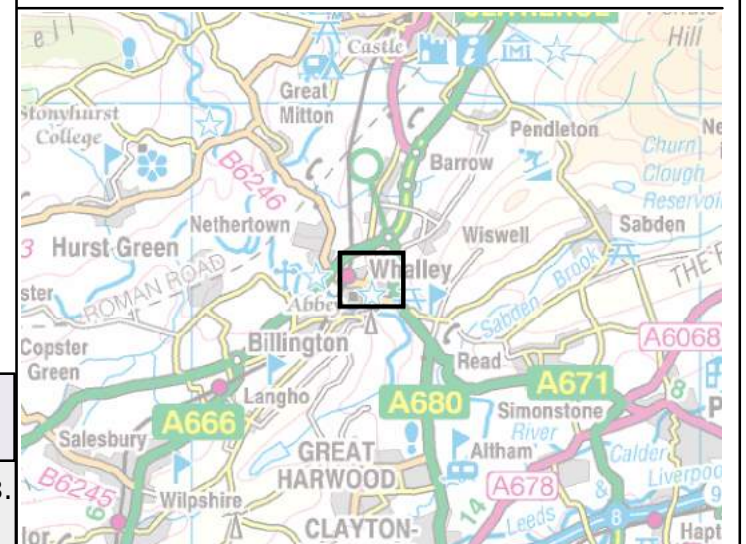


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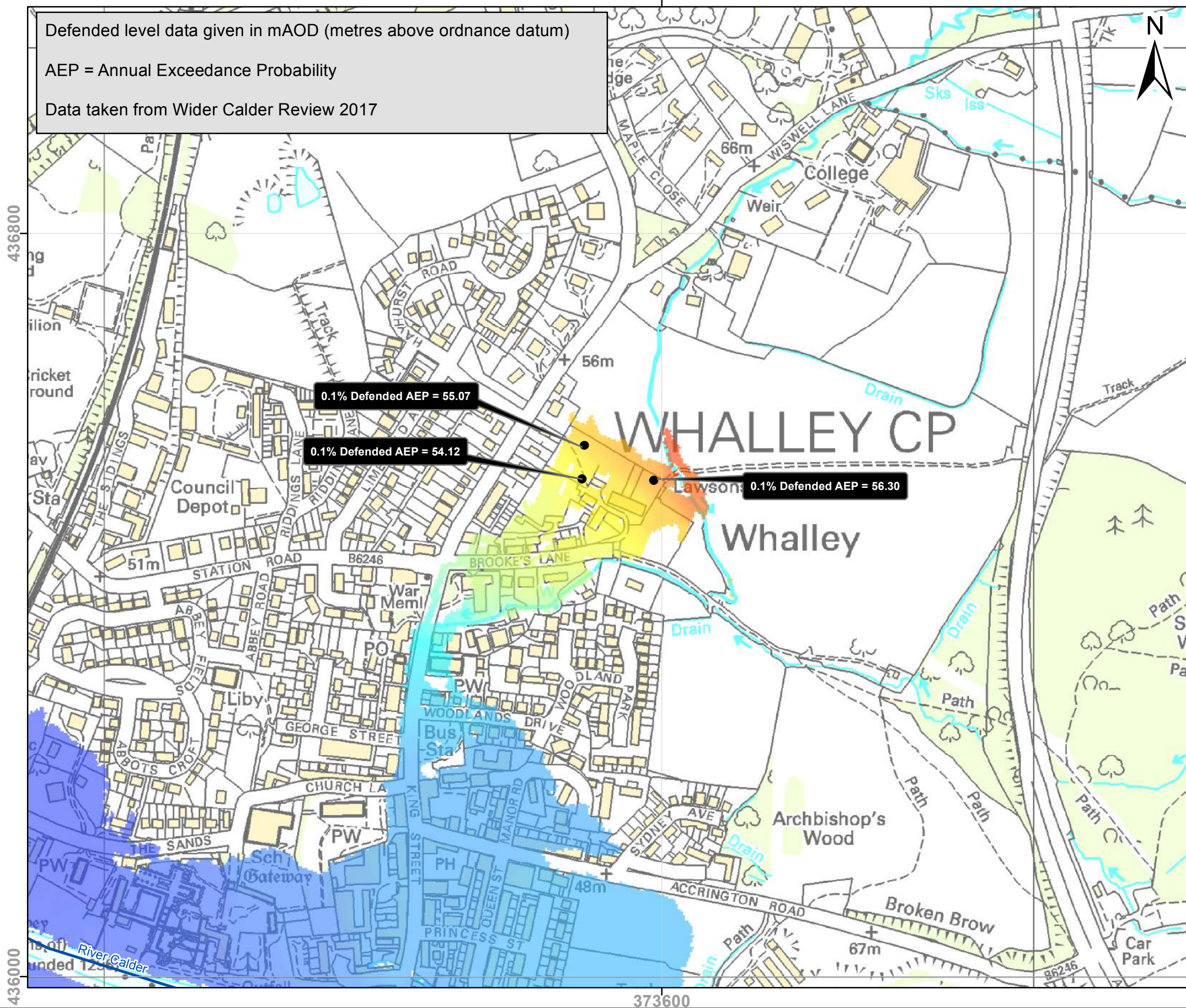
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Defended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



0.1% Defended AEP = 55.07

0.1% Defended AEP = 54.12

0.1% Defended AEP = 56.30

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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

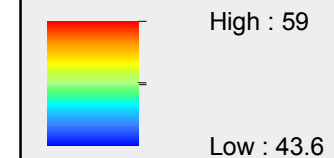
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

 Main River

Fluvial Undefended Scenario 4.0% Annual Probability of Flooding

mAOD



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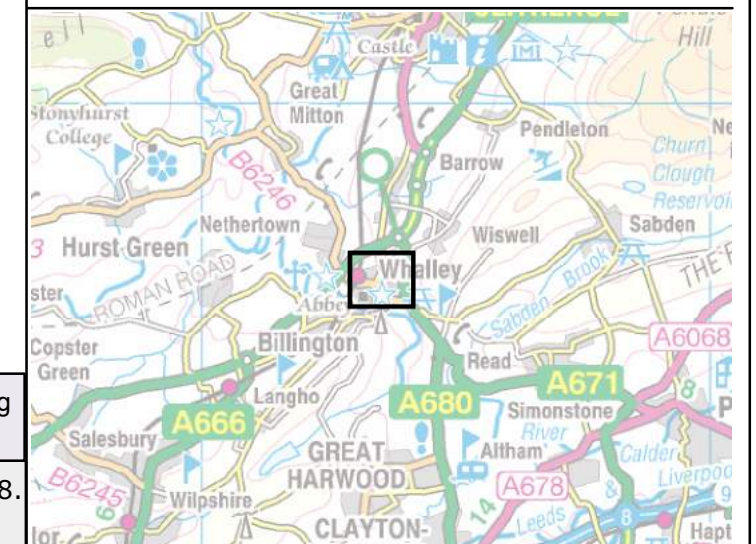
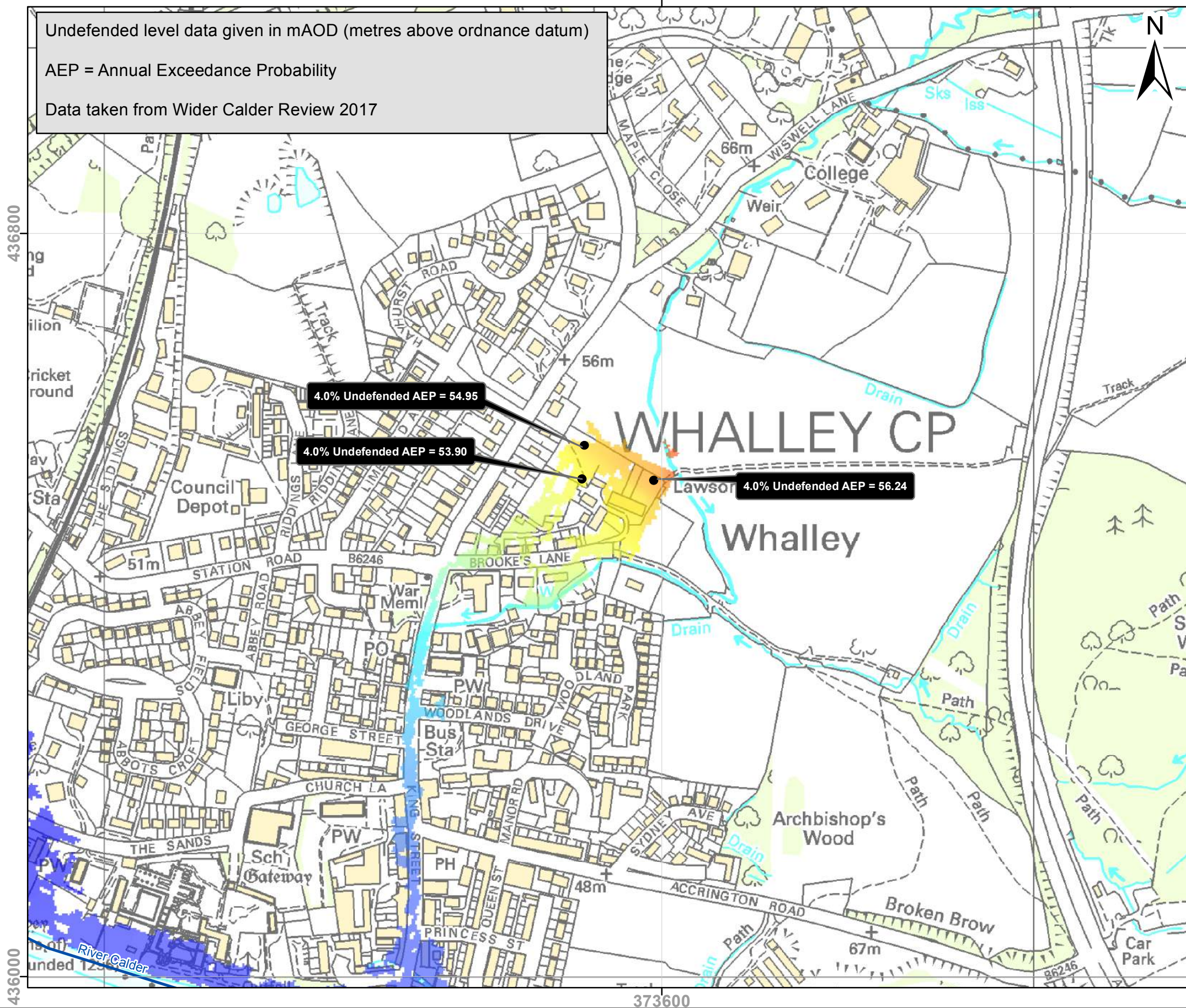
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ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.

Undefended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



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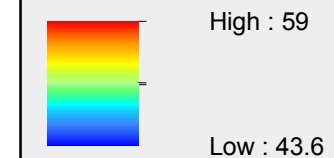
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

 Main River

Fluvial Undefended Scenario 1.0% Annual Probability of Flooding

mAOD



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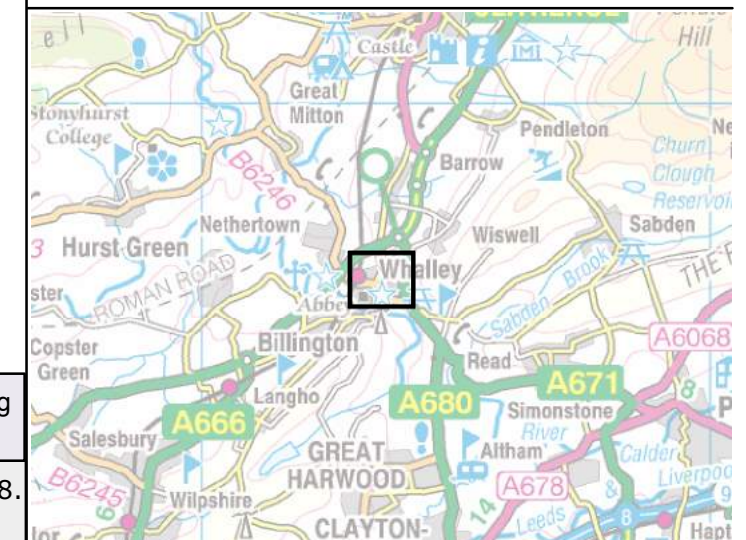
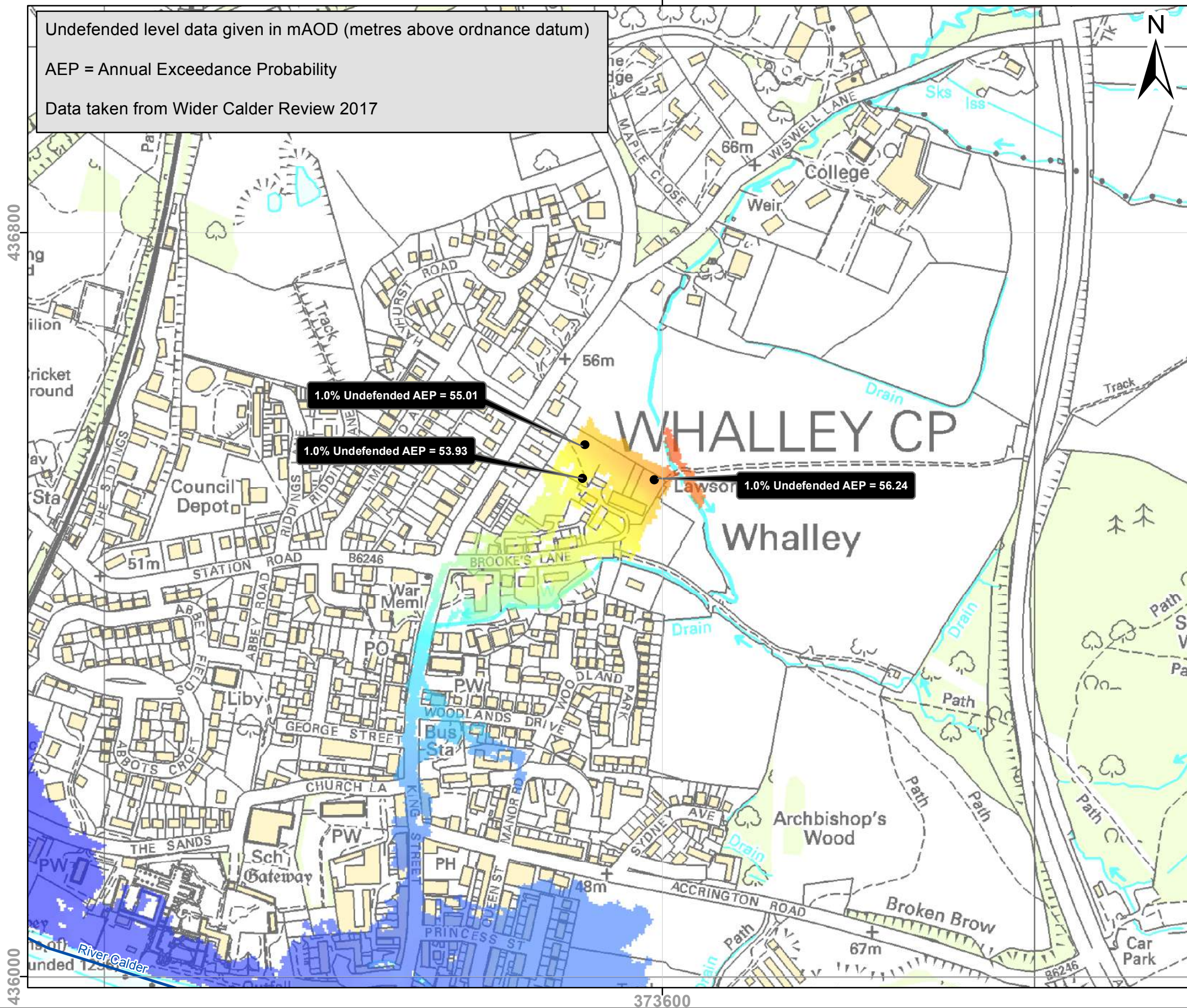
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Undefended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



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Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

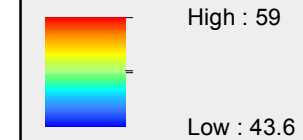
Produced: 16 April 2018
Our Ref: CL82099
NGR: 373,302 436,516

Key

 Main River

Fluvial Undefended Climate Change (+15%)
Scenario 1.0% Annual Probability of Flooding

mAOD



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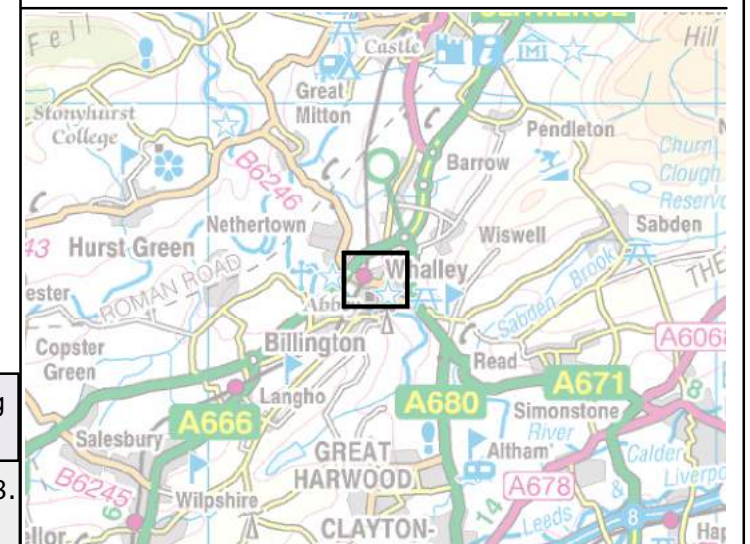
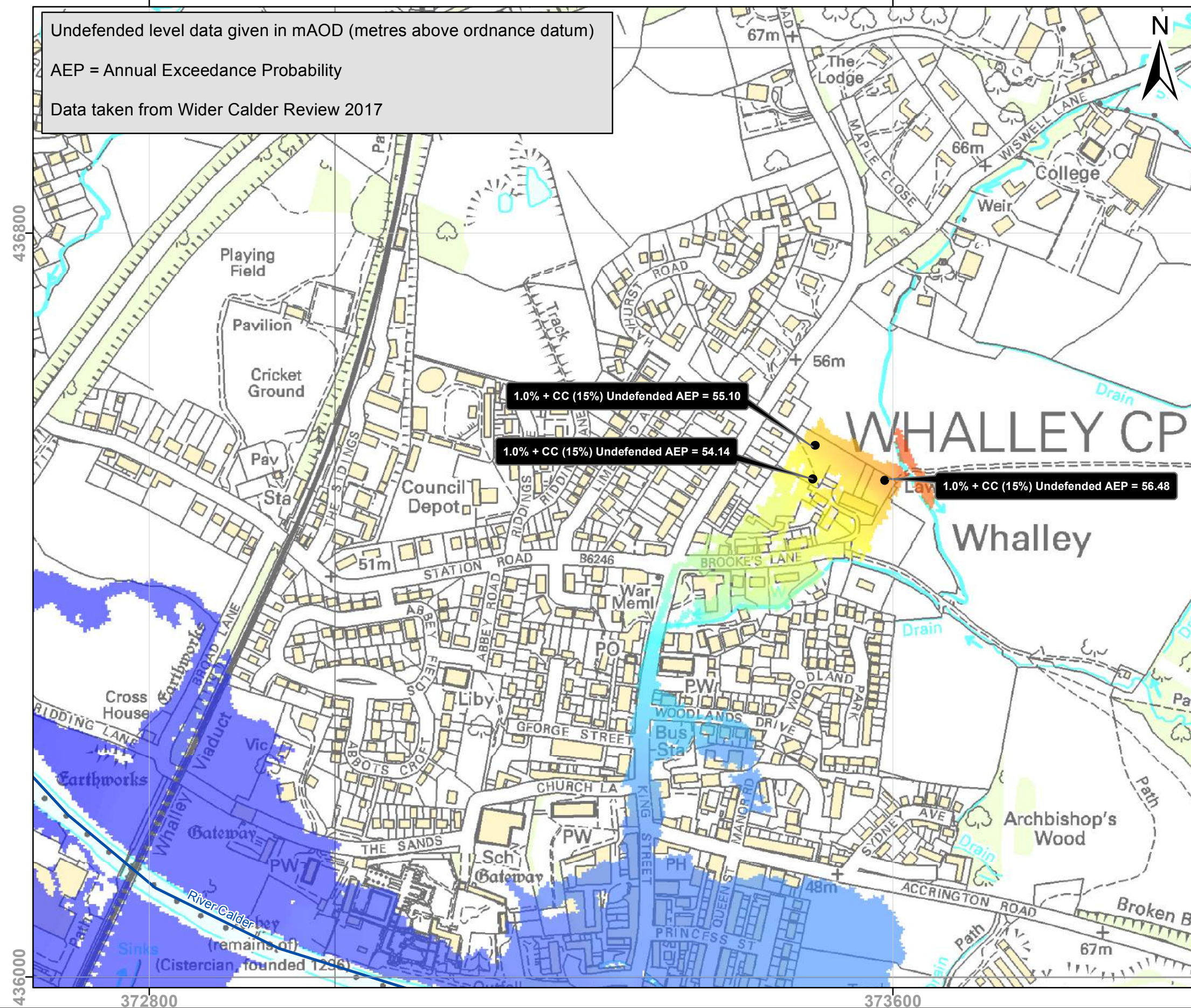
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ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.

Undefended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.


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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

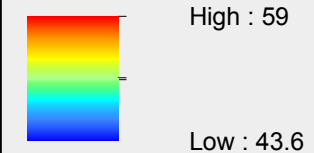
Produced: 13 April 2018
 Our Ref: CL82099
 NGR: 373,545 436,516

Key

 Main River

Fluvial Undefended Scenario 0.5% Annual Probability of Flooding

mAOD



Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

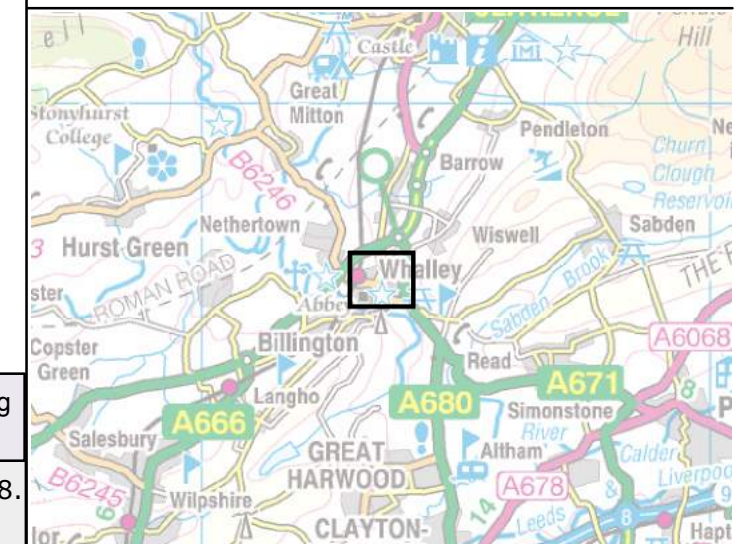
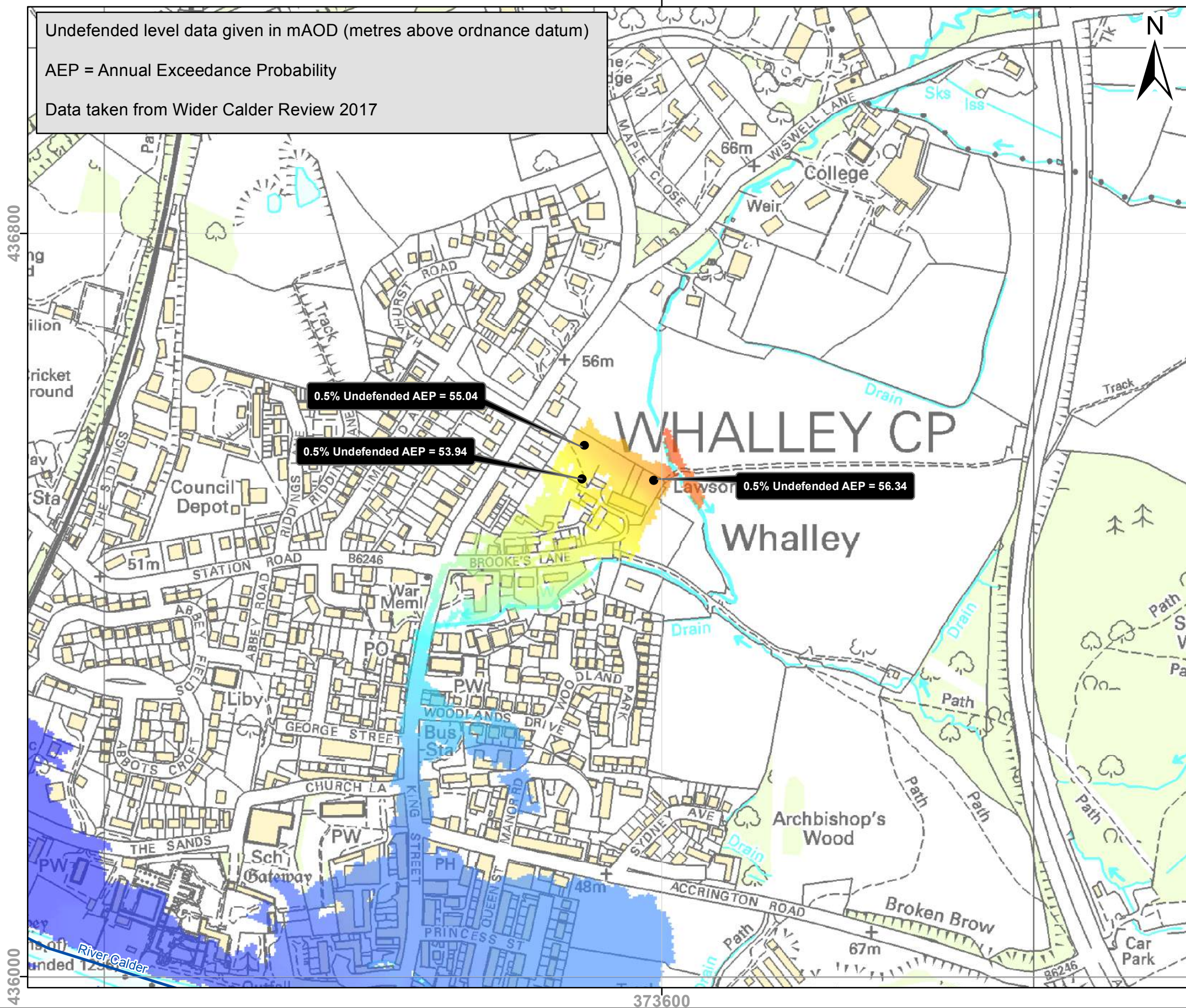
Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.

Undefended level data given in mAOD (metres above ordnance datum)

AEP = Annual Exceedance Probability

Data taken from Wider Calder Review 2017



Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Fluvial Flood Levels Map: Land adjacent to Brookes Lane, Whalley, BB7 9RG

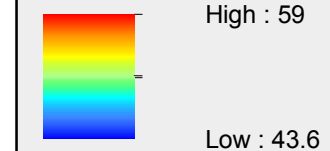
Produced: 13 April 2018
Our Ref: CL82099
NGR: 373,545 436,516

Key

Main River

Fluvial Undefended Scenario 0.1% Annual Probability of Flooding

mAOD



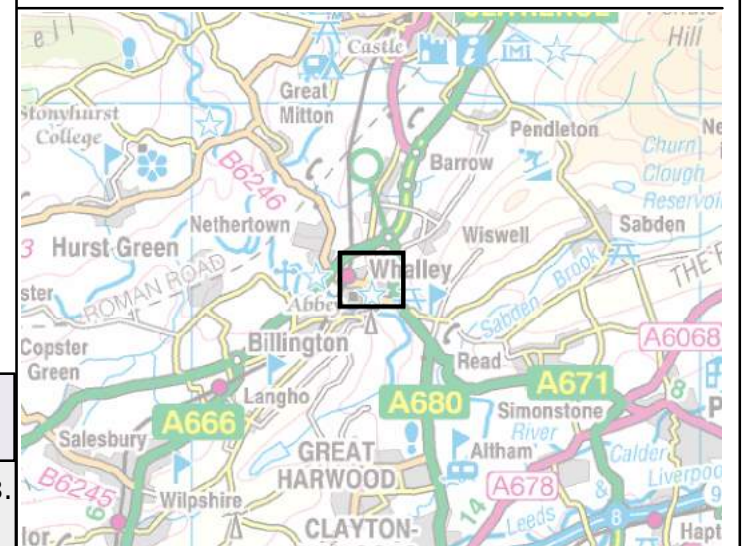
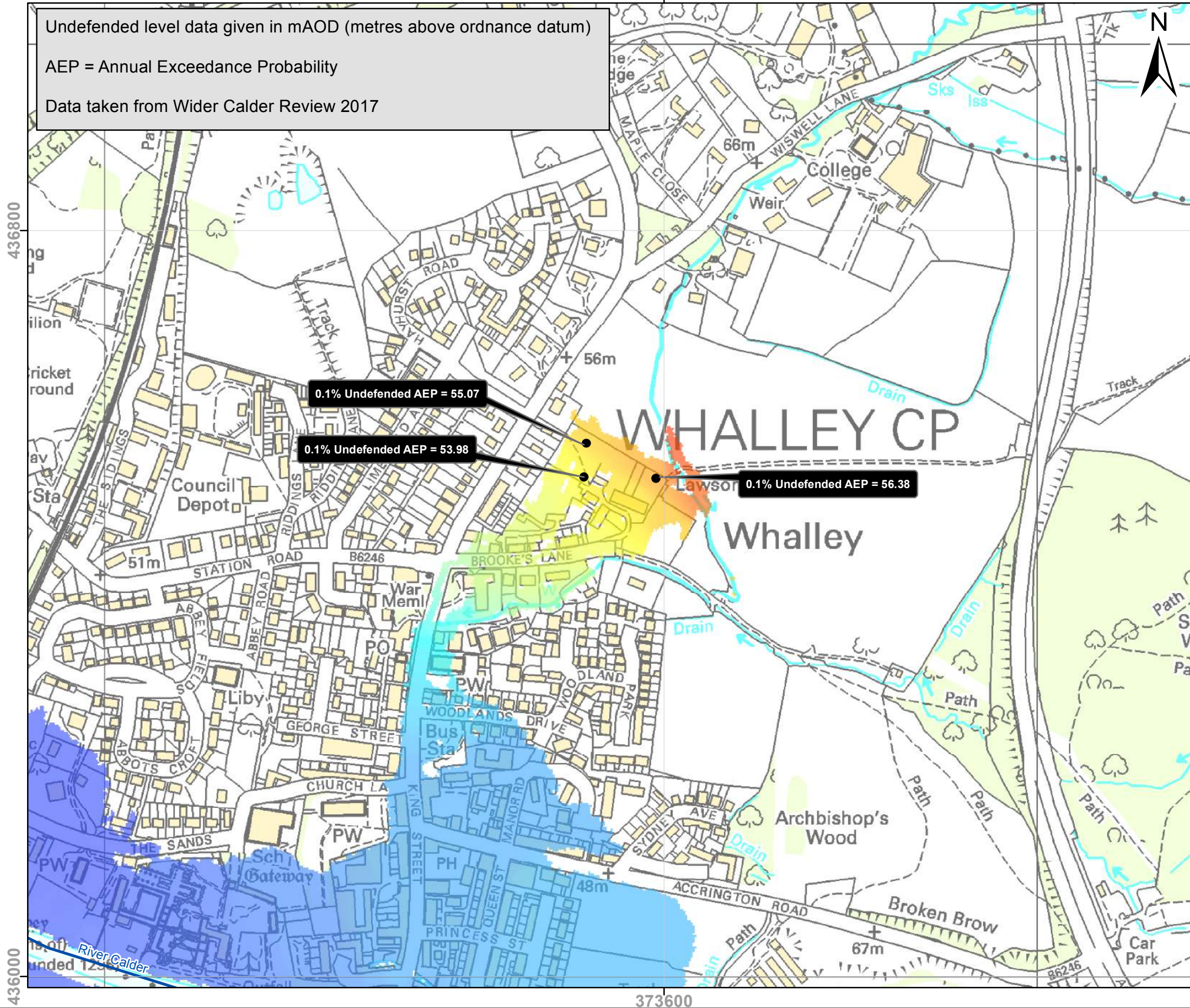
Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of happening each year
- or from a river with a 1.0% or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to 0.1% chance of occurring each year.

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 0.5% tidal, or 1.0% fluvial flood event.

Undefended level data given in mAOD (metres above ordnance datum)
AEP = Annual Exceedance Probability
Data taken from Wider Calder Review 2017



Modelled water levels with climate change using +20% flow allowances are not suitable for the majority of planning purposes. New climate change allowances can be checked on the following website; www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

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APPENDIX 2 – Lancashire County Council Correspondence

From: Suds <suds@lancashire.gov.uk>
Sent: 25 May 2018 11:03
To: keelan@KRSenvironmental.com
Subject: Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG
Attachments: LLFA Pre application Guidance & ToCs.pdf; Pre-application form - July 2017.dotx

Good morning,

Thank you for your query. We will first need you to complete and return the attached application form, together with the supplementary information as specific on the form. We can only provide comments under our Pre-Application advice service for residential developments of 10 or more properties or a site area of 0.5Ha and above. Once the application is received, we will then review the application and confirm application fees etc. Without a pre-application request we will be unable to provide site specific information and will have to make our comments to the Local Planning Authority when a consultation is requested.

I have attached some guidance notes to help you with your application.

The Section 19 (Flood Investigation) reports for Ribble Valley following the December 2015 flooding can be found on the following link which may help provide information on flooding within an area <http://www.lancashire.gov.uk/flooding/>.

Information on watercourses and drainage consent can be found on the following link: <http://www.lancashire.gov.uk/flooding/drains-and-sewers/alterations-to-a-watercourse/>

Please note information on Flood Zones and flooding history can be found on the following link: <https://www.gov.uk/check-flood-risk>

Trusting this is of help.

Helen Lord
Flood Risk Technical Support Officer
Community Services
Lancashire County Council
T: 01772 536275
W: www.lancashire.gov.uk

From: keelan@KRSenvironmental.com [mailto:keelan@KRSenvironmental.com]
Sent: 17 May 2018 14:57
To: Suds <suds@lancashire.gov.uk>
Subject: FW: Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG

Dear Sir/Madam,

I haven't had a response to the email shown below.

Please could you respond ASAP.

Regards,

Keelan

From: keelan@KRSenvironmental.com <keelan@KRSenvironmental.com>

Sent: 17 May 2018 11:36

To: 'FRM@lancashire.gov.uk' <FRM@lancashire.gov.uk>

Subject: FW: Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG

Dear Sir/Madam,

I haven't had a response to the email shown below.

Please could you respond ASAP.

Regards,

Keelan

From: keelan@KRSenvironmental.com <keelan@KRSenvironmental.com>

Sent: 04 May 2018 09:05

To: 'FRM@lancashire.gov.uk' <FRM@lancashire.gov.uk>

Subject: FW: Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG

Dear Sir/Madam,

I haven't had a response to the email shown below.

Please could you respond ASAP.

Regards,

Keelan

From: keelan@KRSenvironmental.com <keelan@KRSenvironmental.com>

Sent: 10 April 2018 15:17

To: 'FRM@lancashire.gov.uk.' <FRM@lancashire.gov.uk>

Subject: Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG

Dear Sir/Madam,

I am undertaking a Flood Risk Assessment for a residential development on Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG. I have attached a site location plan and propose site layout plan and the grid reference is 373508, 436557.

It would be useful if you could advise us of any historic data regarding flooding and drainage issues within this area. If you know of any council sewers within the area and any advice with regards to the disposal of the surface water from the site would also be much appreciated (i.e. the use of SUDs or surface water drainage system). Any other pertinent advice with regards to flood risk and drainage would also be much appreciated.

If you have any queries do not hesitate to contact me.

Regards,

Keelan Serjeant | Director
BSc, MSc, MCIWEM
KRS Environmental Ltd

T: 01686 668957
T: 01484 437420
M: 07857 264 376
E: keelan@krsenvironmental.com
W: krsenvironmental.com

Please think about the environment, only print this email if you need to.

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Lancashire County Council has taken reasonable steps to ensure that outgoing communications do not contain malicious software and it is your responsibility to carry out any checks on this email before accepting the email and opening attachments.

APPENDIX 3 – United Utilities Correspondence

From: Perry, Graham <Graham.Perry@uuplc.co.uk>
Sent: 08 May 2018 11:30
To: keelan@krsenvironmental.com
Cc: Wastewater Developer Services
Subject: Pre Development Enquiry for Brookes Lane Whalley - Our ref - 4200020702
Attachments: PDE 4200020702 Land Adj brookes lane Whalley due 08.05.18 (1.34 MB)

Importance: High

Dear Sir

We have carried out an assessment of your application which is based on the information provided; this pre development advice will be valid for 12 months

Foul

Foul will be allowed to drain to the public combined/ foul sewer network. Our preferred point of discharge would be to the 225mm combined sewer crossing the site at an unrestricted rate.

Surface Water

Surface water from this site must drain to soak away or some other form of infiltration system but if ground conditions confirm that this is not a viable solution all surface water can drain to the 225mm surface water sewer on Clitheroe road at a maximum pass forward flow of 5 l/s.

Connection Application

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

<http://www.unitedutilities.com/connecting-public-sewer.aspx>

Sewer Adoption Agreement

You may wish to offer the proposed new sewers for adoption. United Utilities assess adoption application based on Sewers adoption 6th Edition and for any pumping stations our company addenda document. Please refer to link below to obtain further guidance and application pack:

<http://www.unitedutilities.com/sewer-adoption.aspx>

Existing Sewers Crossing the Site

A public sewer crosses this site and we will require unrestricted access to the sewer for maintenance purposes, we would ask that you maintain a minimum clearance of 6m which is measured 3m from the centre line of the pipe. If you cannot achieve this then you may wish to consider diverting the public sewer.

I suspect that the sewer will interfere with plot 3 on the site and a diversion may be necessary

Please refer to the link below to obtain full details of the processes involved in sewer diversion.

<http://www.unitedutilities.com/sewer-diversion.aspx>

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

Please note, if you intend to put forward your wastewater assets for adoption by United Utilities, the proposed detail design will be subject to a technical appraisal by an Adoption Engineer as we need to be sure that the proposals meets the requirements of Sewers for adoption and United Utilities Asset Standards. The proposed design should give consideration to long term operability and give United Utilities a cost effective proposal for the life of the assets. Therefore, further to this enquiry should you wish to progress a Section 104 agreement, we strongly recommend that no construction commences until the detailed drainage design, submitted as part of the Section 104 agreement, has been assessed and accepted in writing by United Utilities. Any works carried out prior to the technical assessment being approved is done entirely at the developers own risk and could be subject to change.

Regards

Graham Perry

Development Engineer
Developer Services and Planning
Business Operations
United Utilities

T: 01925 679405 (internal 79405)
E: graham.perry@uuplc.co.uk
unitedutilities.com

If you have received a great service today why not tell us?

Visit: unitedutilities.com/wow

EMGateway3.uuplc.co.uk made the following annotations

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Business Park, Lingley Green Avenue, Great Sankey,

Warrington, WA5 3LP
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www.unitedutilities.com
www.unitedutilities.com/subsidiaries

Extract from Map of Public Sewers

The position of underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available.

The actual positions may be different from those shown on the plan and private pipes, sewers or drains may not be recorded.

United Utilities will not accept any liability for any damage caused by the actual positions being different from those shown.

United Utilities Water Limited 2014

The plan is based upon the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office. Crown and United Utilities copyrights are reserved. Unauthorised reproduction will infringe these copyrights.

LEGEND

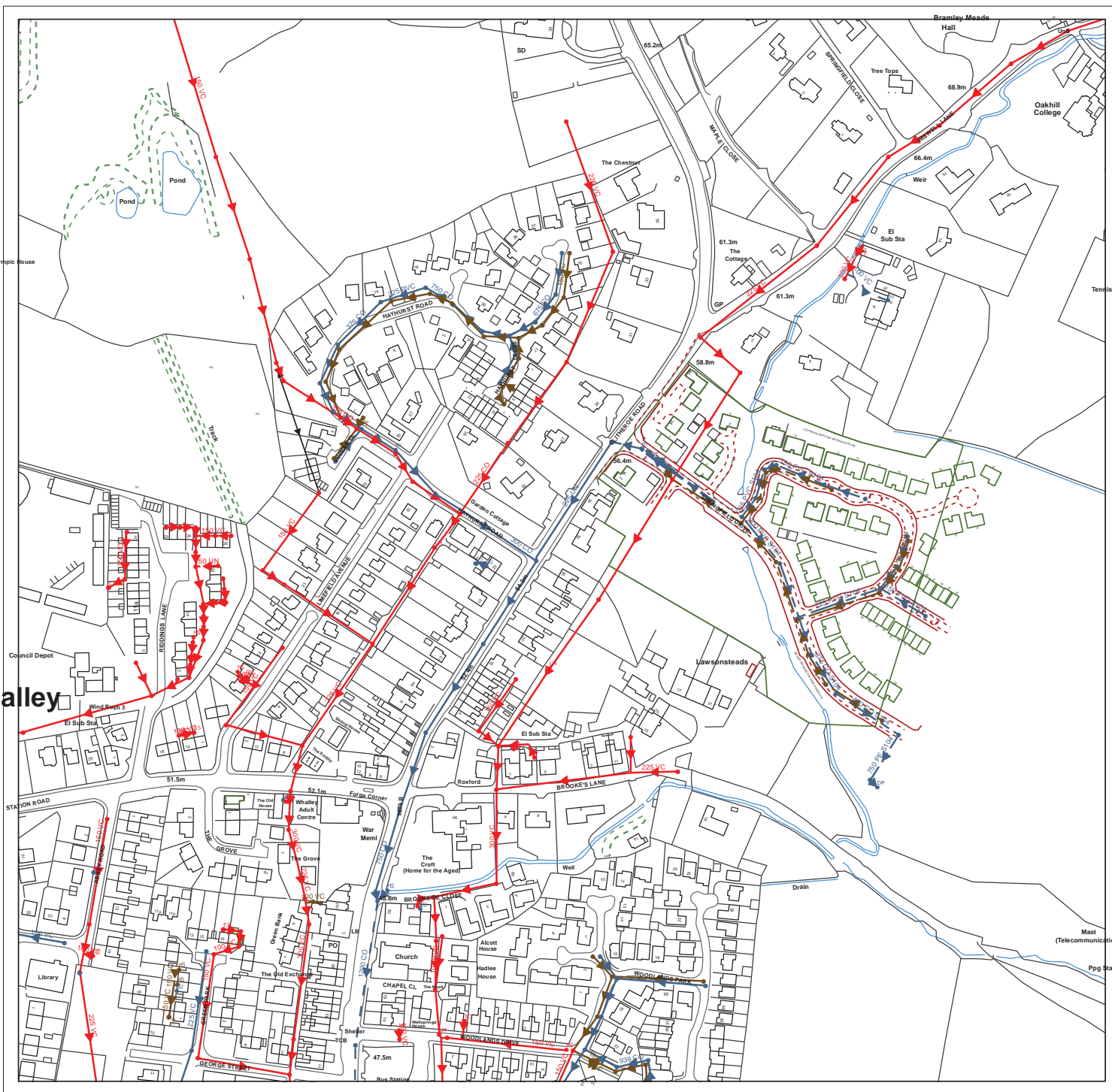
	Water Course			
	Overflow Pipe			
	Sludge Main			
	Highway Drain			
Combined	Surface Water	Foul	Abandoned	
				Public Sewer
				Private Sewer
				Section 104
				Rising Main

BOLTO/02

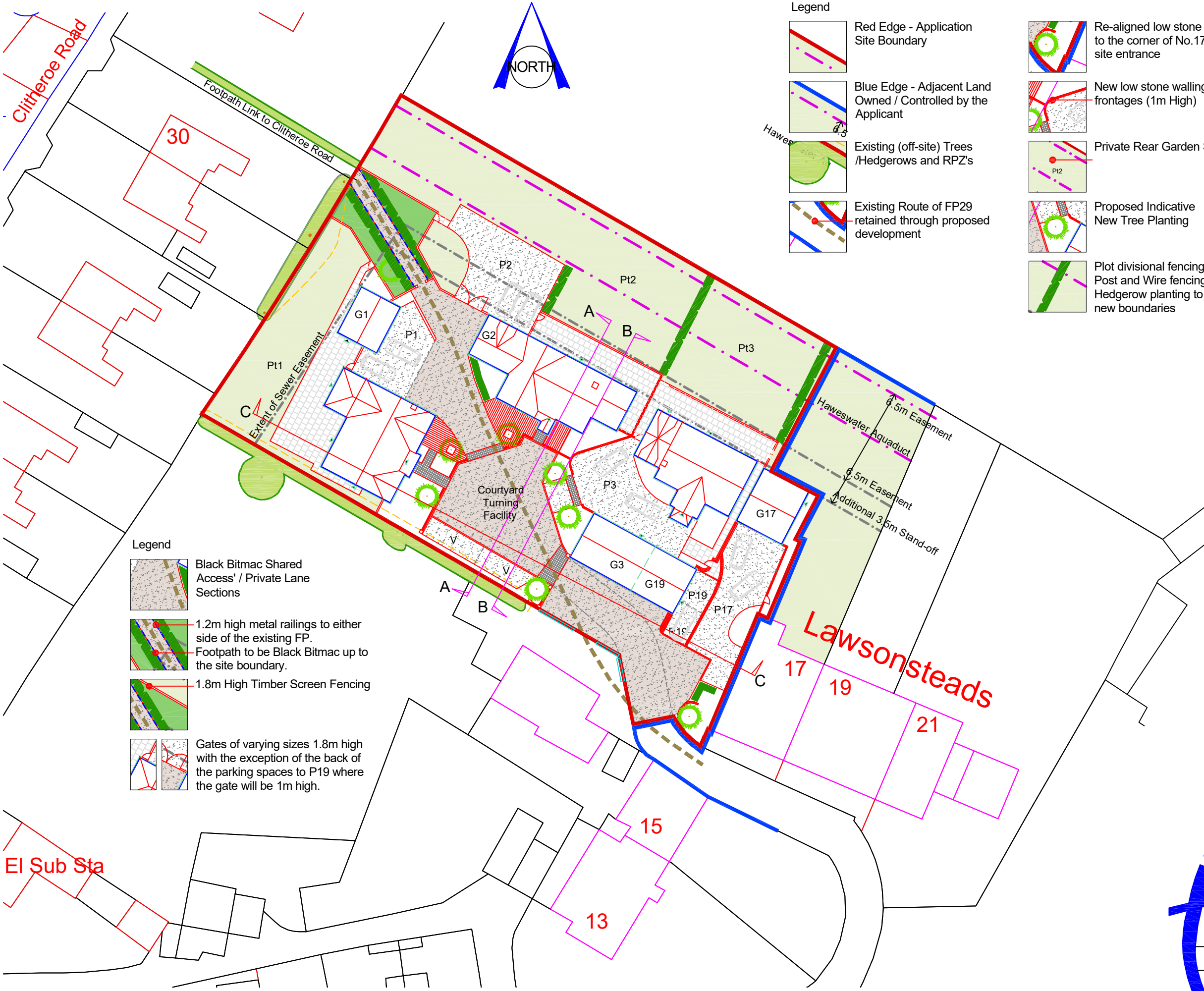
Printed By : Joanne Jones

Date: 01/12/2015

DO NOT SCALE
Approximate Scale: 1:2500



APPENDIX 4 – Proposed Site Layout



- Legend**
- Red Edge - Application Site Boundary
 - Blue Edge - Adjacent Land Owned / Controlled by the Applicant
 - Existing (off-site) Trees / Hedgerows and RPZ's
 - Existing Route of FP29 retained through proposed development
 - Re-aligned low stone walling to the corner of No.17 at the site entrance
 - New low stone walling to site frontages (1m High)
 - Private Rear Garden Spaces
 - Proposed Indicative New Tree Planting
 - Plot divisional fencing Post and Wire fencing with New Hedgerow planting to form the new boundaries
 - Proposed Indicative New Hedgerow Planting
 - Small arrows denote door entry points for dwellings and garages (excluding garage doors)
 - Stone Flagging to rear patio and footpath areas
 - Tegular paved entrances and rumble strip access'

- Legend**
- Black Bitmac Shared Access' / Private Lane Sections
 - 1.2m high metal railings to either side of the existing FP. Footpath to be Black Bitmac up to the site boundary.
 - 1.8m High Timber Screen Fencing
 - Gates of varying sizes 1.8m high with the exception of the back of the parking spaces to P19 where the gate will be 1m high.

- Existing Garage Block for No's 17 and 19 Brookes Lane re-configured for Plot 3 (New Development) and No. 19 Brookes Lane
- New Garage for No.17 Brookes Lane
- 2No new allocated parking spaces for No.19 Brookes Lane to enable a 'No Parking' Covenant in front of the existing garage block on the access.
- 2No 'Visitor' Parking Spaces provided within the new courtyard for the occupants of Plots 1 to 3 Only.
- Illustrates a minimum of 2No parking spaces to the drives plus garaging proposed

SITE PLAN - BROOKES LANE, WHALLEY



Barn Meadow House
 Southfield Fold Farm
 Southfield
 Burnley
 Lancashire
 BB10 3RH
 Tel : 01282 601157
 Mbl : 07976 782876

Client		Mr R. Bolton	
Project		BROOKES LANE, WHALLEY	
Drawing Title		SITE PLAN AND ILLUSTRATIVE LANDSCAPING SCHEME	
Drawing No.		1589RBP/BLW/SP01	
Revision	Checked		
E		Drawn	DGL
		Scale	1:500
		Date	21st Sept 2017
E-mail :		darren.dgla@gmail.com	
		A3	

APPENDIX 5 – Topographical Survey



LEVEL SURVEY
LAND AT 17 BROOKES LANE
WHALLEY

Client: KRS ENVIRONMENTAL LIMITED
 3 PRINCES SQUARE
 PRINCES STREET
 MONTGOMERY
 POWYS
 SY15 6PZ

Reference No	Drawing No	Scale	Scale Factor
80410-09KS	001	1:200	1.0000

Survey Stations
 Grid - Related to OSGB36 (National Grid) and OSTN15 derived from GNSS
 Levels - Related to Ordnance Survey Datum via OSGM15 derived from GNSS

STATIONS	EAST	NORTH	HEIGHT	DESCRIPTION
A	373534.383	436518.036	54.548	Road Nail
B	373548.699	436531.818	54.657	Road Nail
C	373524.786	436521.594	54.363	Road Nail

Revisions/ Notes

- All critical dimension to be checked on site
- Further investigation may be needed to show the full extent of the drainage on site
- Only ICs, fences, walls, building footprints and levels are shown
- Fences/ walls shown do not necessary represent legal boundaries

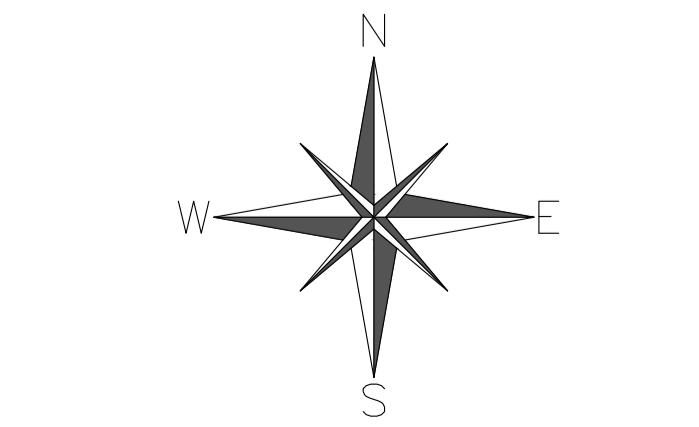
NOTES:

Legend

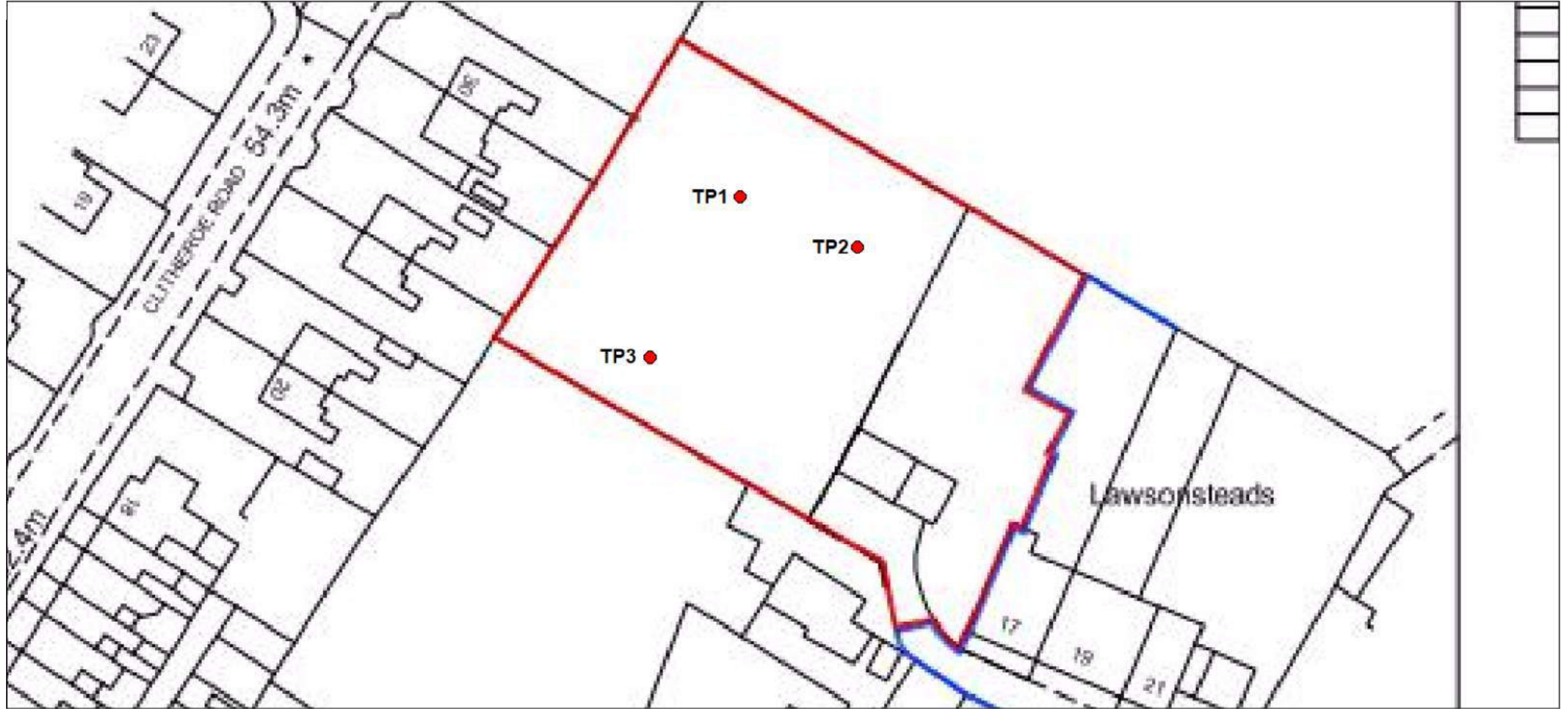
Bol	Bollards	MP	Mile-post
BS	Bus stop	NP	Name plate
BT	British Telecom IC	OG	Overgrown
CL	Ceiling Level	OHH	Overhead
CATV	Cable television IC	PO	Post
DK	Drop kerb	PM	Parking Meter
DR	Drain	RE	Rodding Eye
Elec	Electric IC	RS	Road sign
EP	Electric pole	RW	Retaining Wall
ER	Earth rod	SP	Soil pipe
FFL	Finished Floor Level	ST	Stop tap
FP	Fence post	Stay	Cable stay
FB	Flower Bed	TCB	Telephone call box
G	Gully	FFL 5.55	Finished Floor Level
GP	Gate Post	TL	Door Threshold Level
H/C	Harcure	TP	Telephone pole
HMP	Hazard Marker Posts	Tar	Tarmacadam
IC	Inspection cover	VP	Vent pipe
K	Kerb	W	Water cover
KO	Kerb outlet	WL	Water level
LB	Letter box	WM	Water meter
LP	Lamp post	WO	Water outlet
Mkr	Utility marker	UTL	Unable to lift


FENCE ANNOTATION		Fence/ Height
BW	Barbed wire	
WP	Wooden panel	
CI	Corrugated iron	
CL	Chain link	
CPWP	Concrete post Wooden Panel	
HR	Hand rail	
IR	Iron railing	
PC	Post and chain	
PR	Post and rail	
PW	Post and wire	
SF	Security fence	
WP	Wooden Panel	

IC CL	54.32	IC CL	54.50	TL	54.68	TL	54.60	Spot Level	12.28
-------	-------	-------	-------	----	-------	----	-------	------------	-------



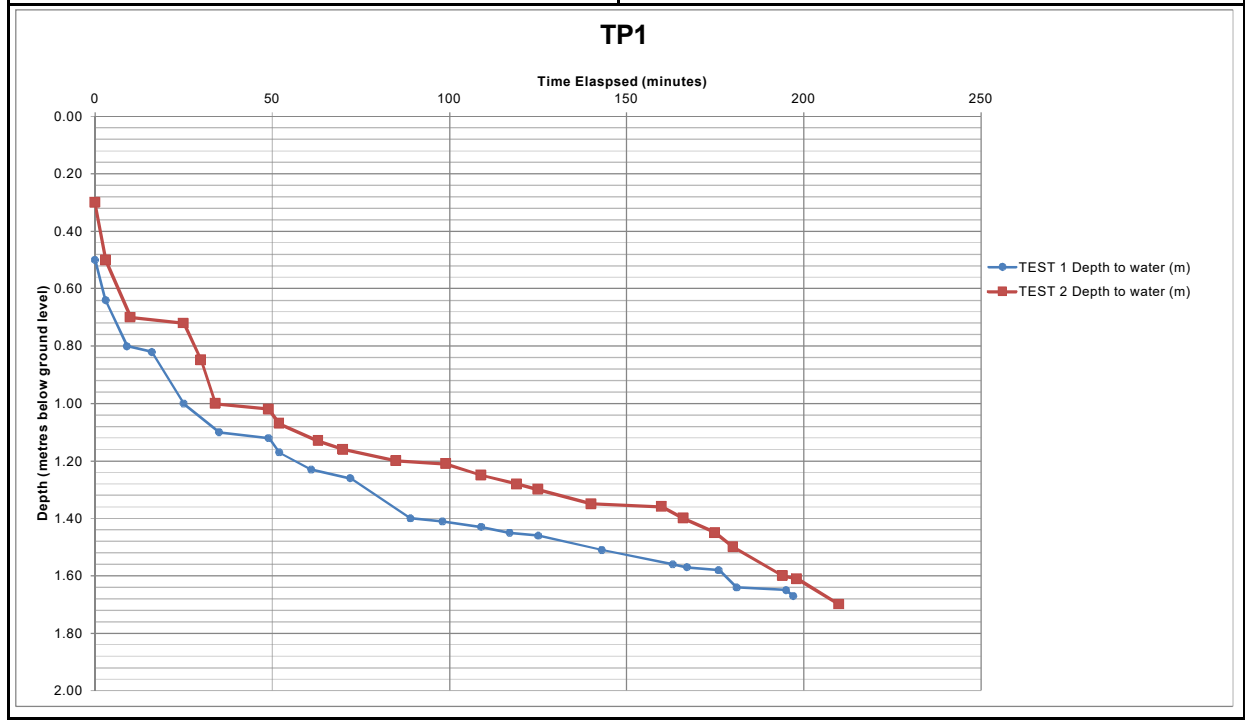
APPENDIX 6 – BRE365 Soakaway Test Results



TP1		Length (m)	2.60	
Date	19/04/2018	Width (m)	1.00	
Site	Land Adjacent 17 Brookes Lane	Depth (m)	2.00	SOIL INFILTRATION RATE TEST See B.R.E. Digest 365, 2007, Soakaway Design.
Job Number	KRS.0356.001	Groundwater Level (mbgl)	Dry	


Remarks -	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
Soil encountered: TOPSOIL to 0.50mBGL; stony, ash FILL to 1.50mBGL; dark brown CLAY to 2.00mBGL. No groundwater seepages were observed to enter the trial pit.	0	0.50	0	0.30		
	3	0.64	3	0.50		
	9	0.80	10	0.70		
	16	0.82	25	0.72		
	25	1.00	30	0.85		
	35	1.10	34	1.00		
	49	1.12	49	1.02		
	52	1.17	52	1.07		
	61	1.23	63	1.13		
	72	1.26	70	1.16		
	89	1.40	85	1.20		
	98	1.41	99	1.21		
	109	1.43	109	1.25		
	117	1.45	119	1.28		
	125	1.46	125	1.30		
	143	1.51	140	1.35		
	163	1.56	160	1.36		
	167	1.57	166	1.40		
	176	1.58	175	1.45		
	181	1.64	180	1.50		
195	1.65	194	1.60			
197	1.67	198	1.61			
		210	1.70			

Effective Storage Depth	m	1.50	1.70	
75% Effective Storage Depth (i.e. depth below GL)	m	1.13	1.28	
25% Effective Storage Depth (i.e. depth below GL)	m	0.38	0.43	
Effective Storage Depth 75%-25%	m	1.63	1.58	
Time to fall to 75% effective depth	mins	20	26	
Time to fall to 25% effective depth	mins	180	192	
V (75%-25%)	m ³	1.9500	2.2100	
a (50%)	m ²	8.0000	8.7200	
t (75%-25%)	mins	160.0000	166.0000	
SOIL INFILTRATION RATE	m/s	2.54E-05	2.54E-05	
DESIGN SOIL INFILTRATION RATE, f	m/s	2.54E-05		



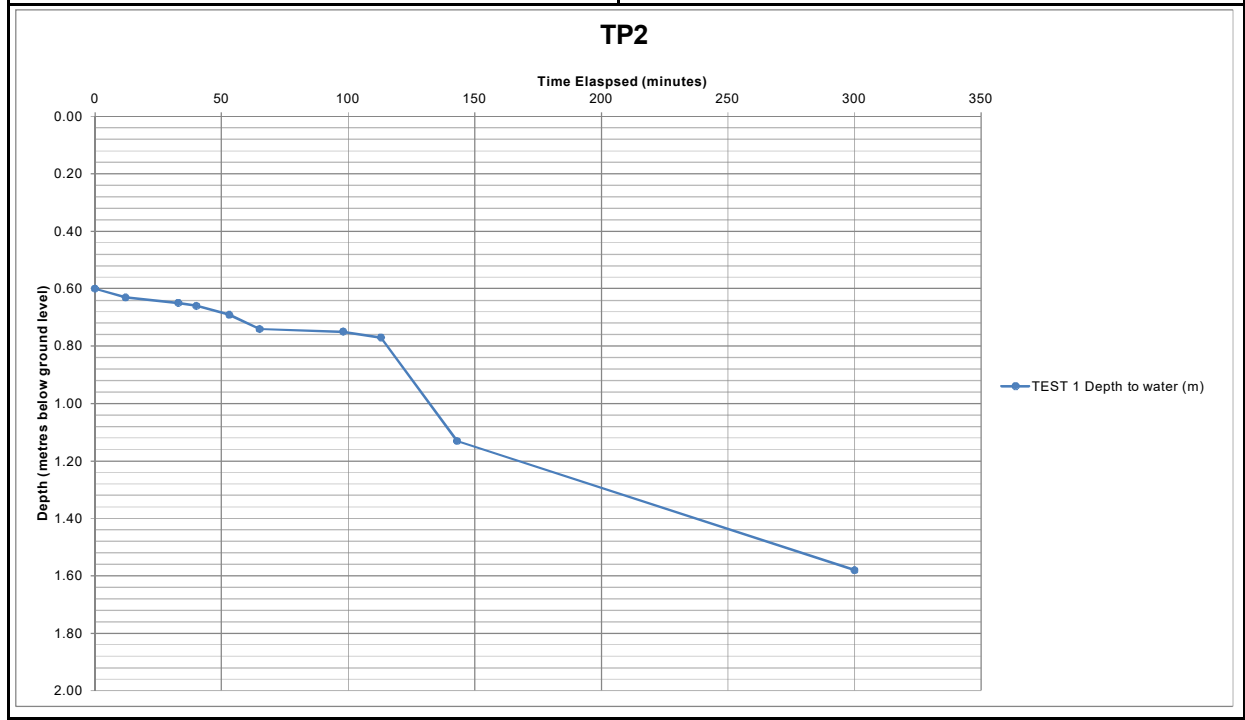




TP2		Length (m)	2.80	
Date	19/04/2018	Width (m)	1.00	
Site	Land Adjacent 17 Brookes Lane	Depth (m)	1.90	SOIL INFILTRATION RATE TEST See B.R.E. Digest 365, 2007, Soakaway Design.
Job Number	KRS.0356.001	Groundwater Level (mbgl)	Dry	


Remarks -	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
Soil encountered: TOPSOIL to 0.40mBGL; stony CLAY 1.40mBGL; dark brown CLAY to 1.90mBGL. No groundwater seepages were observed to enter the trial pit.	0	0.60				
	12	0.63				
	33	0.65				
	40	0.66				
	53	0.69				
	65	0.74				
	98	0.75				
	113	0.77				
	143	1.13				
	300	1.58				

Effective Storage Depth	m	1.30		
75% Effective Storage Depth (i.e. depth below GL)	m	0.98		
25% Effective Storage Depth (i.e. depth below GL)	m	0.33		
Effective Storage Depth 75%-25%	m	1.58		
Time to fall to 75% effective depth	mins	120		
Time to fall to 25% effective depth	mins	300		
V (75%-25%)	m ³	1.8200		
a (50%)	m ²	7.7400		
t (75%-25%)	mins	180.0000		
SOIL INFILTRATION RATE	m/s	2.18E-05		
DESIGN SOIL INFILTRATION RATE, f	m/s	2.18E-05		



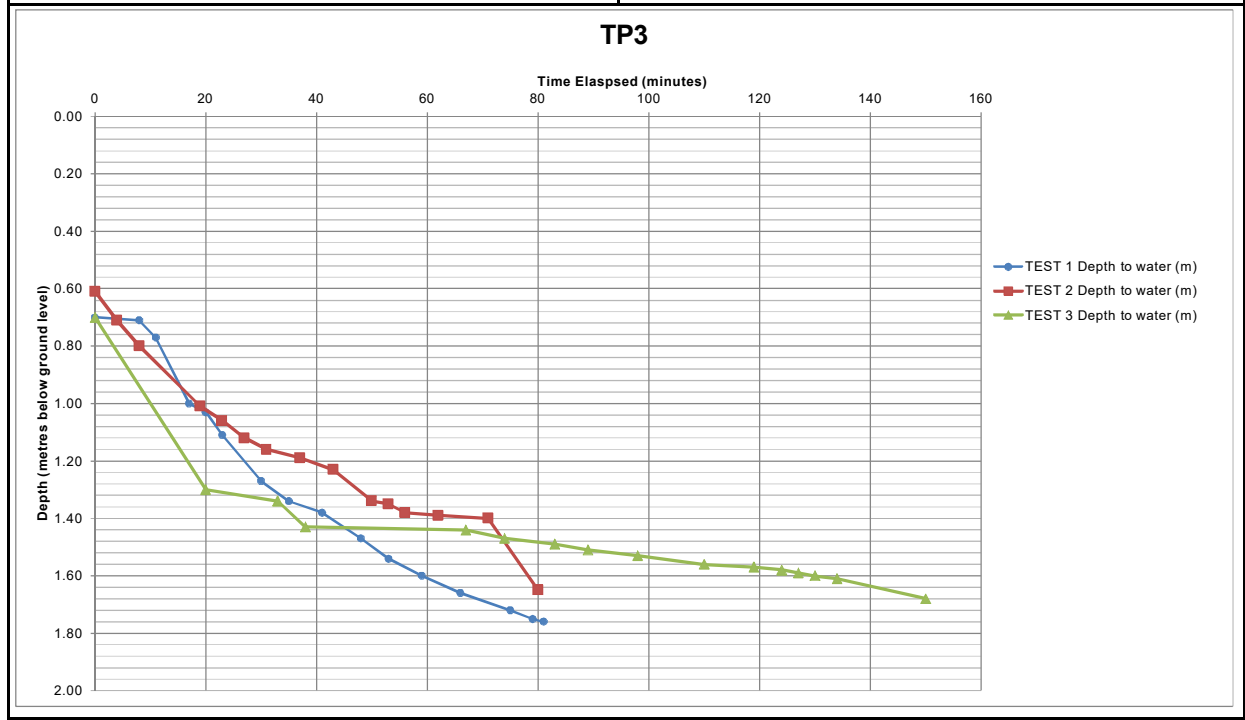




TP3		Length (m)	2.00	
Date	19/04/2018	Width (m)	0.60	
Site	Land Adjacent 17 Brookes Lane	Depth (m)	2.00	SOIL INFILTRATION RATE TEST See B.R.E. Digest 365, 2007, Soakaway Design.
Job Number	KRS.0356.001	Groundwater Level (mbgl)	Dry	

Remarks -	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
Soil encountered: Topsoil to 0.40mBGL; stony CLAY 1.50mBGL; shale to 2.00mBGL. No groundwater seepages were observed to enter the trial pit.	0	0.70	0	0.610	0	0.700
	8	0.71	4	0.710	20	1.300
	11	0.77	8	0.800	33	1.340
	17	1.00	19	1.010	38	1.430
	20	1.03	23	1.060	67	1.440
	23	1.11	27	1.120	74	1.470
	30	1.27	31	1.160	83	1.490
	35	1.34	37	1.190	89	1.510
	41	1.38	43	1.230	98	1.530
	48	1.47	50	1.340	110	1.560
	53	1.54	53	1.350	119	1.570
	59	1.60	56	1.380	124	1.580
	66	1.66	62	1.390	127	1.590
	75	1.72	71	1.400	130	1.600
	79	1.75	80	1.650	134	1.610
	81	1.76			150	1.680

Effective Storage Depth	m	1.30	1.39	1.30
75% Effective Storage Depth (i.e. depth below GL)	m	0.98	1.04	0.98
25% Effective Storage Depth (i.e. depth below GL)	m	1.03	0.96	1.03
Effective Storage Depth 75%-25%	m	0.33	0.35	0.33
Time to fall to 75% effective depth	mins	17	19	20
Time to fall to 25% effective depth	mins	81	80	150
V (75%-25%)	m ³	0.7800	0.8340	0.7800
a (50%)	m ²	4.5800	4.8140	4.5800
t (75%-25%)	mins	64.0000	61.0000	130.0000
SOIL INFILTRATION RATE	m/s	4.44E-05	4.73E-05	2.18E-05
DESIGN SOIL INFILTRATION RATE, f	m/s	3.78E-05		







APPENDIX 7 – Proposed Drainage Layout

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER ARCHITECT'S AND ENGINEER'S DRAWINGS AND SPECIFICATIONS.
2. HOUSE SOAKAWAYS (5 No.) TO BE A MINIMUM OF 5m AWAY FROM BUILDINGS AND A MINIMUM OF 1m ABOVE GROUNDWATER LEVEL.
3. THE LAYOUT SHOWN IS INDICATIVE. MANHOLES, INSPECTION CHAMBERS AND RODDING ACCESSES SHOULD BE CO ORDINATED TO AVOID FOOTPATHS, PATIOS, FENCES, WALLS, HEDGES, ETC. CO ORDINATE COVERS WITH LANDSCAPING. COVERS SHALL NOT BE PART IN HARD/SOFT LANDSCAPING.
4. MANHOLE COVER LEVELS INDICATED ON THE MANHOLE SCHEDULE ARE INDICATIVE ONLY AND SHOULD BE SO ORDINATED TO SUIT EXTERNAL LANDSCAPING FINISHES AND LEVELS.
5. ALL NEW FOUL AND SURFACE WATER DRAINAGE TO BE PVC TO BS EN 1401-1:2009 OR VCW TO BS EN 295.
6. ALL MANHOLE COVERS WITHIN ROADS AND VEHICLE ACCESSIBLE AREAS TO BE C250.
7. ALL MANHOLE COVERS WITHIN PEDESTRIAN AREAS TO BE B125. ALL MANHOLE COVERS WITHIN PAVING/POROUS PAVING TO BE INFILL TYPE.
8. ALL FOUL WATER MANHOLE COVERS TO BE DOUBLE SEALED.
9. ALL FOUL WATER BRANCH DRAINAGE TO BE 100Ø AT A GRADIENT OF 1:40 UNLESS NOTED OTHERWISE.
10. ALL SURFACE WATER BRANCH DRAINAGE TO BE 100Ø AT A GRADIENT OF 1:100 UNLESS NOTED OTHERWISE.
11. REFER TO MANHOLE SCHEDULE FOR SIZES AND GRADIENTS OF MAIN DRAINAGE.
12. CONTRACTOR TO LOCATE ALL EXISTING DRAINAGE RUNS AND SERVICES PRIOR TO COMMENCING WORKS. REFER TO PROJECT NOTES.
13. ALL REDUNDANT DRAINAGE TO BE REMOVED OR INFILLED, AS AGREED WITH BCO.
14. WE NOTE THAT OTHER DRAINS MAY EXIST ON THE SITE. REDUNDANT DRAINS CAN BE REMOVED OR FILLED AS AGREED WITH BCO. LIVE DRAINS ARE TO RETAINED OR DIVERTED.
15. THE LOCATION OF FEATURES ARE INDICATIVE AND SHALL BE CONFIRMED BY THE CONTRACTOR TO SUIT OTHER PROJECT REQUIREMENTS.
16. ALL DRAIN RUNS TO BE AIR TESTED AND CCTV SURVEYED ON COMPLETION/HANDOVER.

FOUL WATER CONNECTION
FINAL CONNECTION TO PUBLIC SEWER.
CONNECTION TO BE APPROVED BY
UNITED UTILITIES UNDER SECTION 106
CONNECTION AGREEMENT

30

Footpath Link to Clitheroe Road

EXISTING 225Ø PUBLIC COMBINED SEWER

Extent of Sewer Easement

Courtyard Turning Facility

Haweswater Aquaduct
6.5m Easement
Additional 3.5m Stand-off



PROPOSED FOUL DRAINAGE 1:500

17

19

21

PROPOSED FOUL DRAINAGE					
MH No.	MH SIZE(mm)	PIPE DIA(mm)	GRADIENT 1:	COVER SIZE(mm)	COVER TYPE
F1	450Ø	100	40	450x450	C250
F2	450Ø	100	40	450x450	C250
F3	450Ø	100	40	450x450	C250
F4	450Ø	100	40	450x450	C250
F5	450Ø	100	40	450x450	C250
F6	450Ø	100	40	450x450	C250
F7	450Ø	100	40	450x450	C250
F8	450Ø	100	40	450x450	C250

KEY
 NEW FOUL WATER SEWER & IC
 EXISTING PUBLIC SEWER

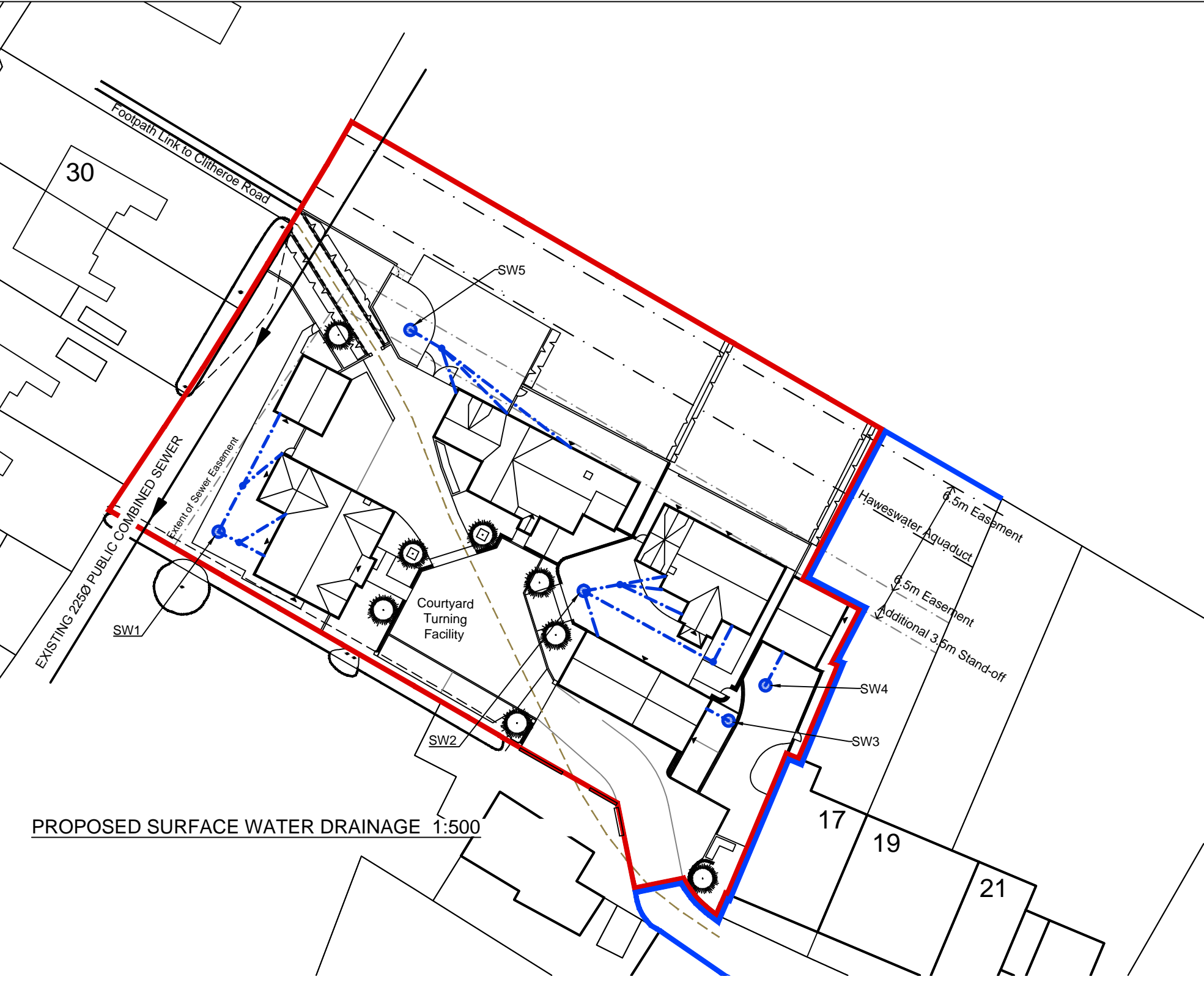
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Job:	BROOKES LANE WHALLEY	
Client:	CATHY BOLTON	
Drawing Title:	FOUL DRAINAGE	
Date:	17.05.2018	
Drawing No:	KRS.0356.001.01	revision:
Scale:	1:500@A3	
Drawn:	AP	
Status:		

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER ARCHITECT'S AND ENGINEER'S DRAWINGS AND SPECIFICATIONS.
2. HOUSE SOAKAWAYS (5 No.) TO BE A MINIMUM OF 5m AWAY FROM BUILDINGS AND A MINIMUM OF 1m ABOVE GROUNDWATER LEVEL.
3. THE LAYOUT SHOWN IS INDICATIVE. MANHOLES, INSPECTION CHAMBERS AND RODDING ACCESSES SHOULD BE CO ORDINATED TO AVOID FOOTPATHS, PATIOS, FENCES, WALLS, HEDGES, ETC. CO ORDINATE COVERS WITH LANDSCAPING. COVERS SHALL NOT BE PART IN HARD/SOFT LANDSCAPING.
4. MANHOLE COVER LEVELS INDICATED ON THE MANHOLE SCHEDULE ARE INDICATIVE ONLY AND SHOULD BE SO ORDINATED TO SUIT EXTERNAL LANDSCAPING FINISHES AND LEVELS.
5. ALL NEW FOUL AND SURFACE WATER DRAINAGE TO BE PVC TO BS EN 1401-1:2009 OR VCW TO BS EN 295.
6. ALL MANHOLE COVERS WITHIN ROADS AND VEHICLE ACCESSIBLE AREAS TO BE C250.
7. ALL MANHOLE COVERS WITHIN PEDESTRIAN AREAS TO BE B125. ALL MANHOLE COVERS WITHIN PAVING/POROUS PAVING TO BE INFILL TYPE.
8. ALL FOUL WATER MANHOLE COVERS TO BE DOUBLE SEALED.
9. ALL FOUL WATER BRANCH DRAINAGE TO BE 100Ø AT A GRADIENT OF 1:40 UNLESS NOTED OTHERWISE.
10. ALL SURFACE WATER BRANCH DRAINAGE TO BE 100Ø AT A GRADIENT OF 1:100 UNLESS NOTED OTHERWISE.
11. REFER TO MANHOLE SCHEDULE FOR SIZES AND GRADIENTS OF MAIN DRAINAGE.
12. CONTRACTOR TO LOCATE ALL EXISTING DRAINAGE RUNS AND SERVICES PRIOR TO COMMENCING WORKS. REFER TO PROJECT NOTES.
13. ALL REDUNDANT DRAINAGE TO BE REMOVED OR INFILLED, AS AGREED WITH BCO.
14. WE NOTE THAT OTHER DRAINS MAY EXIST ON THE SITE. REDUNDANT DRAINS CAN BE REMOVED OR FILLED AS AGREED WITH BCO. LIVE DRAINS ARE TO RETAINED OR DIVERTED.
15. THE LOCATION OF FEATURES ARE INDICATIVE AND SHALL BE CONFIRMED BY THE CONTRACTOR TO SUIT OTHER PROJECT REQUIREMENTS.
16. ALL DRAIN RUNS TO BE AIR TESTED AND CCTV SURVEYED ON COMPLETION/HANDOVER.



PROPOSED SURFACE WATER DRAINAGE 1:500

BRE365 Concrete Ring Soakaway Calculations per SW1, SW2 and SW5

Return Period (years)	Impermeable Area (m ²)	Ring Diameter (mm)	Side Length (m)	Depth (m)	Void Ratio (%)	Required Volume (m ³)	Actual Volume (m ³)	Half Emptying Time
10 + 40%	200	1800	3.60	2.40	65	13.60	22.40	Ok
30 + 40%						17.20		Ok
100 + 40%						22.40		Ok

BRE365 Concrete Ring Soakaway Calculations per SW3 and SW 4

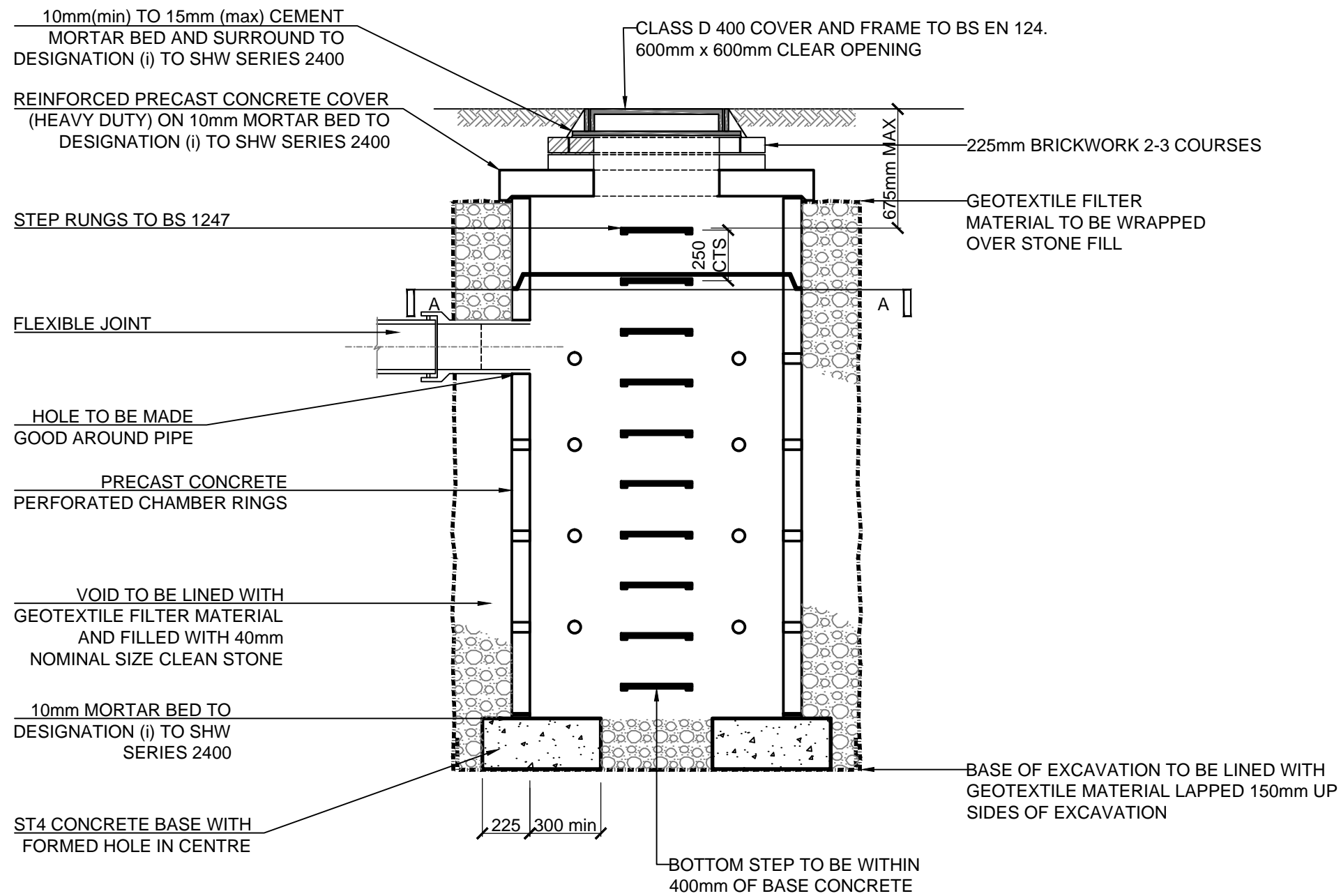
Return Period (years)	Impermeable Area (m ²)	Ring Diameter (mm)	Side Length (m)	Depth (m)	Void Ratio (%)	Required Volume (m ³)	Actual Volume (m ³)	Half Emptying Time
10 + 40%	50	1000	1.80	2.50	65	3.30	6.00	Ok
30 + 40%						4.20		Ok
100 + 40%						5.50		Ok

- KEY
- NEW SURFACE WATER SEWER & IC
 - NEW SURFACE WATER SEWER & SOAKAWAY

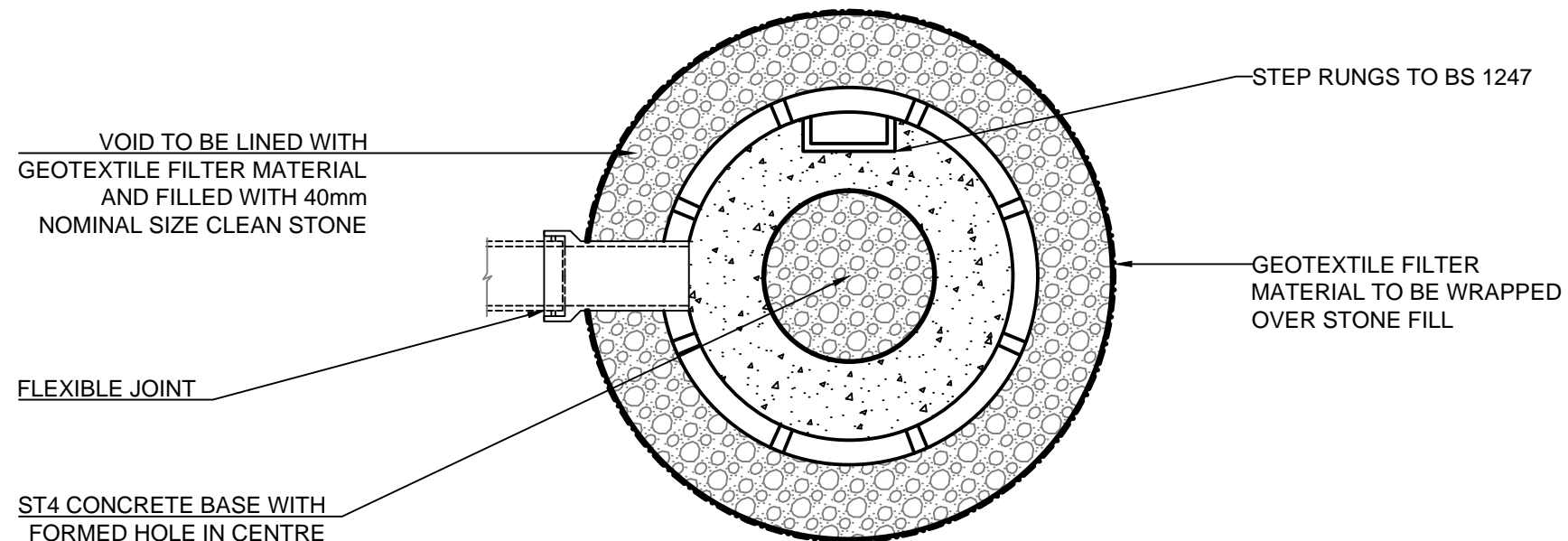
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Job:	BROOKES LANE WHALLEY	
Client:	CATHY BOLTON	
Drawing Title:	SURFACE WATER DRAINAGE	
Date:	17.05.2018	
Drawing No:	KRS.0356.001.02	revision:
Scale:	1:500@A3	
Drawn:	AP	
Status:		



PRECAST CONCRETE SOAKAWAY 1:25



SECTION A-A 1:25

NOTES.

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CHAMBER SIZE TO BE THE LARGEST POSSIBLE IN THE AREA AVAILABLE.
3. STORAGE CAPACITY TO BE BASED ON 100% RUN OFF FROM SURROUNDING IMPERMEABLE AREA.
4. SOAKAGE TESTS IN ACCORDANCE WITH BRE DIGEST 365 ARE REQUIRED PRIOR TO CONSTRUCTION. SOAKAGE RATE FOR THE TRIAL TO BE THREE TIMES THE DESIGN RATE.
5. NO PART OF THE SOAKAWAY MAY FALL BENEATH THE CARRIAGEWAY OR FOOTWAY.
6. COVER AND FRAME TO BE CLASS D400 BADGEMARKED HD AND KITEMARKED AND HAVE A PROTECTIVE COATING COMPLYING WITH BS EN 124:1994. IN AREAS OF BLOCK PAVING AN 'INFILL' TYPE COVER MAY BE REQUIRED.
7. BLOCKS TO BE ENGINEERING CLASS B LAID IN ENGLISH BOND IN MORTAR TO DESIGNATION (i) TO SHW SERIES 2400.
8. PRECAST CONCRETE CHAMBERS SHALL COMPLY WITH BS 5911 PART 200.
9. PERFORATIONS TO BE 40mmØ AT 450mm CTS.
10. TOP RING MAY BE UNPERFORATED.
11. FINISH TO INTERNAL CONCRETE TO BE F1 ON FORMED SURFACES AND U2 ON UNFORMED SURFACES.
12. ENDS OF PIPES SHALL BE NEATLY BUILT INTO CHAMBER AND FINISHED FLUSH WITH CLASS 1 MORTAR.
13. THE NEAREST JOINTS TO CHAMBER SHALL NOT BE RESTRICTED BY CONCRETE.
14. PETROL INTERCEPTORS MAY BE REQUIRED WHERE SOAKAWAYS ARE USED.
15. CHAMBERS MORE THAN 3m DEEP MUST BE PROVIDED WITH GALVANISED LADDERS.
16. SURFACE LEVEL TOLERANCE +0 -6 IN PAVED AREAS, +15 -15 IN VERGES.

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Job: BROOKES LANE WHALLEY

Client: CATHY BOLTON

Drawing Title: DRAINAGE DETAILS SHEET 1

Date: 17.05.2018

Drawing No: KRS.0356.001.03 revision:

Scale: 1:25@A3

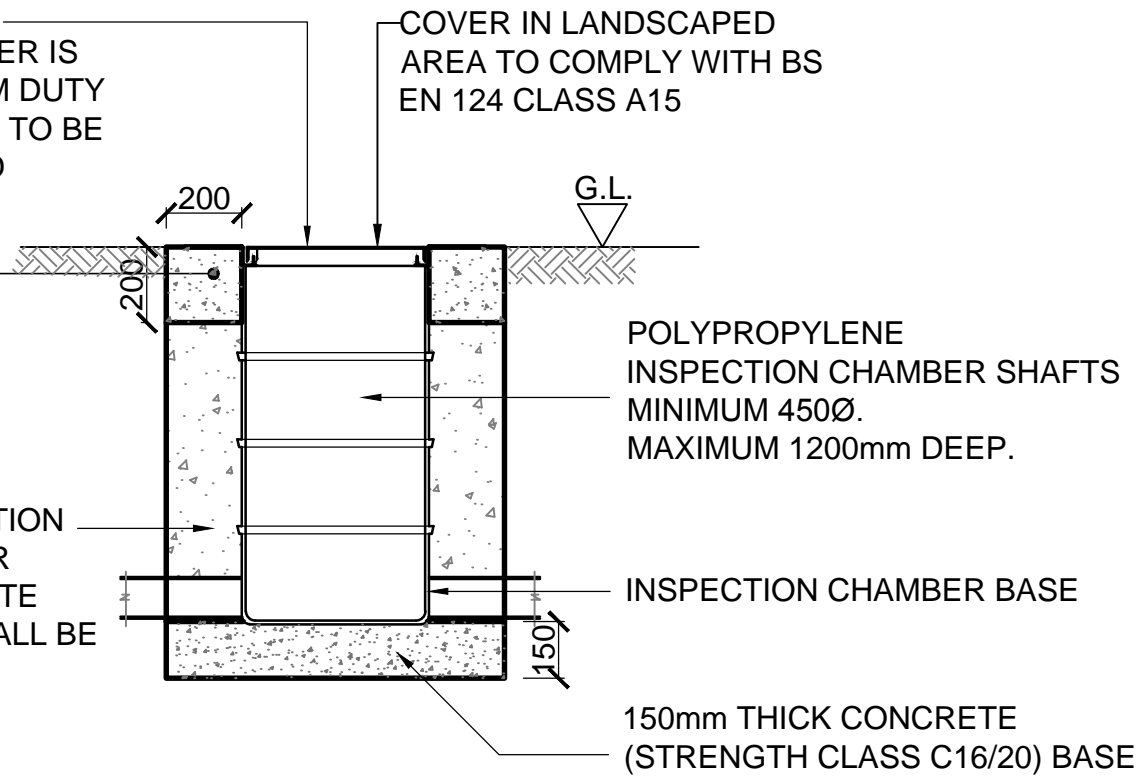
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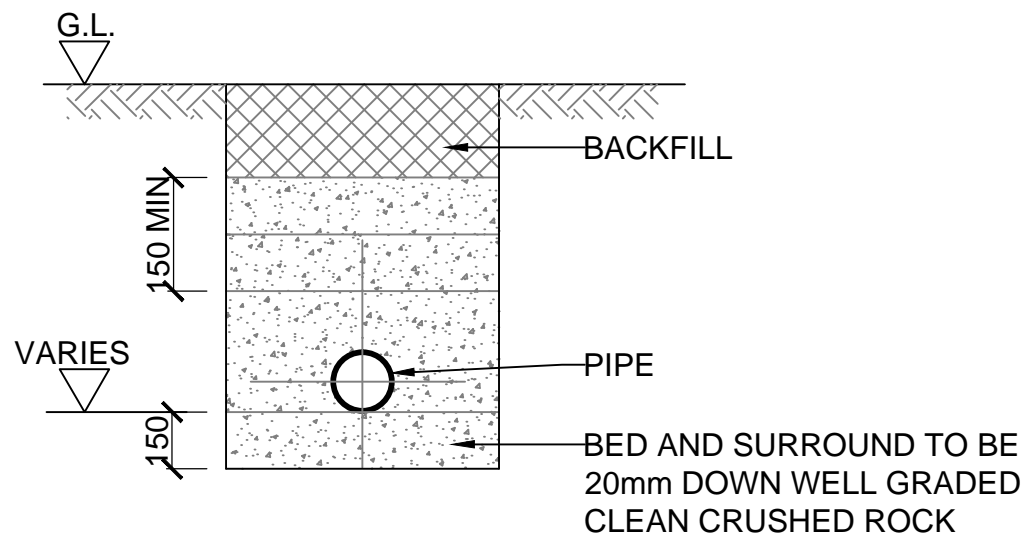
NOTE: IF ANY MANHOLE IS TO BE POSITIONED IN PARKING AREA THEN COVER IS TO BE CLASS B125 TO BS EN B124 MEDIUM DUTY 12.5 TONNE SAFE WORKING LOAD. FRAME TO BE SET IN 200x200mm CONCRETE SURROUND

200 WIDE X 225 DEEP CONCRETE (STRENGTH CLASS C16/20) SURROUND TO COVER. CONCRETE TO HAVE A SMOOTH TROWELLED FINISH, FLUSH TO SURROUNDING GROUND, AND ALL TEMPORARY FORMWORK REMOVED

DOT TYPE 1 SUB BASE OR WHERE INSPECTION CHAMBER IS WITHIN 3M OF A ROADWAY OR VEHICLE ACCESS A 150mm THICK CONCRETE (STRENGTH CLASS C16/20) SURROUND SHALL BE INSTALLED TO FULL DEPTH



**POLYPROPYLENE INSPECTION CHAMBER
DETAIL (MAX 1200mm DEEP) 1:20**



CLASS S BEDDING FACTOR 1:20

NOTES:

1. INVERT LEVELS AND POSITIONS OF EXISTING DRAINS/CHAMBERS/SEWERS WHERE NEW CONNECTIONS ARE TO BE MADE MUST BE CHECKED AND CONFIRMED TO THE ENGINEER PRIOR TO THE COMMENCEMENT OF ANY WORKS.
2. ALL DRAINAGE WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH THE REQUIREMENTS OF THE LOCAL AUTHORITY AND IN CONJUNCTION WITH ALL RELEVANT BRITISH STANDARDS, CODES OF PRACTICE AND 'SEWERS FOR ADOPTION' 7th EDITION, AND ANY ADDENDUMS AS APPROPRIATE.
3. ALL DRAINAGE SHALL COMPLY WITH THE TYPICAL DETAILS AND THE REQUIREMENTS OF BS EN 752 AND PART H OF THE BUILDING REGULATIONS.
4. ANY PART OF THE EXISTING DRAINAGE SYSTEM TO BE RETAINED AS PART OF THE NEW SCHEME SHALL BE CLEANED AND INSPECTED. ANY STRUCTURAL DEFECTS SHALL BE REPAIRED USING APPROPRIATE AND APPROVED MEANS.
5. FOR SETTING OUT DIMENSIONS OF SVPS, RWP'S ETC., REFER TO ARCHITECT'S OR MECHANICAL ENGINEER'S DRAWINGS. POSITIONS SHOWN ARE INDICATIVE AND SUBJECT TO FINAL DESIGN.
6. ALL FOUL AND RWP CONNECTIONS SHALL BE 100mm DIAMETER UNLESS OTHERWISE SPECIFIED.
7. ALL PRECAST CONCRETE UNITS USED IN THE DRAINAGE WORKS SHALL BE MANUFACTURED USING SULPHATE RESISTING CEMENT.
8. MANHOLE COVERS AND FRAMES SHALL BE TO BS EN 124 AND SHALL BE KITEMARKED COVERS AND FRAMES SHALL BE MEDIUM DUTY B125 IN DRIVEWAYS AND VEHICULAR AREAS AND LIGHT DUTY A15 IN FOOTWAYS AND SOFT LANDSCAPING. IN BLOCKED/ CONCRETE PAVED AREAS COVERS SHALL BE RECESSED FABRICATED STEEL. ALL RECESSED COVERS SHALL BE IN ACCORDANCE WITH THE FACTA ASSOCIATION GRADINGS.
9. COVER LEVELS ARE TO BE ADJUSTED LOCALLY TO SUIT FINISHED GROUND LEVELS.
10. ALL MANHOLES/INSPECTION CHAMBERS IN BLOCK PAVED AREAS ARE TO HAVE RECESSED COVERS. MH COVERS IN PAVED AREAS ARE TO HAVE COVER AND FRAME ORIENTATED 'SQUARE' WITH PAVING TO MINIMISE CUT SLABS OR BLOCKS.
11. ALL DRAINAGE TO BE LAID TO LEVELS SHOWN USING FLEXIBLY JOINTED PIPES, EITHER UPVC TO BS 4660 AND BS 5481 OR VITRIFIED CLAYWARE TO BS EN 295.
12. RODDING EYES, ETC, ARE TO BE LAID TO MANUFACTURERS' MINIMUM COVER AND DEPTH TO ALLOW ADEQUATE FALL FROM ADJOINING UNIT.
13. ALL NEW DRAINAGE TO BE JETTED AND CCTV SURVEYED ON COMPLETION. CONTRACTOR TO MAKE SURE THAT THE DRAINAGE IS FULLY OPERATIONAL.
14. ALL RUNS CONNECTING INTO THE PUBLIC DRAINAGE NETWORK TO BE VITRIFIED CLAY, EXTRA LENGTH TO BS EN 295 OR BS65 WITH PLAIN SLEEVED OR SOCKETED FLEXIBLE JOINTS.

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Job: BROOKES LANE WHALLEY

Client: CATHY BOLTON

Drawing Title: DRAINAGE DETAILS SHEET 2

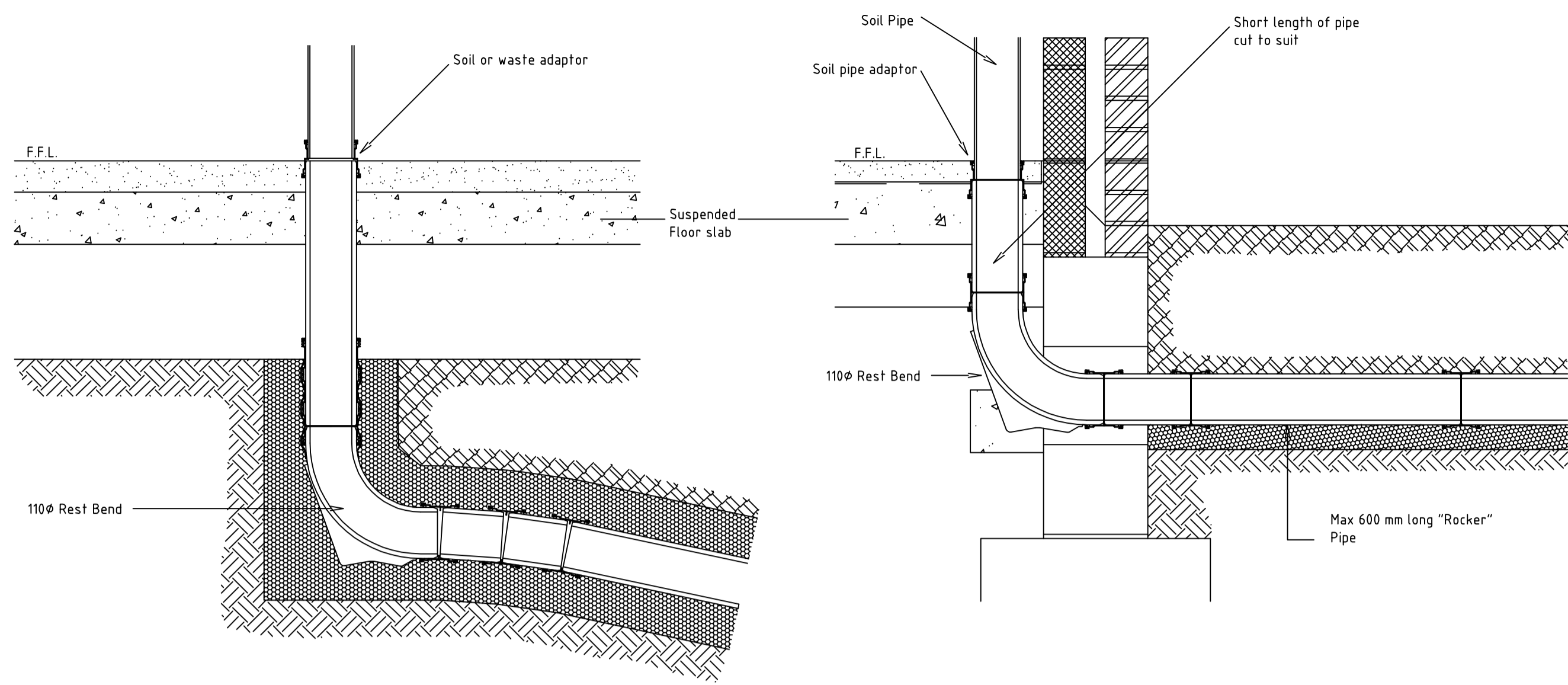
Date: 30.05.2018

Drawing No: KRS.0356.001.04 revision:

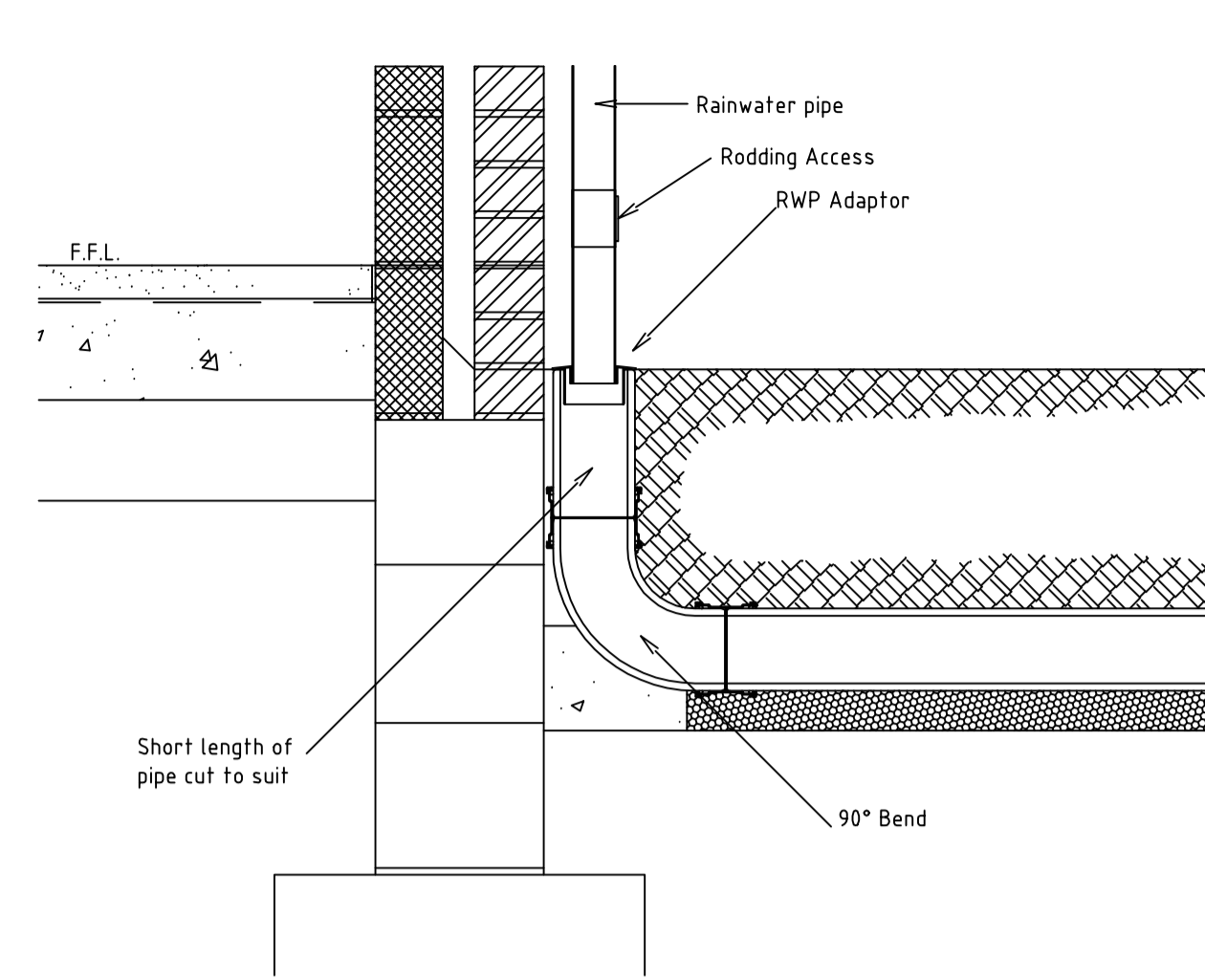
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Drawn: AP

Status:



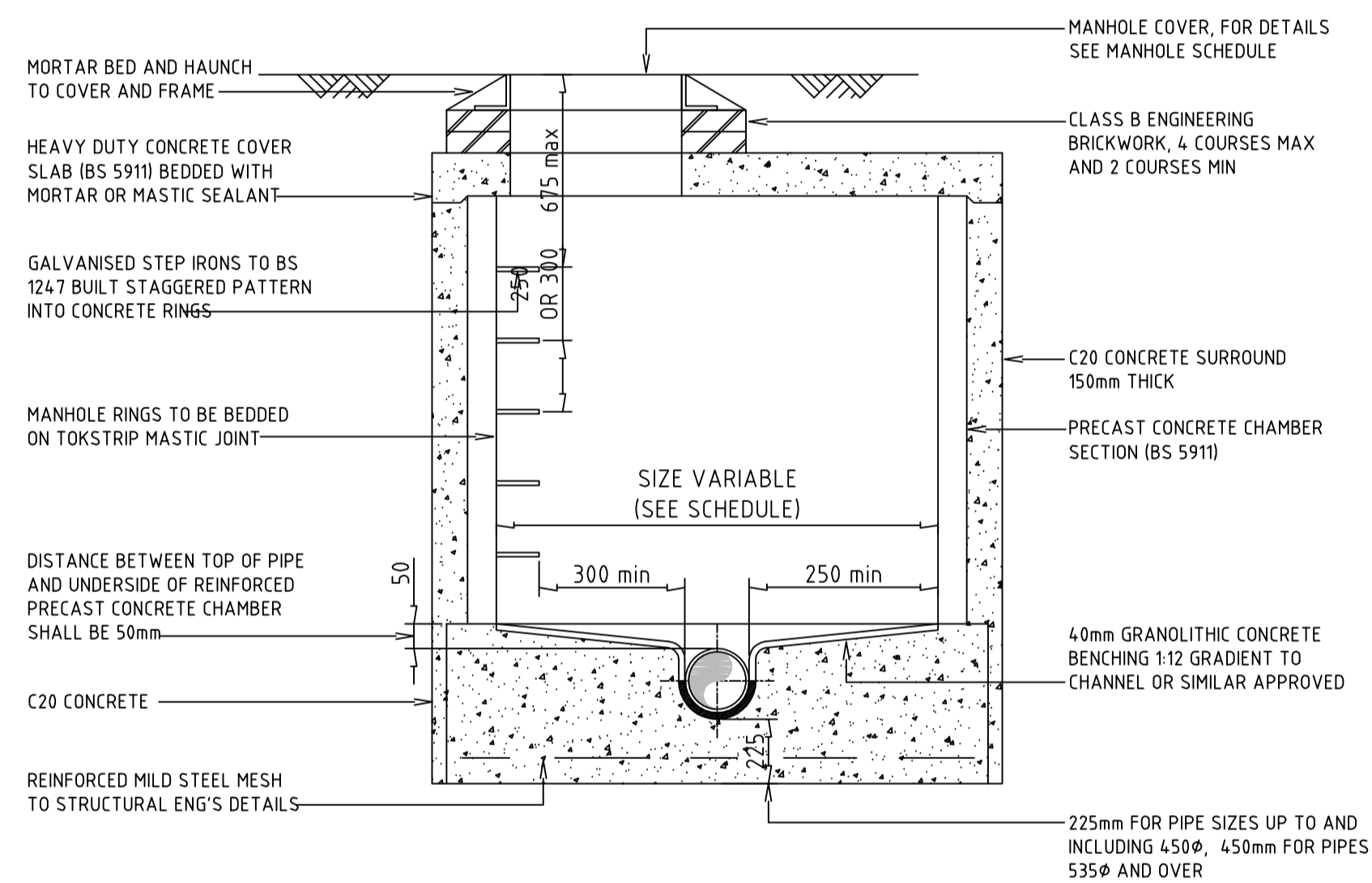
TYPICAL 110 ϕ SVP / WP DRAIN CONNECTIONS



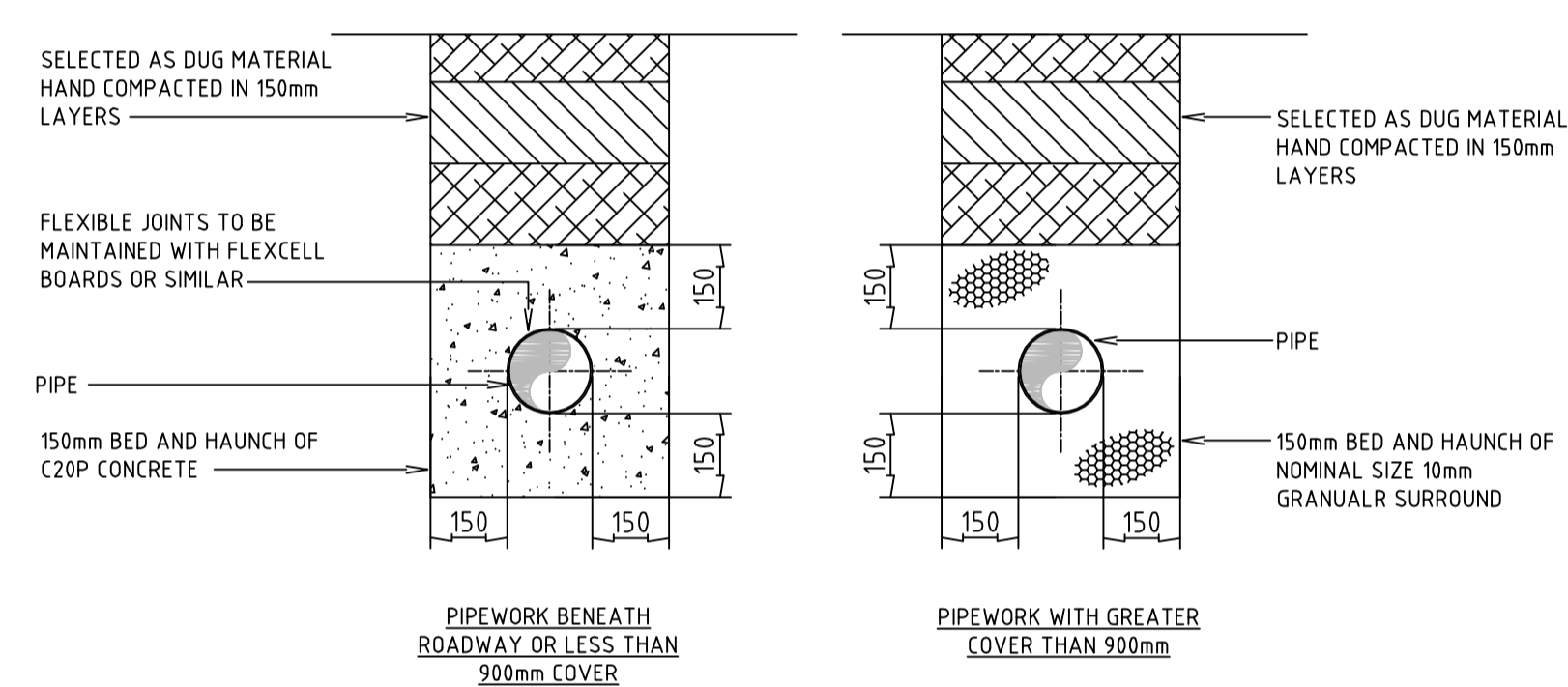
TYPICAL EXTERNAL RWP CONNECTION

NOTES:

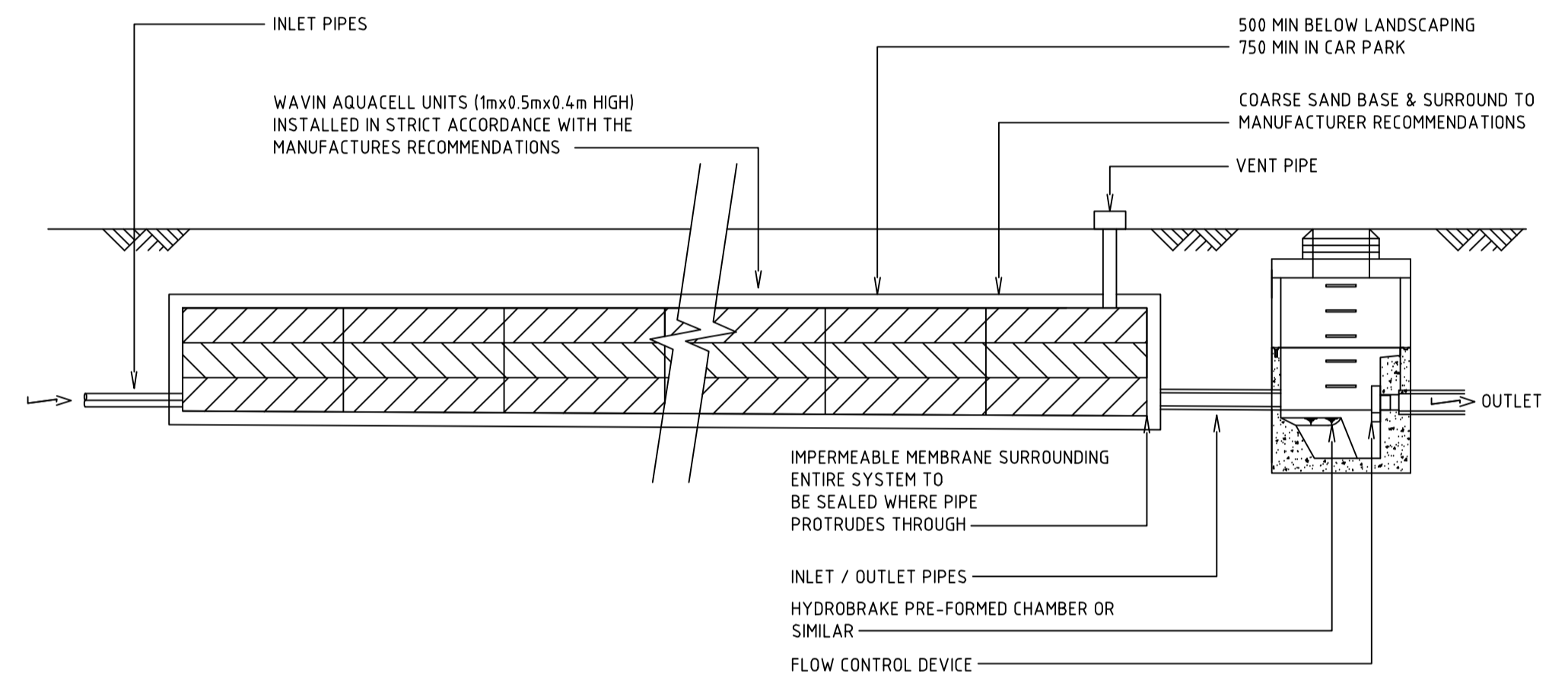
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. MANHOLES IN ACCORDANCE WITH THE DRAINAGE SPECIFICATION
3. WHEN DEPTH OF COVER LEVEL TO TOP OF BENCHING EXCEEDS 900mm STEP IRONS TO BS 1247 TO BE PROVIDED
4. INSITU MASS CONCRETE TO BE 40N/mm²
5. COVER SLABS AND ALL REINFORCED CONCRETE TO BE 30N/mm²
6. ALL EXTERNAL MANHOLE COVER FRAMES SHALL BE BEDDED ON TWO TO FOUR COURSES AS NECESSARY OF CLASS 'B' ENGINEERING BRICKS & HAUNCHED IN CEMENT MORTAR 1:3.
7. ALL PRE-CAST CONCRETE COMPONENTS SHALL BE IN ACCORDANCE WITH BS 5911 PARTS 100 & 200 (SULPHATE RESISTING CEMENT).
8. ALL MANHOLE COVERS SHALL BE AS SPECIFIED IN THE MANHOLE SCHEDULE.
9. WHERE BENCHING IS LESS THAN 450mm WIDE SLOPE SHALL BE 1 IN 12 WITH 25mm RADIUS.
10. PIPES ENTERING MANHOLES SHALL HAVE A FLEXIBLE JOINT WITHIN 750mm OF THE INSIDE FACE OF THE MANHOLE & JOINING WITH A SHORT ROCKER PIPE (EXCEPT WHERE PIPES ARE CAST WITHIN THICKNESS OF STRUCTURAL GROUND SLAB OR WHERE DRAINAGE IS TIED TO STRUCTURAL SLAB USING 'CLASS 2' BEDDING).
11. ALL CONCRETE MANHOLES AND BENCHING SHALL BE SULPHATE RESISTING CEMENT.
12. ALL OPEN CHANNELS IN MANHOLES SHALL BE CONSTRUCTED USING HALF ROUND CHANNELS. BRANCH CONNECTIONS INTO MANHOLES SHALL BE FORMED USING 3/4 CHANNEL AND SWEEP IN THE DIRECTION OF FLOW, EXCEPT WHERE INDICATED ON THE PLANS.



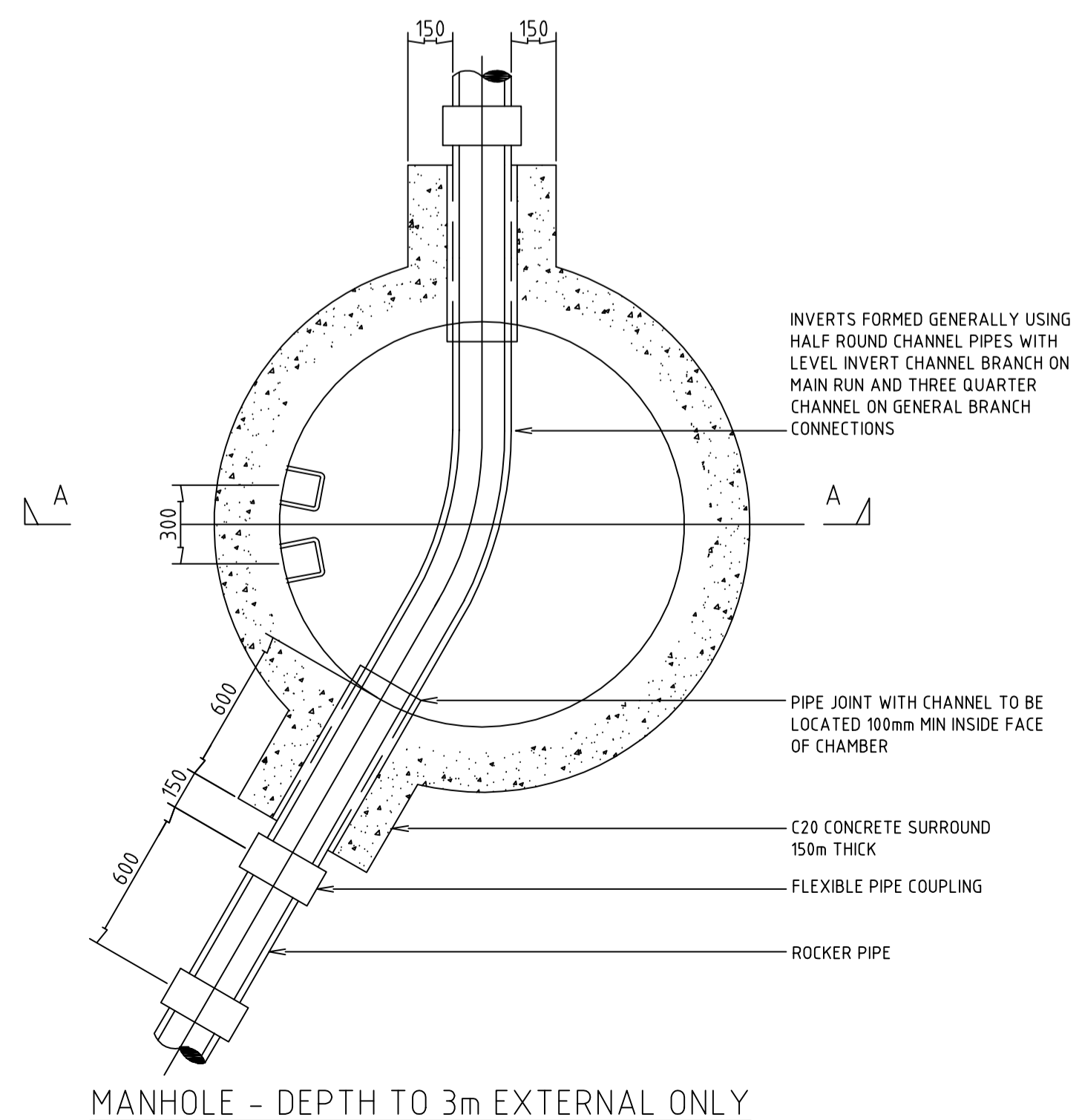
SECTION A-A



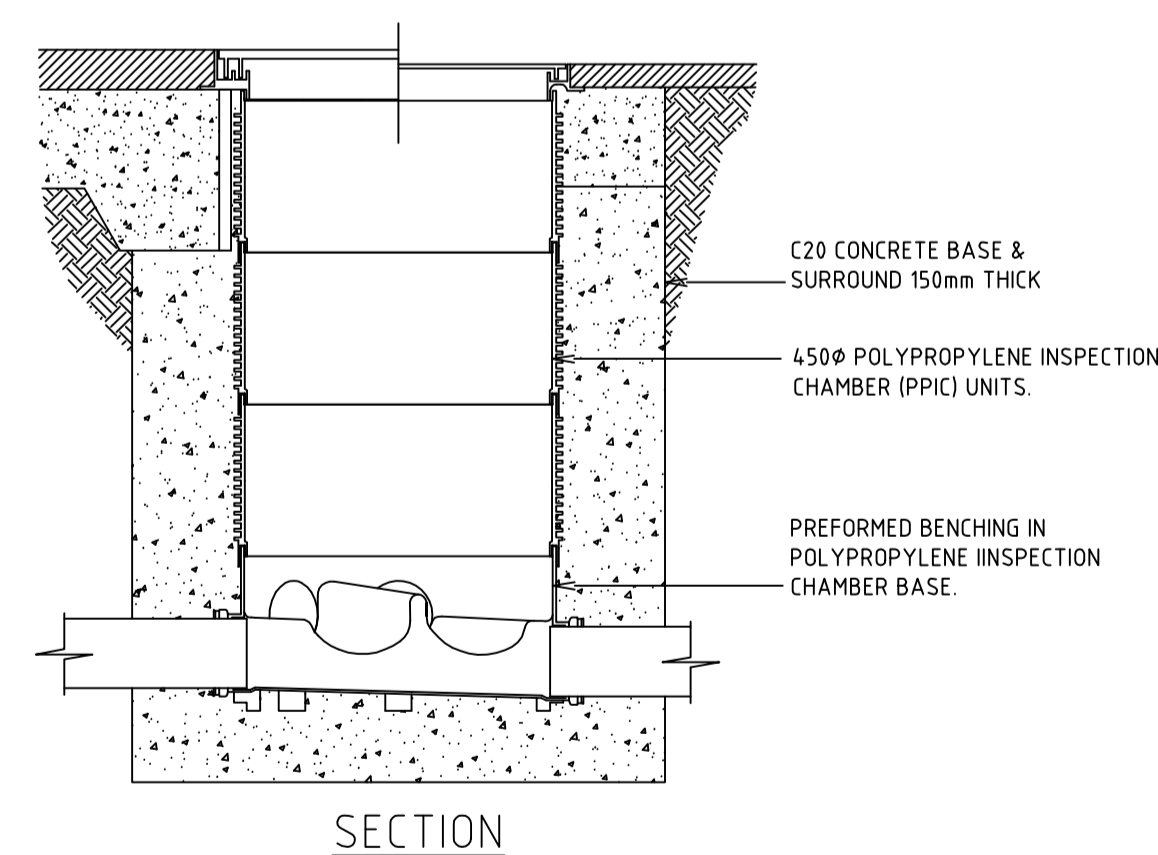
PIPE BEDDING DETAILS



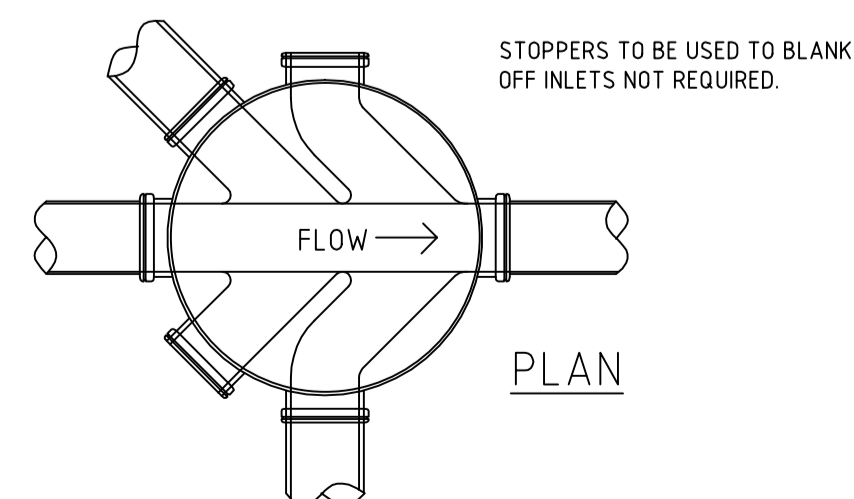
SURFACE WATER RETENTION CHAMBER



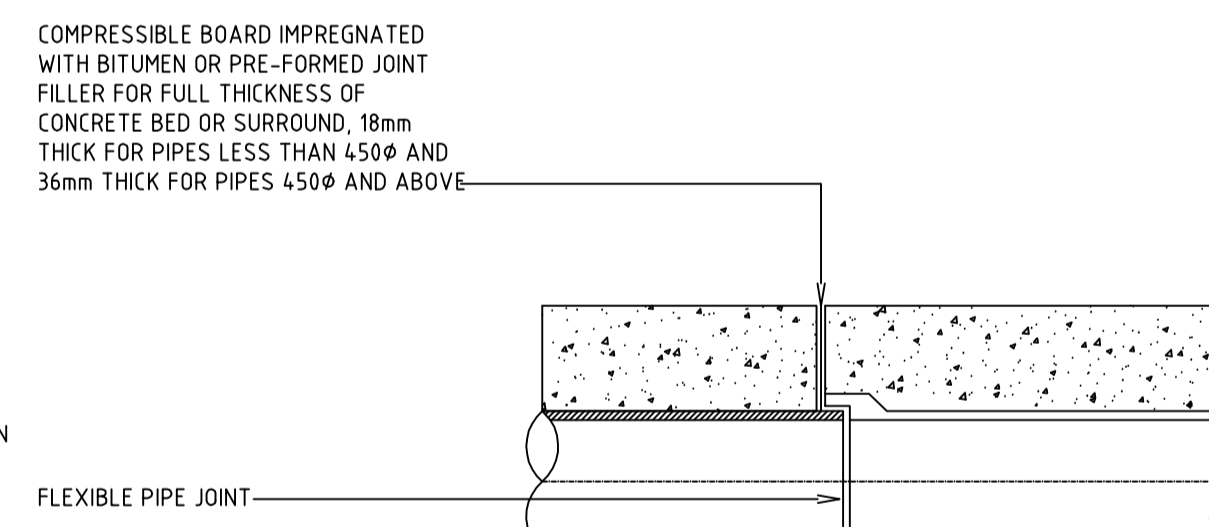
MANHOLE - DEPTH TO 3m EXTERNAL ONLY



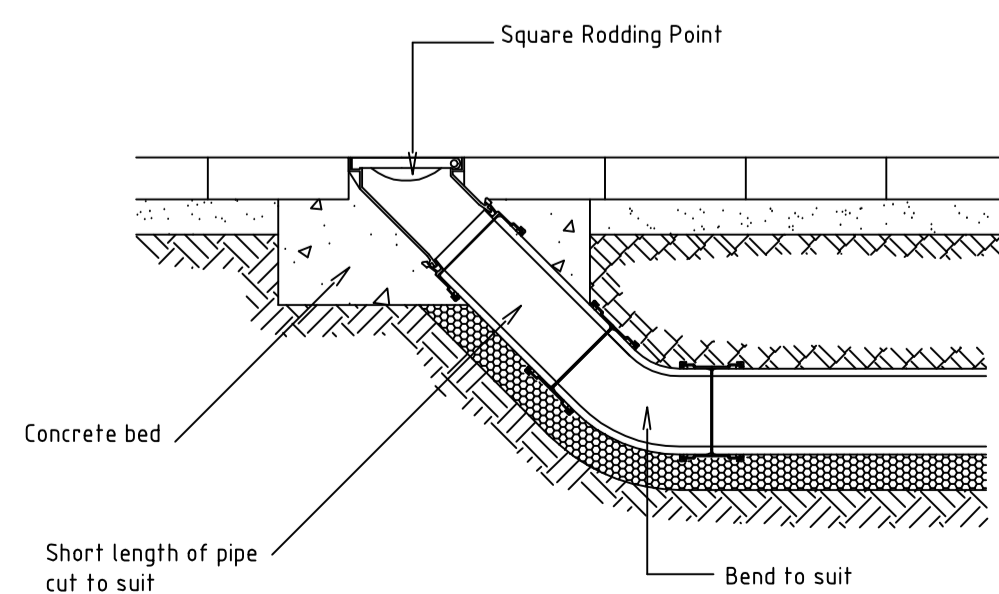
SECTION



450 ϕ INSPECTION CHAMBER



DETAIL OF EXPANSION JOINT FOR CONCRETE BED OR SURROUND



TYPICAL EXTERNAL RODDING EYE DETAIL

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Job: BROOKES LANE WHALLEY

Client: CATHY BOLTON

Drawing Title: DRAINAGE DETAILS SHEET 3

Date: 30.05.2018

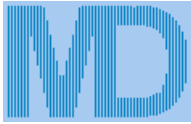
Drawing No: KRS.0356.001.05 revision:

Scale: NTS @ A1

Drawn: AP

Status:

APPENDIX 8 – IoH Method Greenfield Runoff Rates



KRS Environmental Limited.

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Job No.		
Sheet no.	1	
Date	16/05/18	
By	Checked	Reviewed

MasterDrain
HY 10.02

Project	Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG
Title	IoH 124 Method Calculations

Hydrological Data:-

FSR Hydrology:-

Location	= WHALLEY	Grid reference	= SD7335
M5-60 (mm)	= 18.8	r	= 0.30
Soil runoff	= 0.45	SAAR (mm/yr)	= 1060
WRAP	= 4	Area	= England & Wales
Hydrological area	= 10	Hydrological zone	= 7

Soil classification for WRAP type 4
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Design data:-

Area = 0.002046 Km² - 0.205 Ha - 2046 m² % Urbanisation = 0.00%

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(urban)} = Q_{BAR(rural)} (1 + URBAN)^{2NC} [1 + URBAN \{ (21/CIND) - 0.3 \}]$$

where:-

NC varies with the value of SAAR:-

for 500<SAAR<1100 mm then NC = 0.92 - 0.00024SAAR
for 1100<SAAR<3000 mm then NC = 0.74 - 0.000082SAAR

$$CIND = 102.4SOIL + 0.28(CWI - 125) \quad CWI = \text{Catchment Wetness Index}$$

so

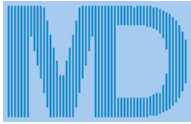
$$CIND = 42.011 \quad CWI = 110.469 \quad NC = 0.666$$

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.004

$$Q_{BAR(rural)} = 1.461 \text{ (l/s)}$$

$$Q_{BAR(urban)} = 1.461 \text{ (l/s)}$$

$Q_{BAR(urban)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.



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Job No.					
Sheet no.	2				
Date	16/05/18				
By		Checked		Reviewed	

Project	Land Adjacent 17 Brookes Lane, Whalley, BB7 9RG
Title	IoH 124 Method Calculations

MasterDrain
HY 10.02

Calculated data:-

Mean Annual Peak Flow $Q_{BAR(urban)} = 1.46 \text{ l/s}$

Values for $Q_{BAR(urban)}$

Ret. per.	m^3/hr	l/s	l/s/ha	Ret. per.	m^3/hr	l/s	l/s/ha
1yr	0.001	1.241	6.068	100yr	0.003	3.067	14.991
2yr	0.001	1.358	6.639	100yr+20%	0.004	3.681	17.989
5yr	0.002	1.767	8.638	100yr+30%	0.004	3.987	19.489
10yr	0.002	2.016	9.851	200yr	0.004	3.505	17.133
30yr	0.002	2.454	11.993	200yr + 30%	0.005	4.557	22.273
50yr	0.003	2.702	13.206	500yr	0.004	3.987	19.489
				1000yr	0.004	4.440	21.701

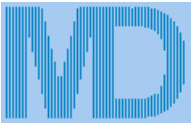
Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7). Note that the 200 year growth curve was taken from W5-074/A.

For WRAP type 1 soils, CIND can become negative for lower values of SAAR. In this case the CIND value is multiplied by -1 to return a positive value (CIND is very small at this point).

APPENDIX 9 – BRE365 Concrete Ring Soakaway Calculations



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Project **Brookes Lane, Whalley**
 Title **1 in 100 Year (+40%) Soakaway Calculations**

Concrete ring design:-

Ring diameter = 1000 mm
 Percentage voids = 65.0
 Climate change = 40%

Return period = 100 yrs
 Imperm. area = 50m²
 Infiltration factor = 0.011376 m/hr

Depth below invert = 2.5m
 Pit side length = 1.8m

Calculations :-

Surface area of soakaway to 50% depth -

$$a_{s50} = \text{Length of side} \times 4 \times \text{Depth}/2 = 9.0 \text{ m}^2 \quad (\text{base not included}).$$

Outflow factor -

$$O_{\text{Fact}} = a_{s50} \times f = 0.102384 \text{ m}^3/\text{s} \quad \text{where Infiltr. factor } (f) = 0.011376 \text{ m/s}$$

Soakaway ring storage volume -

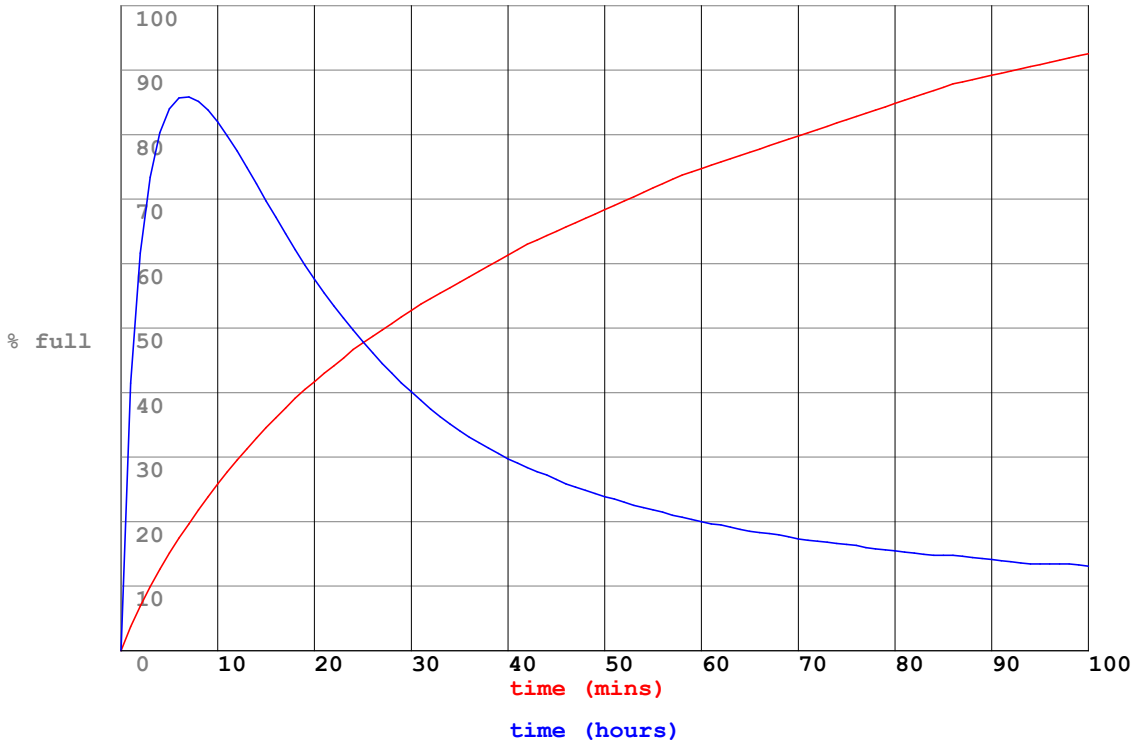
$$S_{\text{actual}} = \text{Pi} \times (\text{Ring diam}/2000)^2 \times \text{depth} = 2.0 \text{ m}^3$$

Gross soakaway pit storage volume -

$$S_{\text{pit}} = \text{Length of side}^2 \times \text{depth} = 8.1 \text{ m}^3$$

Nett soakaway pit storage volume -

$$S_{\text{nett}} = \text{Gross pit volume} - \text{infill (half depth)} = 6.0 \text{ m}^3 \quad (\text{storage} + \text{void})$$



$$\text{Required volume } (S_{\text{reqd}}) = 5.5 \text{ m}^3$$

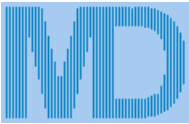
$$\text{Available storage volume} = 6.0 \text{ m}^3$$

$$\text{Spare capacity} = 0.44 \text{ m}^3$$

$$\text{Emptying time to 50\% volume} = \text{N/A hours}$$

Soakaway emptying time OK.

Soakaway dimensions OK.



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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 mins**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	260.17	0.22	0.000	0.22	0.10	4	51	58.83	0.05	0.008	4.11	1.72	4
2	232.94	0.19	0.001	0.41	0.18	7	52	58.13	0.05	0.008	4.15	1.75	7
3	212.25	0.18	0.001	0.59	0.25	10	53	57.45	0.05	0.008	4.19	1.75	10
4	195.87	0.16	0.001	0.75	0.32	13	54	56.79	0.05	0.008	4.23	1.78	13
5	182.52	0.15	0.002	0.90	0.38	15	55	56.15	0.05	0.008	4.27	1.80	15
6	171.38	0.14	0.002	1.04	0.42	17	56	55.53	0.05	0.008	4.31	1.80	17
7	161.92	0.13	0.002	1.17	0.50	20	57	54.92	0.05	0.008	4.35	1.82	20
8	153.77	0.13	0.003	1.30	0.55	22	58	54.33	0.05	0.009	4.39	1.85	22
9	146.64	0.12	0.003	1.42	0.60	24	59	53.75	0.04	0.009	4.42	1.85	24
10	140.36	0.12	0.003	1.54	0.65	26	60	53.19	0.04	0.009	4.45	1.88	26
11	134.77	0.11	0.003	1.65	0.70	28	61	52.64	0.04	0.009	4.48	1.88	28
12	129.75	0.11	0.003	1.76	0.75	30	62	52.10	0.04	0.009	4.51	1.90	30
13	125.14	0.10	0.004	1.86	0.78	31	63	51.58	0.04	0.009	4.54	1.90	31
14	120.74	0.10	0.004	1.96	0.82	33	64	51.07	0.04	0.009	4.57	1.92	33
15	116.72	0.10	0.004	2.06	0.88	35	65	50.58	0.04	0.009	4.60	1.92	35
16	113.01	0.09	0.004	2.15	0.90	36	66	50.09	0.04	0.009	4.63	1.95	36
17	109.59	0.09	0.004	2.24	0.95	38	67	49.62	0.04	0.009	4.66	1.95	38
18	106.42	0.09	0.005	2.33	0.98	39	68	49.15	0.04	0.009	4.69	1.98	39
19	103.46	0.09	0.005	2.41	1.00	40	69	48.70	0.04	0.009	4.72	1.98	40
20	100.70	0.08	0.005	2.48	1.05	42	70	48.25	0.04	0.009	4.75	2.00	42
21	98.12	0.08	0.005	2.56	1.08	43	71	47.82	0.04	0.009	4.78	2.00	43
22	95.70	0.08	0.005	2.63	1.10	44	72	47.39	0.04	0.009	4.81	2.02	44
23	93.42	0.08	0.005	2.70	1.12	45	73	46.98	0.04	0.009	4.84	2.02	45
24	91.28	0.08	0.005	2.78	1.18	47	74	46.57	0.04	0.010	4.87	2.05	47
25	89.25	0.07	0.006	2.84	1.20	48	75	46.17	0.04	0.010	4.90	2.05	48
26	87.33	0.07	0.006	2.90	1.22	49	76	45.78	0.04	0.010	4.93	2.08	49
27	85.50	0.07	0.006	2.96	1.25	50	77	45.39	0.04	0.010	4.96	2.08	50
28	83.77	0.07	0.006	3.02	1.28	51	78	45.02	0.04	0.010	4.99	2.10	51
29	82.13	0.07	0.006	3.08	1.30	52	79	44.65	0.04	0.010	5.02	2.10	52
30	80.56	0.07	0.006	3.14	1.32	53	80	44.29	0.04	0.010	5.05	2.12	53
31	79.07	0.07	0.006	3.20	1.35	54	81	43.93	0.04	0.010	5.08	2.12	54
32	77.64	0.06	0.006	3.25	1.38	55	82	43.58	0.04	0.010	5.11	2.15	55
33	76.27	0.06	0.006	3.30	1.38	55	83	43.24	0.04	0.010	5.14	2.15	55
34	74.96	0.06	0.007	3.35	1.40	56	84	42.91	0.04	0.010	5.17	2.18	56
35	73.71	0.06	0.007	3.40	1.42	57	85	42.58	0.04	0.010	5.20	2.18	57
36	72.50	0.06	0.007	3.45	1.45	58	86	42.25	0.04	0.010	5.23	2.20	58
37	71.35	0.06	0.007	3.50	1.48	59	87	41.94	0.03	0.010	5.25	2.20	59
38	70.23	0.06	0.007	3.55	1.50	60	88	41.63	0.03	0.010	5.27	2.22	60
39	69.16	0.06	0.007	3.60	1.50	60	89	41.32	0.03	0.010	5.29	2.22	60
40	68.13	0.06	0.007	3.65	1.52	61	90	41.02	0.03	0.010	5.31	2.22	61
41	67.13	0.06	0.007	3.70	1.55	62	91	40.72	0.03	0.010	5.33	2.25	62
42	66.17	0.06	0.007	3.75	1.58	63	92	40.43	0.03	0.010	5.35	2.25	63
43	65.25	0.05	0.007	3.79	1.60	64	93	40.14	0.03	0.010	5.37	2.25	64
44	64.35	0.05	0.007	3.83	1.60	64	94	39.86	0.03	0.011	5.39	2.28	64
45	63.48	0.05	0.008	3.87	1.62	65	95	39.58	0.03	0.011	5.41	2.28	65
46	62.65	0.05	0.008	3.91	1.65	66	96	39.31	0.03	0.011	5.43	2.28	66
47	61.83	0.05	0.008	3.95	1.65	66	97	39.04	0.03	0.011	5.45	2.30	66
48	61.05	0.05	0.008	3.99	1.68	67	98	38.78	0.03	0.011	5.47	2.30	67
49	60.28	0.05	0.008	4.03	1.70	68	99	38.52	0.03	0.011	5.49	2.30	68
50	59.54	0.05	0.008	4.07	1.70	68	100	38.26	0.03	0.011	5.51	2.32	68



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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 hours**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	%full		Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	53.2	2.66	0.189	2.47	1.02	41		51	3.1	0.16	0.184	1.40	1.02	24
2	33.9	1.69	0.487	3.67	1.55	62		52	3.1	0.15	0.181	1.37	1.55	23
3	25.5	1.28	0.578	4.37	1.82	73		53	3.1	0.15	0.178	1.34	1.82	23
4	20.7	1.04	0.632	4.78	2.00	80		54	3.0	0.15	0.174	1.32	2.00	22
5	17.7	0.88	0.662	5.00	2.10	84		55	3.0	0.15	0.172	1.30	2.10	22
6	15.5	0.77	0.674	5.10	2.15	86		56	2.9	0.15	0.170	1.28	2.15	22
7	13.8	0.69	0.677	5.11	2.15	86		57	2.9	0.14	0.166	1.25	2.15	21
8	12.6	0.63	0.671	5.07	2.12	85		58	2.8	0.14	0.162	1.23	2.12	21
9	11.5	0.58	0.660	4.99	2.10	84		59	2.8	0.14	0.160	1.21	2.10	20
10	10.7	0.53	0.645	4.88	2.05	82		60	2.8	0.14	0.158	1.19	2.05	20
11	9.9	0.50	0.629	4.75	2.00	80		61	2.7	0.14	0.156	1.17	2.00	20
12	9.3	0.47	0.610	4.61	1.92	77		62	2.7	0.14	0.153	1.16	1.92	19
13	8.8	0.44	0.591	4.46	1.88	75		63	2.7	0.13	0.151	1.14	1.88	19
14	8.3	0.42	0.570	4.31	1.80	72		64	2.6	0.13	0.148	1.12	1.80	19
15	7.9	0.39	0.550	4.15	1.75	70		65	2.6	0.13	0.146	1.10	1.75	18
16	7.5	0.38	0.529	4.00	1.68	67		66	2.6	0.13	0.144	1.09	1.68	18
17	7.2	0.36	0.509	3.85	1.62	65		67	2.5	0.13	0.143	1.08	1.62	18
18	6.9	0.34	0.490	3.70	1.55	62		68	2.5	0.13	0.142	1.07	1.55	18
19	6.6	0.33	0.471	3.56	1.50	60		69	2.5	0.12	0.139	1.05	1.50	18
20	6.4	0.32	0.454	3.43	1.45	58		70	2.5	0.12	0.137	1.03	1.45	17
21	6.1	0.31	0.437	3.30	1.38	55		71	2.4	0.12	0.134	1.02	1.38	17
22	5.9	0.30	0.421	3.18	1.32	53		72	2.4	0.12	0.134	1.01	1.32	17
23	5.7	0.29	0.405	3.07	1.30	52		73	2.4	0.12	0.132	1.00	1.30	17
24	5.6	0.28	0.392	2.96	1.25	50		74	2.4	0.12	0.131	0.99	1.25	17
25	5.4	0.27	0.378	2.85	1.20	48		75	2.3	0.12	0.129	0.98	1.20	16
26	5.2	0.26	0.364	2.75	1.15	46		76	2.3	0.12	0.129	0.97	1.15	16
27	5.1	0.25	0.351	2.65	1.12	45		77	2.3	0.11	0.126	0.95	1.12	16
28	5.0	0.25	0.339	2.56	1.08	43		78	2.3	0.11	0.124	0.94	1.08	16
29	4.8	0.24	0.328	2.47	1.02	41		79	2.2	0.11	0.123	0.93	1.02	16
30	4.7	0.24	0.317	2.39	1.00	40		80	2.2	0.11	0.121	0.92	1.00	15
31	4.6	0.23	0.306	2.31	0.98	39		81	2.2	0.11	0.120	0.91	0.98	15
32	4.5	0.22	0.296	2.23	0.92	37		82	2.2	0.11	0.120	0.90	0.92	15
33	4.4	0.22	0.287	2.16	0.90	36		83	2.2	0.11	0.118	0.89	0.90	15
34	4.3	0.21	0.277	2.09	0.88	35		84	2.1	0.11	0.117	0.88	0.88	15
35	4.2	0.21	0.269	2.03	0.85	34		85	2.1	0.11	0.115	0.88	0.85	15
36	4.1	0.20	0.260	1.97	0.82	33		86	2.1	0.11	0.115	0.88	0.82	15
37	4.0	0.20	0.254	1.92	0.80	32		87	2.1	0.10	0.115	0.87	0.80	15
38	3.9	0.20	0.247	1.87	0.78	31		88	2.1	0.10	0.113	0.86	0.78	14
39	3.9	0.19	0.241	1.82	0.78	31		89	2.1	0.10	0.112	0.85	0.78	14
40	3.8	0.19	0.235	1.77	0.75	30		90	2.0	0.10	0.111	0.84	0.75	14
41	3.7	0.19	0.229	1.73	0.72	29		91	2.0	0.10	0.110	0.83	0.72	14
42	3.6	0.18	0.224	1.69	0.70	28		92	2.0	0.10	0.109	0.82	0.70	14
43	3.6	0.18	0.219	1.65	0.70	28		93	2.0	0.10	0.107	0.81	0.70	14
44	3.5	0.18	0.214	1.62	0.68	27		94	2.0	0.10	0.106	0.80	0.68	13
45	3.5	0.17	0.209	1.58	0.68	27		95	2.0	0.10	0.105	0.80	0.68	13
46	3.4	0.17	0.205	1.54	0.65	26		96	1.9	0.10	0.105	0.80	0.65	13
47	3.3	0.17	0.200	1.51	0.62	25		97	1.9	0.10	0.105	0.80	0.62	13
48	3.3	0.16	0.195	1.48	0.62	25		98	1.9	0.10	0.105	0.80	0.62	13
49	3.2	0.16	0.192	1.45	0.60	24		99	1.9	0.09	0.104	0.79	0.60	13
50	3.2	0.16	0.188	1.42	0.60	24		100	1.9	0.09	0.103	0.78	0.60	13



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Project **Brookes Lane, Whalley**

Title **Hydrology data**

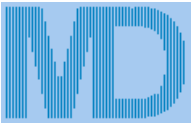
Location hydrological data (FSR):-

Location	=	WHALLEY	Grid reference	=	SD7335
M5-60 (mm)	=	18.8	r	=	0.30
Soil index	=	0.45	SAAR (mm/yr)	=	1060
WRAP	=	4	Area	=	England and Wales

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Project **Brookes Lane, Whalley**
 Title **1 in 30 Year (+40%) Soakaway Calculations**

Concrete ring design:-

Ring diameter = 1000 mm
 Percentage voids = 65.0
 Climate change = 40%

Return period = 30 yrs
 Imperm. area = 50m²
 Infiltration factor = 0.011376 m/hr

Depth below invert = 2.5m
 Pit side length = 1.8m

Calculations :-

Surface area of soakaway to 50% depth -

$$a_{s50} = \text{Length of side} \times 4 \times \text{Depth}/2 = 9.0 \text{ m}^2 \quad (\text{base not included}).$$

Outflow factor -

$$O_{\text{Fact}} = a_{s50} \times f = 0.102384 \text{ m}^3/\text{s} \quad \text{where Infiltr. factor } (f) = 0.011376 \text{ m/s}$$

Soakaway ring storage volume -

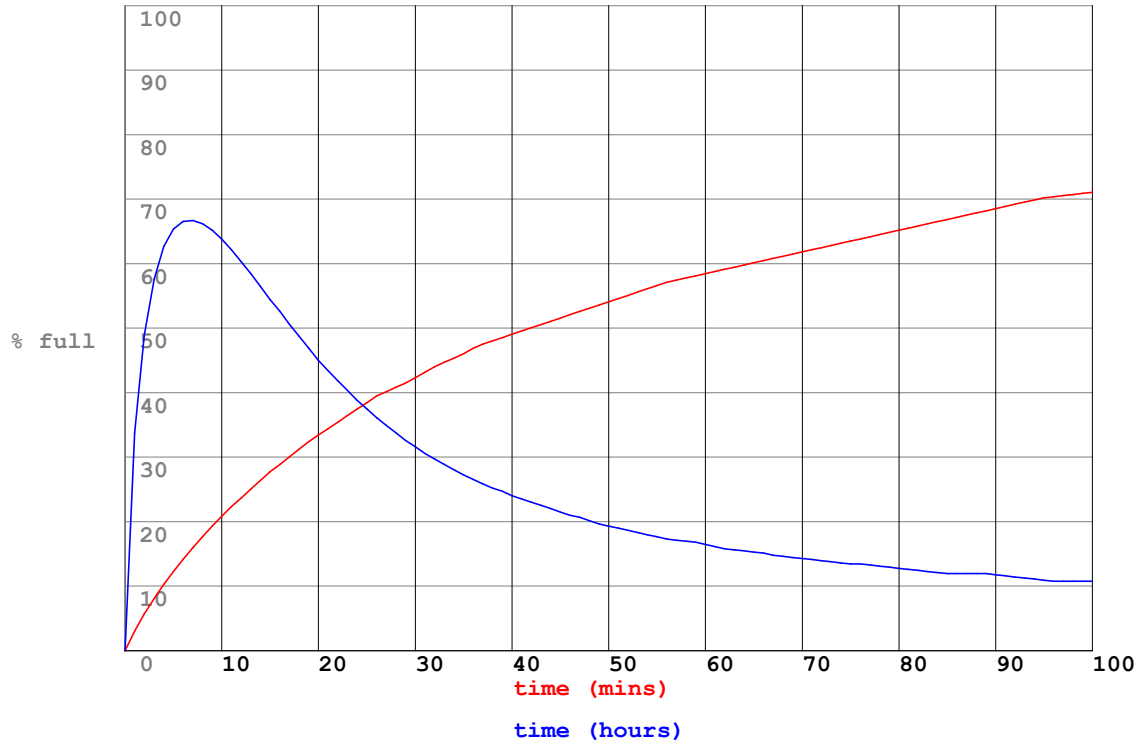
$$S_{\text{actual}} = \text{Pi} \times (\text{Ring diam}/2000)^2 \times \text{depth} = 2.0 \text{ m}^3$$

Gross soakaway pit storage volume -

$$S_{\text{pit}} = \text{Length of side}^2 \times \text{depth} = 8.1 \text{ m}^3$$

Nett soakaway pit storage volume -

$$S_{\text{nett}} = \text{Gross pit volume} - \text{infill (half depth)} = 6.0 \text{ m}^3 \quad (\text{storage} + \text{void})$$



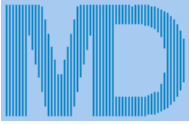
$$\text{Required volume } (S_{\text{reqd}}) = 4.2 \text{ m}^3$$

$$\text{Available storage volume} = 6.0 \text{ m}^3$$

$$\text{Spare capacity} = 1.72 \text{ m}^3$$

$$\text{Emptying time to 50\% volume} = \text{N/A hours}$$

Soakaway emptying time OK.



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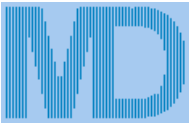
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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 mins**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	210.67	0.18	0.000	0.18	0.08	3	51	44.84	0.04	0.006	3.25	1.38	3
2	187.57	0.16	0.001	0.34	0.15	6	52	44.30	0.04	0.006	3.28	1.38	6
3	170.08	0.14	0.001	0.48	0.20	8	53	43.77	0.04	0.006	3.31	1.40	8
4	156.27	0.13	0.001	0.61	0.25	10	54	43.26	0.04	0.007	3.34	1.40	10
5	145.05	0.12	0.001	0.73	0.30	12	55	42.77	0.04	0.007	3.37	1.42	12
6	135.72	0.11	0.002	0.84	0.35	14	56	42.29	0.04	0.007	3.40	1.42	14
7	127.80	0.11	0.002	0.95	0.40	16	57	41.82	0.03	0.007	3.42	1.42	16
8	120.99	0.10	0.002	1.05	0.45	18	58	41.37	0.03	0.007	3.44	1.45	18
9	115.06	0.10	0.002	1.15	0.48	19	59	40.92	0.03	0.007	3.46	1.45	19
10	109.83	0.09	0.002	1.24	0.52	21	60	40.49	0.03	0.007	3.48	1.45	21
11	105.18	0.09	0.003	1.33	0.55	22	61	40.07	0.03	0.007	3.50	1.48	22
12	101.02	0.08	0.003	1.41	0.60	24	62	39.66	0.03	0.007	3.52	1.48	24
13	97.23	0.08	0.003	1.49	0.62	25	63	39.26	0.03	0.007	3.54	1.48	25
14	93.69	0.08	0.003	1.57	0.65	26	64	38.87	0.03	0.007	3.56	1.50	26
15	90.46	0.08	0.003	1.65	0.70	28	65	38.48	0.03	0.007	3.58	1.50	28
16	87.49	0.07	0.003	1.72	0.72	29	66	38.11	0.03	0.007	3.60	1.50	29
17	84.75	0.07	0.003	1.79	0.75	30	67	37.75	0.03	0.007	3.62	1.52	30
18	82.22	0.07	0.004	1.86	0.78	31	68	37.39	0.03	0.007	3.64	1.52	31
19	79.86	0.07	0.004	1.93	0.80	32	69	37.04	0.03	0.007	3.66	1.52	32
20	77.67	0.06	0.004	1.99	0.82	33	70	36.70	0.03	0.007	3.68	1.55	33
21	75.62	0.06	0.004	2.05	0.85	34	71	36.37	0.03	0.007	3.70	1.55	34
22	73.70	0.06	0.004	2.11	0.88	35	72	36.05	0.03	0.007	3.72	1.55	35
23	71.90	0.06	0.004	2.17	0.90	36	73	35.73	0.03	0.007	3.74	1.58	36
24	70.20	0.06	0.004	2.23	0.92	37	74	35.42	0.03	0.007	3.76	1.58	37
25	68.60	0.06	0.004	2.29	0.95	38	75	35.11	0.03	0.007	3.78	1.60	38
26	67.08	0.06	0.005	2.35	0.98	39	76	34.81	0.03	0.007	3.80	1.60	39
27	65.65	0.05	0.005	2.39	1.00	40	77	34.52	0.03	0.007	3.82	1.60	40
28	64.29	0.05	0.005	2.43	1.02	41	78	34.23	0.03	0.007	3.84	1.62	41
29	62.99	0.05	0.005	2.47	1.02	41	79	33.95	0.03	0.008	3.86	1.62	41
30	61.76	0.05	0.005	2.52	1.05	42	80	33.67	0.03	0.008	3.88	1.62	42
31	60.59	0.05	0.005	2.57	1.08	43	81	33.40	0.03	0.008	3.90	1.65	43
32	59.47	0.05	0.005	2.62	1.10	44	82	33.14	0.03	0.008	3.92	1.65	44
33	58.40	0.05	0.005	2.66	1.12	45	83	32.88	0.03	0.008	3.94	1.65	45
34	57.38	0.05	0.005	2.70	1.12	45	84	32.62	0.03	0.008	3.96	1.68	45
35	56.40	0.05	0.005	2.74	1.15	46	85	32.37	0.03	0.008	3.98	1.68	46
36	55.46	0.05	0.005	2.79	1.18	47	86	32.12	0.03	0.008	4.00	1.68	47
37	54.55	0.05	0.006	2.83	1.20	48	87	31.88	0.03	0.008	4.02	1.70	48
38	53.69	0.04	0.006	2.86	1.20	48	88	31.64	0.03	0.008	4.04	1.70	48
39	52.85	0.04	0.006	2.89	1.22	49	89	31.41	0.03	0.008	4.06	1.70	49
40	52.05	0.04	0.006	2.92	1.22	49	90	31.18	0.03	0.008	4.08	1.72	49
41	51.28	0.04	0.006	2.95	1.25	50	91	30.96	0.03	0.008	4.10	1.72	50
42	50.53	0.04	0.006	2.98	1.25	50	92	30.74	0.03	0.008	4.12	1.72	50
43	49.81	0.04	0.006	3.01	1.28	51	93	30.52	0.03	0.008	4.14	1.75	51
44	49.11	0.04	0.006	3.04	1.28	51	94	30.30	0.03	0.008	4.16	1.75	51
45	48.44	0.04	0.006	3.07	1.30	52	95	30.09	0.03	0.008	4.18	1.75	52
46	47.79	0.04	0.006	3.10	1.30	52	96	29.89	0.02	0.008	4.19	1.75	52
47	47.16	0.04	0.006	3.13	1.32	53	97	29.68	0.02	0.008	4.20	1.78	53
48	46.55	0.04	0.006	3.16	1.32	53	98	29.48	0.02	0.008	4.21	1.78	53
49	45.96	0.04	0.006	3.19	1.35	54	99	29.29	0.02	0.008	4.22	1.78	54
50	45.39	0.04	0.006	3.22	1.35	54	100	29.09	0.02	0.008	4.23	1.78	54



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Job No.		
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MasterDrain
SW 16.03

Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 hours**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	%full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	40.5	2.02	0.006	2.01	0.85	34	51	2.6	0.13	0.150	1.13	0.85	19
2	25.8	1.29	0.386	2.91	1.22	49	52	2.5	0.13	0.147	1.11	1.22	19
3	19.5	0.98	0.455	3.43	1.45	58	53	2.5	0.12	0.144	1.09	1.45	18
4	15.9	0.80	0.495	3.73	1.58	63	54	2.5	0.12	0.142	1.07	1.58	18
5	13.6	0.68	0.515	3.89	1.62	65	55	2.4	0.12	0.139	1.05	1.62	18
6	12.0	0.60	0.525	3.96	1.68	67	56	2.4	0.12	0.137	1.03	1.68	17
7	10.7	0.54	0.526	3.97	1.68	67	57	2.4	0.12	0.134	1.02	1.68	17
8	9.8	0.49	0.521	3.94	1.65	66	58	2.3	0.12	0.134	1.01	1.65	17
9	9.0	0.45	0.513	3.88	1.62	65	59	2.3	0.12	0.132	1.00	1.62	17
10	8.3	0.42	0.503	3.80	1.60	64	60	2.3	0.11	0.129	0.98	1.60	16
11	7.8	0.39	0.490	3.70	1.55	62	61	2.2	0.11	0.128	0.96	1.55	16
12	7.3	0.37	0.476	3.59	1.50	60	62	2.2	0.11	0.125	0.94	1.50	16
13	6.9	0.35	0.460	3.48	1.45	58	63	2.2	0.11	0.123	0.93	1.45	16
14	6.5	0.33	0.446	3.36	1.40	56	64	2.2	0.11	0.121	0.92	1.40	15
15	6.2	0.31	0.429	3.24	1.35	54	65	2.1	0.11	0.120	0.91	1.35	15
16	6.0	0.30	0.414	3.13	1.32	53	66	2.1	0.11	0.120	0.90	1.32	15
17	5.7	0.28	0.399	3.01	1.28	51	67	2.1	0.10	0.117	0.88	1.28	15
18	5.5	0.27	0.383	2.90	1.22	49	68	2.1	0.10	0.115	0.87	1.22	15
19	5.3	0.26	0.369	2.79	1.18	47	69	2.1	0.10	0.113	0.86	1.18	14
20	5.1	0.25	0.355	2.68	1.12	45	70	2.0	0.10	0.112	0.85	1.12	14
21	4.9	0.24	0.342	2.58	1.08	43	71	2.0	0.10	0.111	0.84	1.08	14
22	4.7	0.24	0.329	2.49	1.05	42	72	2.0	0.10	0.110	0.83	1.05	14
23	4.6	0.23	0.318	2.40	1.00	40	73	2.0	0.10	0.109	0.82	1.00	14
24	4.4	0.22	0.306	2.31	0.98	39	74	2.0	0.10	0.107	0.81	0.98	14
25	4.3	0.22	0.296	2.23	0.92	37	75	1.9	0.10	0.106	0.80	0.92	13
26	4.2	0.21	0.285	2.15	0.90	36	76	1.9	0.10	0.105	0.80	0.90	13
27	4.1	0.20	0.274	2.08	0.88	35	77	1.9	0.09	0.104	0.79	0.88	13
28	4.0	0.20	0.266	2.01	0.85	34	78	1.9	0.09	0.103	0.78	0.85	13
29	3.9	0.19	0.257	1.94	0.82	33	79	1.9	0.09	0.102	0.77	0.82	13
30	3.8	0.19	0.249	1.88	0.80	32	80	1.8	0.09	0.101	0.76	0.80	13
31	3.7	0.18	0.241	1.82	0.78	31	81	1.8	0.09	0.099	0.75	0.78	13
32	3.6	0.18	0.233	1.77	0.75	30	82	1.8	0.09	0.098	0.74	0.75	12
33	3.5	0.18	0.228	1.72	0.72	29	83	1.8	0.09	0.097	0.73	0.72	12
34	3.4	0.17	0.221	1.67	0.70	28	84	1.8	0.09	0.096	0.72	0.70	12
35	3.4	0.17	0.215	1.62	0.68	27	85	1.8	0.09	0.095	0.71	0.68	12
36	3.3	0.17	0.209	1.58	0.68	27	86	1.7	0.09	0.093	0.71	0.68	12
37	3.2	0.16	0.203	1.54	0.65	26	87	1.7	0.09	0.093	0.71	0.65	12
38	3.2	0.16	0.199	1.50	0.62	25	88	1.7	0.09	0.093	0.71	0.62	12
39	3.1	0.16	0.194	1.47	0.62	25	89	1.7	0.09	0.093	0.71	0.62	12
40	3.1	0.15	0.189	1.43	0.60	24	90	1.7	0.08	0.093	0.70	0.60	12
41	3.0	0.15	0.184	1.40	0.60	24	91	1.7	0.08	0.091	0.69	0.60	12
42	3.0	0.15	0.181	1.37	0.58	23	92	1.7	0.08	0.090	0.68	0.58	11
43	2.9	0.15	0.178	1.34	0.58	23	93	1.7	0.08	0.088	0.67	0.58	11
44	2.9	0.14	0.173	1.31	0.55	22	94	1.6	0.08	0.088	0.66	0.55	11
45	2.8	0.14	0.170	1.28	0.55	22	95	1.6	0.08	0.087	0.65	0.55	11
46	2.8	0.14	0.166	1.25	0.52	21	96	1.6	0.08	0.085	0.64	0.52	11
47	2.7	0.14	0.162	1.23	0.52	21	97	1.6	0.08	0.084	0.64	0.52	11
48	2.7	0.13	0.159	1.20	0.50	20	98	1.6	0.08	0.084	0.64	0.50	11
49	2.6	0.13	0.156	1.17	0.50	20	99	1.6	0.08	0.084	0.64	0.50	11
50	2.6	0.13	0.152	1.15	0.48	19	100	1.6	0.08	0.084	0.64	0.48	11



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Job No.		
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MasterDrain
SW 16.03

Project **Brookes Lane, Whalley**

Title **Hydrology data**

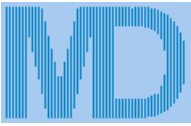
Location hydrological data (FSR):-

Location	= WHALLEY	Grid reference	= SD7335
M5-60 (mm)	= 18.8	r	= 0.30
Soil index	= 0.45	SAAR (mm/yr)	= 1060
WRAP	= 4	Area	= England and Wales

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Project **Brookes Lane, Whalley**
 Title **1 in 10 Year (+40%) Soakaway Calculations**

Concrete ring design:-

Ring diameter = 1000 mm
 Percentage voids = 65.0
 Climate change = 40%

Return period = 10 yrs
 Imperm. area = 50m²
 Infiltration factor = 0.011376 m/hr

Depth below invert = 2.5m
 Pit side length = 1.8m

Calculations :-

Surface area of soakaway to 50% depth -

$$a_{s50} = \text{Length of side} \times 4 \times \text{Depth}/2 = 9.0 \text{ m}^2 \quad (\text{base not included}).$$

Outflow factor -

$$O_{\text{Fact}} = a_{s50} \times f = 0.102384 \text{ m}^3/\text{s} \quad \text{where Infiltr. factor } (f) = 0.011376 \text{ m/s}$$

Soakaway ring storage volume -

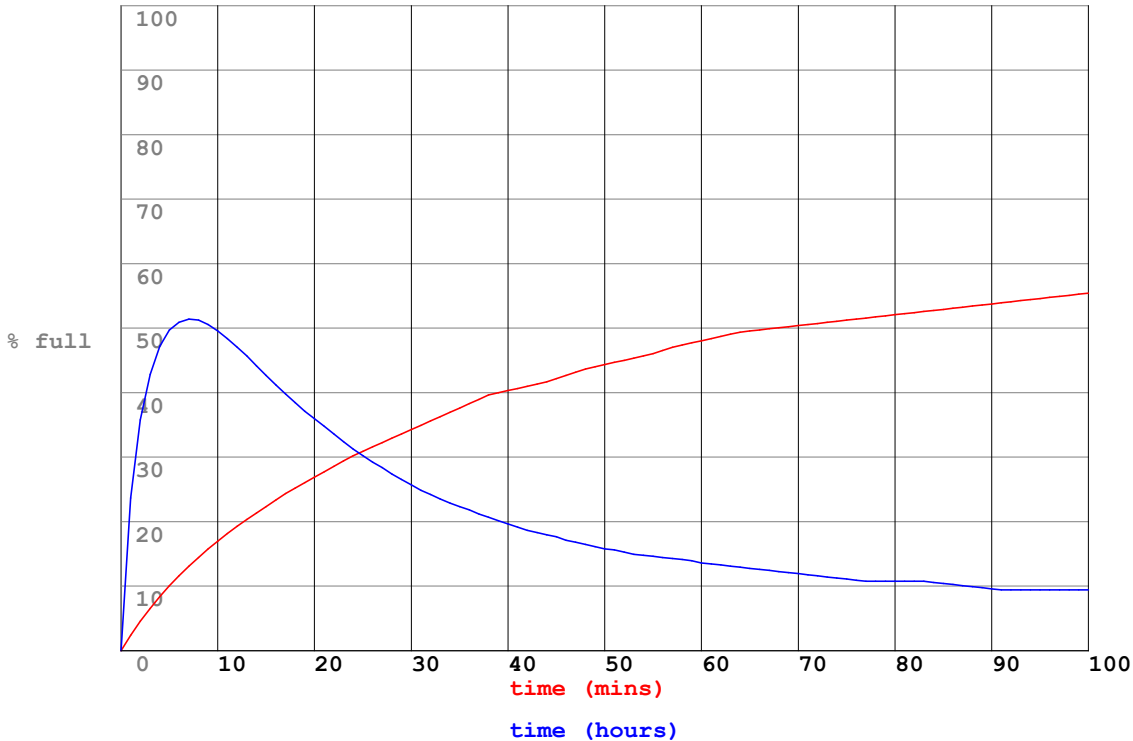
$$S_{\text{actual}} = \text{Pi} \times (\text{Ring diam}/2000)^2 \times \text{depth} = 2.0 \text{ m}^3$$

Gross soakaway pit storage volume -

$$S_{\text{pit}} = \text{Length of side}^2 \times \text{depth} = 8.1 \text{ m}^3$$

Nett soakaway pit storage volume -

$$S_{\text{nett}} = \text{Gross pit volume} - \text{infill (half depth)} = 6.0 \text{ m}^3 \quad (\text{storage} + \text{void})$$



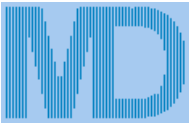
$$\text{Required volume } (S_{\text{reqd}}) = 3.3 \text{ m}^3$$

$$\text{Available storage volume} = 6.0 \text{ m}^3$$

$$\text{Spare capacity} = 2.65 \text{ m}^3$$

$$\text{Emptying time to 50\% volume} = \text{N/A hours}$$

Soakaway emptying time OK.



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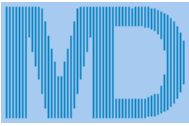
Job No.		
Sheet no.	2	
Date	25/05/18	
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SW 16.03

Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 mins**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	173.76	0.14	0.000	0.14	0.05	2	51	34.99	0.03	0.005	2.66	1.12	2
2	153.93	0.13	0.001	0.27	0.12	5	52	34.57	0.03	0.005	2.68	1.12	5
3	138.95	0.12	0.001	0.39	0.18	7	53	34.16	0.03	0.005	2.70	1.12	7
4	127.17	0.11	0.001	0.50	0.20	8	54	33.75	0.03	0.005	2.72	1.15	8
5	117.62	0.10	0.001	0.60	0.25	10	55	33.36	0.03	0.005	2.74	1.15	10
6	109.69	0.09	0.001	0.69	0.30	12	56	32.99	0.03	0.005	2.77	1.18	12
7	102.98	0.09	0.002	0.78	0.32	13	57	32.62	0.03	0.005	2.80	1.18	13
8	97.22	0.08	0.002	0.86	0.35	14	58	32.26	0.03	0.006	2.82	1.18	14
9	92.21	0.08	0.002	0.94	0.40	16	59	31.91	0.03	0.006	2.84	1.20	16
10	87.80	0.07	0.002	1.01	0.42	17	60	31.57	0.03	0.006	2.86	1.20	17
11	83.89	0.07	0.002	1.08	0.45	18	61	31.24	0.03	0.006	2.88	1.20	18
12	80.39	0.07	0.002	1.15	0.48	19	62	30.91	0.03	0.006	2.90	1.22	19
13	77.23	0.06	0.002	1.21	0.50	20	63	30.60	0.03	0.006	2.92	1.22	20
14	74.33	0.06	0.002	1.27	0.52	21	64	30.29	0.03	0.006	2.94	1.22	21
15	71.69	0.06	0.003	1.33	0.55	22	65	29.99	0.02	0.006	2.95	1.25	22
16	69.26	0.06	0.003	1.39	0.58	23	66	29.70	0.02	0.006	2.96	1.25	23
17	67.03	0.06	0.003	1.45	0.60	24	67	29.41	0.02	0.006	2.97	1.25	24
18	64.97	0.05	0.003	1.50	0.62	25	68	29.13	0.02	0.006	2.98	1.25	25
19	63.06	0.05	0.003	1.55	0.65	26	69	28.86	0.02	0.006	2.99	1.25	26
20	61.28	0.05	0.003	1.60	0.68	27	70	28.60	0.02	0.006	3.00	1.25	27
21	59.62	0.05	0.003	1.65	0.70	28	71	28.33	0.02	0.006	3.01	1.28	28
22	58.07	0.05	0.003	1.70	0.72	29	72	28.08	0.02	0.006	3.02	1.28	29
23	56.61	0.05	0.003	1.75	0.72	29	73	27.83	0.02	0.006	3.03	1.28	29
24	55.24	0.05	0.004	1.80	0.75	30	74	27.59	0.02	0.006	3.04	1.28	30
25	53.95	0.04	0.004	1.84	0.78	31	75	27.35	0.02	0.006	3.05	1.28	31
26	52.73	0.04	0.004	1.88	0.80	32	76	27.11	0.02	0.006	3.06	1.28	32
27	51.58	0.04	0.004	1.92	0.80	32	77	26.88	0.02	0.006	3.07	1.30	32
28	50.49	0.04	0.004	1.96	0.82	33	78	26.66	0.02	0.006	3.08	1.30	33
29	49.45	0.04	0.004	2.00	0.85	34	79	26.44	0.02	0.006	3.09	1.30	34
30	48.46	0.04	0.004	2.04	0.85	34	80	26.22	0.02	0.006	3.10	1.30	34
31	47.52	0.04	0.004	2.08	0.88	35	81	26.01	0.02	0.006	3.11	1.30	35
32	46.63	0.04	0.004	2.12	0.90	36	82	25.81	0.02	0.006	3.12	1.30	36
33	45.77	0.04	0.004	2.16	0.90	36	83	25.60	0.02	0.006	3.13	1.32	36
34	44.96	0.04	0.004	2.20	0.92	37	84	25.40	0.02	0.006	3.14	1.32	37
35	44.17	0.04	0.004	2.24	0.95	38	85	25.21	0.02	0.006	3.15	1.32	38
36	43.42	0.04	0.004	2.28	0.95	38	86	25.02	0.02	0.006	3.16	1.32	38
37	42.70	0.04	0.005	2.32	0.98	39	87	24.83	0.02	0.006	3.17	1.32	39
38	42.01	0.04	0.005	2.36	1.00	40	88	24.64	0.02	0.006	3.18	1.32	40
39	41.35	0.03	0.005	2.38	1.00	40	89	24.46	0.02	0.006	3.19	1.35	40
40	40.71	0.03	0.005	2.40	1.00	40	90	24.28	0.02	0.006	3.20	1.35	40
41	40.10	0.03	0.005	2.42	1.02	41	91	24.11	0.02	0.006	3.21	1.35	41
42	39.50	0.03	0.005	2.44	1.02	41	92	23.93	0.02	0.006	3.22	1.35	41
43	38.93	0.03	0.005	2.46	1.02	41	93	23.76	0.02	0.006	3.23	1.35	41
44	38.38	0.03	0.005	2.48	1.05	42	94	23.60	0.02	0.006	3.24	1.35	42
45	37.85	0.03	0.005	2.51	1.05	42	95	23.43	0.02	0.006	3.25	1.38	42
46	37.33	0.03	0.005	2.54	1.08	43	96	23.27	0.02	0.006	3.26	1.38	43
47	36.83	0.03	0.005	2.57	1.08	43	97	23.11	0.02	0.006	3.27	1.38	43
48	36.35	0.03	0.005	2.60	1.10	44	98	22.96	0.02	0.006	3.28	1.38	44
49	35.89	0.03	0.005	2.62	1.10	44	99	22.81	0.02	0.006	3.29	1.38	44
50	35.43	0.03	0.005	2.64	1.10	44	100	22.65	0.02	0.006	3.30	1.38	44



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MasterDrain
SW 16.03

Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 hours**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	%full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	31.6	1.58	0.166	1.41	0.60	24	51	2.1	0.11	0.123	0.93	0.60	16
2	20.1	1.00	0.282	2.13	0.90	36	52	2.1	0.10	0.120	0.91	0.90	15
3	15.3	0.76	0.337	2.55	1.08	43	53	2.1	0.10	0.118	0.89	1.08	15
4	12.5	0.63	0.372	2.81	1.18	47	54	2.0	0.10	0.115	0.88	1.18	15
5	10.8	0.54	0.392	2.96	1.25	50	55	2.0	0.10	0.115	0.87	1.25	15
6	9.5	0.47	0.401	3.03	1.28	51	56	2.0	0.10	0.113	0.86	1.28	14
7	8.5	0.43	0.405	3.06	1.28	51	57	2.0	0.10	0.112	0.85	1.28	14
8	7.8	0.39	0.403	3.05	1.28	51	58	1.9	0.10	0.111	0.84	1.28	14
9	7.2	0.36	0.399	3.01	1.28	51	59	1.9	0.10	0.110	0.83	1.28	14
10	6.7	0.33	0.391	2.95	1.25	50	60	1.9	0.09	0.107	0.81	1.25	14
11	6.2	0.31	0.381	2.88	1.20	48	61	1.9	0.09	0.105	0.80	1.20	13
12	5.9	0.29	0.370	2.80	1.18	47	62	1.9	0.09	0.104	0.79	1.18	13
13	5.5	0.28	0.360	2.72	1.15	46	63	1.8	0.09	0.103	0.78	1.15	13
14	5.3	0.26	0.348	2.63	1.10	44	64	1.8	0.09	0.102	0.77	1.10	13
15	5.0	0.25	0.337	2.54	1.08	43	65	1.8	0.09	0.101	0.76	1.08	13
16	4.8	0.24	0.325	2.45	1.02	41	66	1.8	0.09	0.099	0.75	1.02	13
17	4.6	0.23	0.313	2.37	1.00	40	67	1.8	0.09	0.098	0.74	1.00	12
18	4.4	0.22	0.303	2.29	0.95	38	68	1.7	0.09	0.097	0.73	0.95	12
19	4.3	0.21	0.292	2.21	0.92	37	69	1.7	0.09	0.096	0.72	0.92	12
20	4.1	0.21	0.283	2.14	0.90	36	70	1.7	0.09	0.095	0.71	0.90	12
21	4.0	0.20	0.274	2.07	0.88	35	71	1.7	0.08	0.093	0.70	0.88	12
22	3.8	0.19	0.264	2.00	0.85	34	72	1.7	0.08	0.091	0.69	0.85	12
23	3.7	0.19	0.256	1.93	0.80	32	73	1.7	0.08	0.090	0.68	0.80	11
24	3.6	0.18	0.247	1.86	0.78	31	74	1.6	0.08	0.088	0.67	0.78	11
25	3.5	0.18	0.238	1.80	0.75	30	75	1.6	0.08	0.088	0.66	0.75	11
26	3.4	0.17	0.230	1.74	0.72	29	76	1.6	0.08	0.087	0.65	0.72	11
27	3.3	0.17	0.224	1.69	0.70	28	77	1.6	0.08	0.085	0.64	0.70	11
28	3.2	0.16	0.216	1.63	0.68	27	78	1.6	0.08	0.084	0.64	0.68	11
29	3.2	0.16	0.209	1.58	0.68	27	79	1.6	0.08	0.084	0.64	0.68	11
30	3.1	0.15	0.202	1.53	0.65	26	80	1.5	0.08	0.084	0.64	0.65	11
31	3.0	0.15	0.197	1.48	0.62	25	81	1.5	0.08	0.084	0.64	0.62	11
32	3.0	0.15	0.191	1.44	0.60	24	82	1.5	0.08	0.084	0.64	0.60	11
33	2.9	0.14	0.184	1.40	0.60	24	83	1.5	0.08	0.084	0.64	0.60	11
34	2.8	0.14	0.180	1.36	0.58	23	84	1.5	0.07	0.083	0.63	0.58	11
35	2.8	0.14	0.175	1.33	0.55	22	85	1.5	0.07	0.082	0.62	0.55	10
36	2.7	0.14	0.172	1.30	0.55	22	86	1.5	0.07	0.080	0.61	0.55	10
37	2.7	0.13	0.167	1.26	0.52	21	87	1.5	0.07	0.079	0.60	0.52	10
38	2.6	0.13	0.162	1.23	0.52	21	88	1.4	0.07	0.079	0.59	0.52	10
39	2.6	0.13	0.159	1.20	0.50	20	89	1.4	0.07	0.077	0.58	0.50	10
40	2.5	0.13	0.156	1.17	0.50	20	90	1.4	0.07	0.076	0.57	0.50	10
41	2.5	0.12	0.151	1.14	0.48	19	91	1.4	0.07	0.075	0.56	0.48	9
42	2.4	0.12	0.147	1.11	0.48	19	92	1.4	0.07	0.074	0.56	0.48	9
43	2.4	0.12	0.144	1.09	0.45	18	93	1.4	0.07	0.074	0.56	0.45	9
44	2.4	0.12	0.142	1.07	0.45	18	94	1.4	0.07	0.074	0.56	0.45	9
45	2.3	0.12	0.139	1.05	0.45	18	95	1.4	0.07	0.074	0.56	0.45	9
46	2.3	0.11	0.136	1.02	0.42	17	96	1.4	0.07	0.074	0.56	0.42	9
47	2.3	0.11	0.132	1.00	0.42	17	97	1.4	0.07	0.074	0.56	0.42	9
48	2.2	0.11	0.129	0.98	0.40	16	98	1.3	0.07	0.074	0.56	0.40	9
49	2.2	0.11	0.128	0.96	0.40	16	99	1.3	0.07	0.074	0.56	0.40	9
50	2.2	0.11	0.125	0.94	0.40	16	100	1.3	0.07	0.074	0.56	0.40	9



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MasterDrain
SW 16.03

Project **Brookes Lane, Whalley**

Title **Hydrology data**

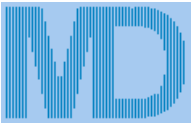
Location hydrological data (FSR):-

Location	= WHALLEY	Grid reference	= SD7335
M5-60 (mm)	= 18.8	r	= 0.30
Soil index	= 0.45	SAAR (mm/yr)	= 1060
WRAP	= 4	Area	= England and Wales

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Project **Brookes Lane, Whalley**
 Title **1 in 100 Year (+40%) Soakaway Calculations**

Concrete ring design:-

Ring diameter = 1800 mm
 Percentage voids = 65.0
 Climate change = 40%

Return period = 100 yrs
 Imperm. area = 200m²
 Infiltration factor = 0.011376 m/hr

Depth below invert = 2.4m
 Pit side length = 3.6m

Calculations :-

Surface area of soakaway to 50% depth -

$$a_{s50} = \text{Length of side} \times 4 \times \text{Depth}/2 = 17.3 \text{ m}^2 \text{ (base not included).}$$

Outflow factor -

$$O_{\text{Fact}} = a_{s50} \times f = 0.1965773 \text{ m}^3/\text{s} \text{ where Infiltr. factor (f) = 0.011376 m/s}$$

Soakaway ring storage volume -

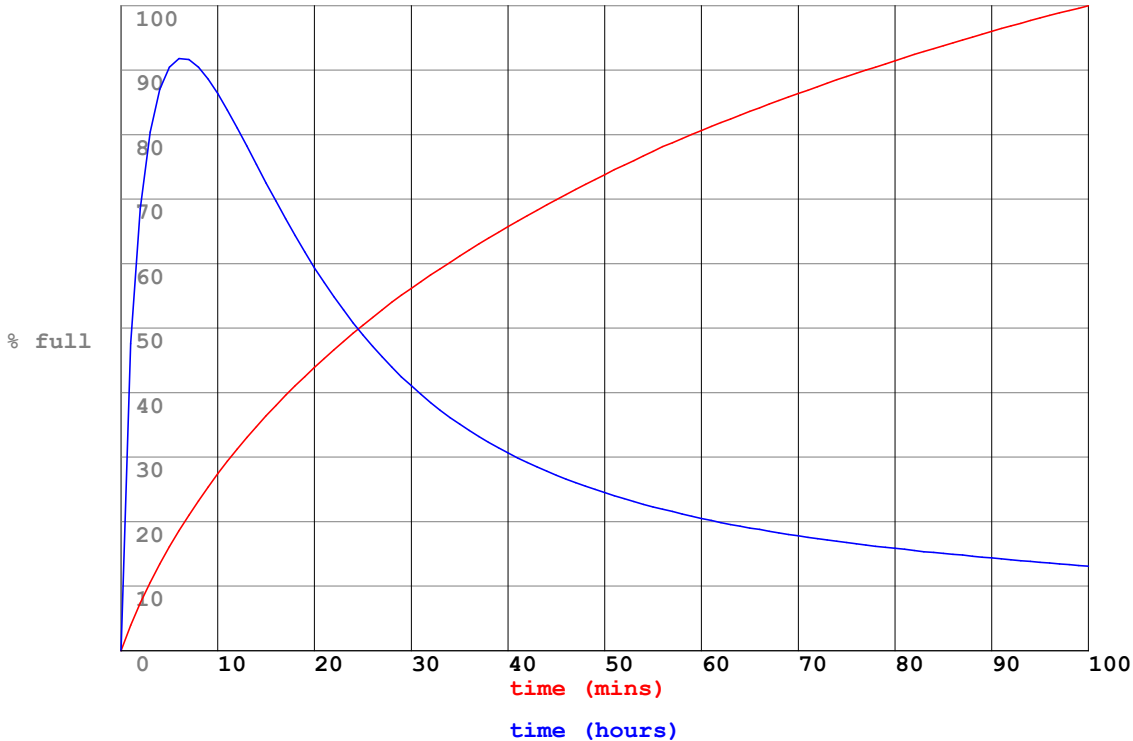
$$S_{\text{actual}} = \text{Pi} \times (\text{Ring diam}/2000)^2 \times \text{depth} = 6.1 \text{ m}^3$$

Gross soakaway pit storage volume -

$$S_{\text{pit}} = \text{Length of side}^2 \times \text{depth} = 31.1 \text{ m}^3$$

Nett soakaway pit storage volume -

$$S_{\text{nett}} = \text{Gross pit volume} - \text{infill (half depth)} = 22.4 \text{ m}^3 \text{ (storage + void)}$$



$$\text{Required volume } (S_{\text{reqd}}) = 22.4 \text{ m}^3$$

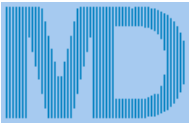
$$\text{Available storage volume} = 22.4 \text{ m}^3$$

$$\text{Spare capacity} = 0.01 \text{ m}^3$$

$$\text{Emptying time to 50\% volume} = \text{N/A hours}$$

Soakaway emptying time OK.

Soakaway dimensions OK.



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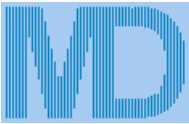
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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 mins**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	260.17	0.87	0.002	0.87	0.10	4	51	58.83	0.20	0.033	16.67	1.80	4
2	232.94	0.78	0.003	1.65	0.17	7	52	58.13	0.19	0.034	16.83	1.80	7
3	212.25	0.71	0.005	2.36	0.26	11	53	57.45	0.19	0.034	16.99	1.82	11
4	195.87	0.65	0.006	3.00	0.31	13	54	56.79	0.19	0.034	17.15	1.85	13
5	182.52	0.61	0.007	3.60	0.38	16	55	56.15	0.19	0.035	17.31	1.85	16
6	171.38	0.57	0.008	4.16	0.46	19	56	55.53	0.19	0.035	17.47	1.87	19
7	161.92	0.54	0.009	4.69	0.50	21	57	54.92	0.18	0.035	17.61	1.90	21
8	153.77	0.51	0.010	5.19	0.55	23	58	54.33	0.18	0.036	17.75	1.90	23
9	146.64	0.49	0.011	5.67	0.60	25	59	53.75	0.18	0.036	17.89	1.92	25
10	140.36	0.47	0.012	6.13	0.65	27	60	53.19	0.18	0.036	18.03	1.94	27
11	134.77	0.45	0.013	6.57	0.70	29	61	52.64	0.18	0.037	18.17	1.94	29
12	129.75	0.43	0.014	6.99	0.74	31	62	52.10	0.17	0.037	18.30	1.97	31
13	125.14	0.42	0.015	7.39	0.79	33	63	51.58	0.17	0.037	18.43	1.97	33
14	120.74	0.40	0.016	7.77	0.84	35	64	51.07	0.17	0.037	18.56	1.99	35
15	116.72	0.39	0.016	8.14	0.86	36	65	50.58	0.17	0.038	18.69	2.02	36
16	113.01	0.38	0.017	8.50	0.91	38	66	50.09	0.17	0.038	18.82	2.02	38
17	109.59	0.37	0.018	8.85	0.96	40	67	49.62	0.17	0.038	18.95	2.04	40
18	106.42	0.35	0.018	9.18	0.98	41	68	49.15	0.16	0.038	19.07	2.04	41
19	103.46	0.34	0.019	9.50	1.01	42	69	48.70	0.16	0.039	19.19	2.06	42
20	100.70	0.34	0.020	9.82	1.06	44	70	48.25	0.16	0.039	19.31	2.06	44
21	98.12	0.33	0.020	10.13	1.08	45	71	47.82	0.16	0.039	19.43	2.09	45
22	95.70	0.32	0.021	10.43	1.13	47	72	47.39	0.16	0.039	19.55	2.09	47
23	93.42	0.31	0.022	10.72	1.15	48	73	46.98	0.16	0.040	19.67	2.11	48
24	91.28	0.30	0.022	11.00	1.18	49	74	46.57	0.16	0.040	19.79	2.14	49
25	89.25	0.30	0.023	11.28	1.20	50	75	46.17	0.15	0.040	19.90	2.14	50
26	87.33	0.29	0.023	11.55	1.25	52	76	45.78	0.15	0.040	20.01	2.16	52
27	85.50	0.29	0.024	11.82	1.27	53	77	45.39	0.15	0.040	20.12	2.16	53
28	83.77	0.28	0.024	12.08	1.30	54	78	45.02	0.15	0.041	20.23	2.16	54
29	82.13	0.27	0.025	12.32	1.32	55	79	44.65	0.15	0.041	20.34	2.18	55
30	80.56	0.27	0.025	12.56	1.34	56	80	44.29	0.15	0.041	20.45	2.18	56
31	79.07	0.26	0.026	12.79	1.37	57	81	43.93	0.15	0.041	20.56	2.21	57
32	77.64	0.26	0.026	13.02	1.39	58	82	43.58	0.15	0.041	20.67	2.21	58
33	76.27	0.25	0.027	13.24	1.42	59	83	43.24	0.14	0.042	20.77	2.23	59
34	74.96	0.25	0.027	13.46	1.44	60	84	42.91	0.14	0.042	20.87	2.23	60
35	73.71	0.25	0.027	13.68	1.46	61	85	42.58	0.14	0.042	20.97	2.26	61
36	72.50	0.24	0.028	13.89	1.49	62	86	42.25	0.14	0.042	21.07	2.26	62
37	71.35	0.24	0.028	14.10	1.51	63	87	41.94	0.14	0.043	21.17	2.28	63
38	70.23	0.23	0.029	14.30	1.54	64	88	41.63	0.14	0.043	21.27	2.28	64
39	69.16	0.23	0.029	14.50	1.56	65	89	41.32	0.14	0.043	21.37	2.30	65
40	68.13	0.23	0.030	14.70	1.58	66	90	41.02	0.14	0.043	21.47	2.30	66
41	67.13	0.22	0.030	14.89	1.61	67	91	40.72	0.14	0.043	21.57	2.30	67
42	66.17	0.22	0.030	15.08	1.61	67	92	40.43	0.13	0.043	21.66	2.33	67
43	65.25	0.22	0.031	15.27	1.63	68	93	40.14	0.13	0.044	21.75	2.33	68
44	64.35	0.21	0.031	15.45	1.66	69	94	39.86	0.13	0.044	21.84	2.35	69
45	63.48	0.21	0.031	15.63	1.68	70	95	39.58	0.13	0.044	21.93	2.35	70
46	62.65	0.21	0.032	15.81	1.70	71	96	39.31	0.13	0.044	22.02	2.35	71
47	61.83	0.21	0.032	15.99	1.73	72	97	39.04	0.13	0.044	22.11	2.38	72
48	61.05	0.20	0.032	16.16	1.73	72	98	38.78	0.13	0.045	22.19	2.38	72
49	60.28	0.20	0.033	16.33	1.75	73	99	38.52	0.13	0.045	22.27	2.40	73
50	59.54	0.20	0.033	16.50	1.78	74	100	38.26	0.13	0.045	22.35	2.40	74



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SW 16.03

Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 hours**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	%full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	53.2	10.64	0.000	10.64	1.15	48	51	3.1	0.63	0.736	5.37	1.15	24
2	33.9	6.77	2.094	15.32	1.66	69	52	3.1	0.62	0.721	5.27	1.66	24
3	25.5	5.11	2.457	17.97	1.92	80	53	3.1	0.61	0.708	5.17	1.92	23
4	20.7	4.15	2.660	19.46	2.09	87	54	3.0	0.60	0.695	5.07	2.09	23
5	17.7	3.53	2.765	20.23	2.16	90	55	3.0	0.59	0.681	4.98	2.16	22
6	15.5	3.10	2.806	20.52	2.21	92	56	2.9	0.59	0.670	4.90	2.21	22
7	13.8	2.77	2.801	20.49	2.21	92	57	2.9	0.58	0.659	4.82	2.21	22
8	12.6	2.51	2.767	20.23	2.16	90	58	2.8	0.57	0.649	4.74	2.16	21
9	11.5	2.30	2.709	19.82	2.14	89	59	2.8	0.56	0.637	4.66	2.14	21
10	10.7	2.13	2.641	19.31	2.06	86	60	2.8	0.55	0.627	4.58	2.06	20
11	9.9	1.99	2.562	18.74	2.02	84	61	2.7	0.55	0.618	4.51	2.02	20
12	9.3	1.86	2.477	18.12	1.94	81	62	2.7	0.54	0.608	4.44	1.94	20
13	8.8	1.76	2.392	17.49	1.87	78	63	2.7	0.53	0.598	4.37	1.87	20
14	8.3	1.66	2.303	16.85	1.80	75	64	2.6	0.53	0.590	4.31	1.80	19
15	7.9	1.58	2.216	16.21	1.75	73	65	2.6	0.52	0.582	4.25	1.75	19
16	7.5	1.51	2.131	15.59	1.68	70	66	2.6	0.52	0.573	4.20	1.68	19
17	7.2	1.44	2.048	14.98	1.61	67	67	2.5	0.51	0.567	4.14	1.61	19
18	6.9	1.38	1.967	14.39	1.54	64	68	2.5	0.50	0.559	4.08	1.54	18
19	6.6	1.32	1.889	13.82	1.49	62	69	2.5	0.50	0.550	4.03	1.49	18
20	6.4	1.27	1.815	13.27	1.42	59	70	2.5	0.49	0.544	3.98	1.42	18
21	6.1	1.23	1.745	12.76	1.37	57	71	2.4	0.49	0.537	3.93	1.37	18
22	5.9	1.19	1.677	12.27	1.32	55	72	2.4	0.48	0.531	3.88	1.32	17
23	5.7	1.15	1.614	11.81	1.27	53	73	2.4	0.48	0.524	3.84	1.27	17
24	5.6	1.11	1.555	11.36	1.22	51	74	2.4	0.47	0.518	3.79	1.22	17
25	5.4	1.08	1.496	10.94	1.18	49	75	2.3	0.47	0.513	3.75	1.18	17
26	5.2	1.05	1.442	10.55	1.13	47	76	2.3	0.46	0.506	3.70	1.13	17
27	5.1	1.02	1.391	10.18	1.10	46	77	2.3	0.46	0.500	3.66	1.10	16
28	5.0	0.99	1.343	9.83	1.06	44	78	2.3	0.45	0.495	3.62	1.06	16
29	4.8	0.96	1.297	9.49	1.01	42	79	2.2	0.45	0.490	3.58	1.01	16
30	4.7	0.94	1.255	9.18	0.98	41	80	2.2	0.45	0.485	3.55	0.98	16
31	4.6	0.92	1.216	8.88	0.96	40	81	2.2	0.44	0.480	3.51	0.96	16
32	4.5	0.90	1.176	8.60	0.91	38	82	2.2	0.44	0.475	3.47	0.91	16
33	4.4	0.87	1.139	8.33	0.89	37	83	2.2	0.43	0.469	3.43	0.89	15
34	4.3	0.86	1.106	8.08	0.86	36	84	2.1	0.43	0.464	3.40	0.86	15
35	4.2	0.84	1.073	7.85	0.84	35	85	2.1	0.43	0.460	3.37	0.84	15
36	4.1	0.82	1.043	7.63	0.82	34	86	2.1	0.42	0.455	3.34	0.82	15
37	4.0	0.80	1.014	7.42	0.79	33	87	2.1	0.42	0.452	3.31	0.79	15
38	3.9	0.79	0.988	7.22	0.77	32	88	2.1	0.41	0.447	3.27	0.77	15
39	3.9	0.77	0.962	7.03	0.74	31	89	2.1	0.41	0.442	3.24	0.74	14
40	3.8	0.76	0.937	6.85	0.74	31	90	2.0	0.41	0.439	3.21	0.74	14
41	3.7	0.74	0.912	6.68	0.72	30	91	2.0	0.40	0.434	3.18	0.72	14
42	3.6	0.73	0.891	6.52	0.70	29	92	2.0	0.40	0.431	3.15	0.70	14
43	3.6	0.72	0.871	6.37	0.67	28	93	2.0	0.40	0.428	3.12	0.67	14
44	3.5	0.70	0.850	6.22	0.67	28	94	2.0	0.39	0.423	3.09	0.67	14
45	3.5	0.69	0.831	6.08	0.65	27	95	2.0	0.39	0.418	3.06	0.65	14
46	3.4	0.68	0.813	5.95	0.65	27	96	1.9	0.39	0.414	3.04	0.65	14
47	3.3	0.67	0.796	5.82	0.62	26	97	1.9	0.38	0.411	3.01	0.62	13
48	3.3	0.66	0.780	5.70	0.60	25	98	1.9	0.38	0.408	2.98	0.60	13
49	3.2	0.65	0.763	5.59	0.60	25	99	1.9	0.38	0.405	2.95	0.60	13
50	3.2	0.64	0.749	5.48	0.60	25	100	1.9	0.38	0.400	2.93	0.60	13



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Job No.		
Sheet no. 4		
Date 25/05/18		
By	Checked	Reviewed

MasterDrain
SW 16.03

Project **Brookes Lane, Whalley**

Title **Hydrology data**

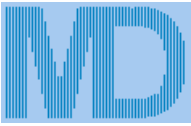
Location hydrological data (FSR):-

Location	= WHALLEY	Grid reference	= SD7335
M5-60 (mm)	= 18.8	r	= 0.30
Soil index	= 0.45	SAAR (mm/yr)	= 1060
WRAP	= 4	Area	= England and Wales

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Sheet no.	1	
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Project **Brookes Lane, Whalley**
 Title **1 in 30 Year (+40%) Soakaway Calculations**

Concrete ring design:-

Ring diameter = 1800 mm
 Percentage voids = 65.0
 Climate change = 40%

Return period = 30 yrs
 Imperm. area = 200m²
 Infiltration factor = 0.011376 m/hr

Depth below invert = 2.4m
 Pit side length = 3.6m

Calculations :-

Surface area of soakaway to 50% depth -

$$a_{s50} = \text{Length of side} \times 4 \times \text{Depth}/2 = 17.3 \text{ m}^2 \text{ (base not included).}$$

Outflow factor -

$$O_{\text{Fact}} = a_{s50} \times f = 0.1965773 \text{ m}^3/\text{s} \text{ where Infiltr. factor } (f) = 0.011376 \text{ m/s}$$

Soakaway ring storage volume -

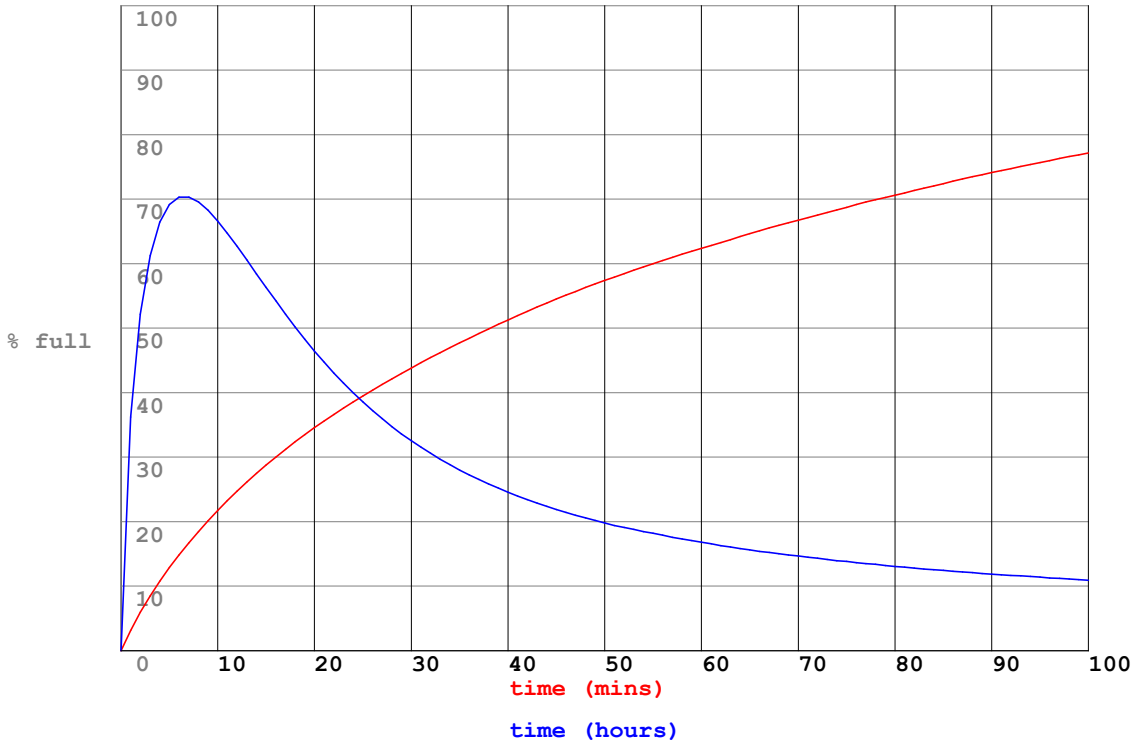
$$S_{\text{actual}} = \text{Pi} \times (\text{Ring diam}/2000)^2 \times \text{depth} = 6.1 \text{ m}^3$$

Gross soakaway pit storage volume -

$$S_{\text{pit}} = \text{Length of side}^2 \times \text{depth} = 31.1 \text{ m}^3$$

Nett soakaway pit storage volume -

$$S_{\text{nett}} = \text{Gross pit volume} - \text{infill (half depth)} = 22.4 \text{ m}^3 \text{ (storage + void)}$$



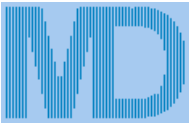
$$\text{Required volume } (S_{\text{reqd}}) = 17.2 \text{ m}^3$$

$$\text{Available storage volume} = 22.4 \text{ m}^3$$

$$\text{Spare capacity} = 5.11 \text{ m}^3$$

$$\text{Emptying time to 50\% volume} = 18 \text{ hours}$$

Soakaway emptying time OK.



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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 mins**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	210.67	0.70	0.001	0.70	0.07	3	51	44.84	0.15	0.026	12.95	1.39	3
2	187.57	0.63	0.003	1.33	0.14	6	52	44.30	0.15	0.026	13.07	1.39	6
3	170.08	0.57	0.004	1.90	0.19	8	53	43.77	0.15	0.027	13.19	1.42	8
4	156.27	0.52	0.005	2.41	0.26	11	54	43.26	0.14	0.027	13.30	1.42	11
5	145.05	0.48	0.006	2.88	0.31	13	55	42.77	0.14	0.027	13.41	1.44	13
6	135.72	0.45	0.007	3.32	0.36	15	56	42.29	0.14	0.027	13.52	1.44	15
7	127.80	0.43	0.008	3.74	0.41	17	57	41.82	0.14	0.027	13.63	1.46	17
8	120.99	0.40	0.008	4.13	0.43	18	58	41.37	0.14	0.028	13.74	1.46	18
9	115.06	0.38	0.009	4.50	0.48	20	59	40.92	0.14	0.028	13.85	1.49	20
10	109.83	0.37	0.010	4.86	0.53	22	60	40.49	0.13	0.028	13.95	1.49	22
11	105.18	0.35	0.010	5.20	0.55	23	61	40.07	0.13	0.028	14.05	1.51	23
12	101.02	0.34	0.011	5.53	0.60	25	62	39.66	0.13	0.028	14.15	1.51	25
13	97.23	0.32	0.012	5.84	0.62	26	63	39.26	0.13	0.029	14.25	1.54	26
14	93.69	0.31	0.012	6.14	0.65	27	64	38.87	0.13	0.029	14.35	1.54	27
15	90.46	0.30	0.013	6.43	0.70	29	65	38.48	0.13	0.029	14.45	1.56	29
16	87.49	0.29	0.013	6.71	0.72	30	66	38.11	0.13	0.029	14.55	1.56	30
17	84.75	0.28	0.014	6.98	0.74	31	67	37.75	0.13	0.029	14.65	1.58	31
18	82.22	0.27	0.015	7.24	0.77	32	68	37.39	0.12	0.030	14.74	1.58	32
19	79.86	0.27	0.015	7.49	0.82	34	69	37.04	0.12	0.030	14.83	1.58	34
20	77.67	0.26	0.016	7.73	0.84	35	70	36.70	0.12	0.030	14.92	1.61	35
21	75.62	0.25	0.016	7.96	0.86	36	71	36.37	0.12	0.030	15.01	1.61	36
22	73.70	0.25	0.016	8.19	0.89	37	72	36.05	0.12	0.030	15.10	1.63	37
23	71.90	0.24	0.017	8.41	0.91	38	73	35.73	0.12	0.030	15.19	1.63	38
24	70.20	0.23	0.017	8.62	0.94	39	74	35.42	0.12	0.031	15.28	1.63	39
25	68.60	0.23	0.018	8.83	0.94	39	75	35.11	0.12	0.031	15.37	1.66	39
26	67.08	0.22	0.018	9.03	0.96	40	76	34.81	0.12	0.031	15.46	1.66	40
27	65.65	0.22	0.019	9.23	0.98	41	77	34.52	0.12	0.031	15.55	1.68	41
28	64.29	0.21	0.019	9.42	1.01	42	78	34.23	0.11	0.031	15.63	1.68	42
29	62.99	0.21	0.019	9.61	1.03	43	79	33.95	0.11	0.032	15.71	1.68	43
30	61.76	0.21	0.020	9.80	1.06	44	80	33.67	0.11	0.032	15.79	1.70	44
31	60.59	0.20	0.020	9.98	1.08	45	81	33.40	0.11	0.032	15.87	1.70	45
32	59.47	0.20	0.020	10.16	1.08	45	82	33.14	0.11	0.032	15.95	1.70	45
33	58.40	0.19	0.021	10.33	1.10	46	83	32.88	0.11	0.032	16.03	1.73	46
34	57.38	0.19	0.021	10.50	1.13	47	84	32.62	0.11	0.032	16.11	1.73	47
35	56.40	0.19	0.021	10.67	1.15	48	85	32.37	0.11	0.033	16.19	1.73	48
36	55.46	0.18	0.022	10.83	1.15	48	86	32.12	0.11	0.033	16.27	1.75	48
37	54.55	0.18	0.022	10.99	1.18	49	87	31.88	0.11	0.033	16.35	1.75	49
38	53.69	0.18	0.022	11.15	1.20	50	88	31.64	0.11	0.033	16.43	1.75	50
39	52.85	0.18	0.023	11.31	1.22	51	89	31.41	0.10	0.033	16.50	1.78	51
40	52.05	0.17	0.023	11.46	1.22	51	90	31.18	0.10	0.033	16.57	1.78	51
41	51.28	0.17	0.023	11.61	1.25	52	91	30.96	0.10	0.033	16.64	1.78	52
42	50.53	0.17	0.024	11.76	1.27	53	92	30.74	0.10	0.034	16.71	1.80	53
43	49.81	0.17	0.024	11.91	1.27	53	93	30.52	0.10	0.034	16.78	1.80	53
44	49.11	0.16	0.024	12.05	1.30	54	94	30.30	0.10	0.034	16.85	1.80	54
45	48.44	0.16	0.024	12.19	1.32	55	95	30.09	0.10	0.034	16.92	1.82	55
46	47.79	0.16	0.025	12.32	1.32	55	96	29.89	0.10	0.034	16.99	1.82	55
47	47.16	0.16	0.025	12.45	1.34	56	97	29.68	0.10	0.034	17.06	1.82	56
48	46.55	0.16	0.025	12.59	1.34	56	98	29.48	0.10	0.034	17.13	1.85	56
49	45.96	0.15	0.026	12.71	1.37	57	99	29.29	0.10	0.035	17.19	1.85	57
50	45.39	0.15	0.026	12.83	1.37	57	100	29.09	0.10	0.035	17.25	1.85	57



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Job No.		
Sheet no. 3		
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MasterDrain
SW 16.03

Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 hours**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	%full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	40.5	8.10	0.000	8.10	0.86	36	51	2.6	0.51	0.595	4.34	0.86	19
2	25.8	5.15	1.594	11.66	1.25	52	52	2.5	0.51	0.583	4.27	1.25	19
3	19.5	3.90	1.871	13.69	1.46	61	53	2.5	0.50	0.573	4.20	1.46	19
4	15.9	3.19	2.030	14.85	1.58	66	54	2.5	0.49	0.564	4.13	1.58	18
5	13.6	2.73	2.115	15.47	1.66	69	55	2.4	0.49	0.555	4.07	1.66	18
6	12.0	2.40	2.149	15.72	1.68	70	56	2.4	0.48	0.547	4.00	1.68	18
7	10.7	2.15	2.149	15.72	1.68	70	57	2.4	0.47	0.537	3.93	1.68	18
8	9.8	1.95	2.125	15.55	1.68	70	58	2.3	0.47	0.529	3.87	1.68	17
9	9.0	1.80	2.087	15.26	1.63	68	59	2.3	0.46	0.521	3.81	1.63	17
10	8.3	1.67	2.036	14.89	1.61	67	60	2.3	0.46	0.513	3.76	1.61	17
11	7.8	1.56	1.979	14.47	1.56	65	61	2.2	0.45	0.506	3.70	1.56	17
12	7.3	1.46	1.917	14.01	1.51	63	62	2.2	0.44	0.498	3.64	1.51	16
13	6.9	1.38	1.851	13.54	1.46	61	63	2.2	0.44	0.491	3.59	1.46	16
14	6.5	1.31	1.786	13.06	1.39	58	64	2.2	0.43	0.483	3.54	1.39	16
15	6.2	1.25	1.722	12.59	1.34	56	65	2.1	0.43	0.477	3.49	1.34	16
16	6.0	1.19	1.658	12.12	1.30	54	66	2.1	0.42	0.470	3.44	1.30	15
17	5.7	1.14	1.596	11.66	1.25	52	67	2.1	0.42	0.464	3.40	1.25	15
18	5.5	1.09	1.533	11.22	1.20	50	68	2.1	0.42	0.459	3.36	1.20	15
19	5.3	1.05	1.476	10.79	1.15	48	69	2.1	0.41	0.454	3.32	1.15	15
20	5.1	1.01	1.419	10.38	1.10	46	70	2.0	0.41	0.449	3.28	1.10	15
21	4.9	0.98	1.366	9.99	1.08	45	71	2.0	0.40	0.442	3.24	1.08	14
22	4.7	0.95	1.315	9.62	1.03	43	72	2.0	0.40	0.437	3.20	1.03	14
23	4.6	0.92	1.268	9.27	0.98	41	73	2.0	0.39	0.432	3.16	0.98	14
24	4.4	0.89	1.222	8.94	0.96	40	74	2.0	0.39	0.428	3.12	0.96	14
25	4.3	0.86	1.179	8.62	0.94	39	75	1.9	0.39	0.423	3.09	0.94	14
26	4.2	0.84	1.139	8.32	0.89	37	76	1.9	0.38	0.418	3.05	0.89	14
27	4.1	0.82	1.099	8.04	0.86	36	77	1.9	0.38	0.413	3.02	0.86	14
28	4.0	0.79	1.062	7.77	0.84	35	78	1.9	0.38	0.410	2.99	0.84	13
29	3.9	0.77	1.027	7.51	0.82	34	79	1.9	0.37	0.405	2.95	0.82	13
30	3.8	0.76	0.994	7.28	0.79	33	80	1.8	0.37	0.400	2.92	0.79	13
31	3.7	0.74	0.965	7.05	0.77	32	81	1.8	0.37	0.396	2.89	0.77	13
32	3.6	0.72	0.934	6.84	0.74	31	82	1.8	0.36	0.392	2.86	0.74	13
33	3.5	0.70	0.908	6.63	0.72	30	83	1.8	0.36	0.387	2.83	0.72	13
34	3.4	0.69	0.880	6.44	0.70	29	84	1.8	0.36	0.383	2.81	0.70	13
35	3.4	0.68	0.857	6.26	0.67	28	85	1.8	0.35	0.380	2.78	0.67	12
36	3.3	0.66	0.832	6.09	0.65	27	86	1.7	0.35	0.377	2.75	0.65	12
37	3.2	0.65	0.811	5.93	0.65	27	87	1.7	0.35	0.373	2.73	0.65	12
38	3.2	0.64	0.790	5.78	0.62	26	88	1.7	0.34	0.369	2.70	0.62	12
39	3.1	0.62	0.770	5.63	0.60	25	89	1.7	0.34	0.365	2.67	0.60	12
40	3.1	0.61	0.750	5.49	0.60	25	90	1.7	0.34	0.362	2.65	0.60	12
41	3.0	0.60	0.732	5.36	0.58	24	91	1.7	0.34	0.360	2.63	0.58	12
42	3.0	0.59	0.716	5.23	0.55	23	92	1.7	0.33	0.355	2.61	0.55	12
43	2.9	0.58	0.699	5.11	0.55	23	93	1.7	0.33	0.354	2.59	0.55	12
44	2.9	0.57	0.683	5.00	0.53	22	94	1.6	0.33	0.351	2.57	0.53	11
45	2.8	0.56	0.668	4.89	0.53	22	95	1.6	0.33	0.349	2.55	0.53	11
46	2.8	0.55	0.654	4.79	0.50	21	96	1.6	0.32	0.346	2.52	0.50	11
47	2.7	0.54	0.641	4.69	0.50	21	97	1.6	0.32	0.342	2.50	0.50	11
48	2.7	0.54	0.629	4.60	0.50	21	98	1.6	0.32	0.339	2.48	0.50	11
49	2.6	0.53	0.618	4.51	0.48	20	99	1.6	0.32	0.337	2.46	0.48	11
50	2.6	0.52	0.604	4.43	0.48	20	100	1.6	0.31	0.333	2.44	0.48	11



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Project **Brookes Lane, Whalley**

Title **Hydrology data**

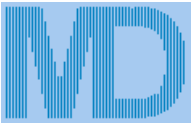
Location hydrological data (FSR):-

Location	= WHALLEY	Grid reference	= SD7335
M5-60 (mm)	= 18.8	r	= 0.30
Soil index	= 0.45	SAAR (mm/yr)	= 1060
WRAP	= 4	Area	= England and Wales

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Project **Brookes Lane, Whalley**
 Title **1 in 10 Year (+40%) Soakaway Calculations**

Concrete ring design:-

Ring diameter = 1800 mm
 Percentage voids = 65.0
 Climate change = 40%

Return period = 10 yrs
 Imperm. area = 200m²
 Infiltration factor = 0.011376 m/hr

Depth below invert = 2.4m
 Pit side length = 3.6m

Calculations :-

Surface area of soakaway to 50% depth -

$$a_{s50} = \text{Length of side} \times 4 \times \text{Depth}/2 = 17.3 \text{ m}^2 \text{ (base not included).}$$

Outflow factor -

$$O_{\text{Fact}} = a_{s50} \times f = 0.1965773 \text{ m}^3/\text{s} \text{ where Infiltr. factor } (f) = 0.011376 \text{ m/s}$$

Soakaway ring storage volume -

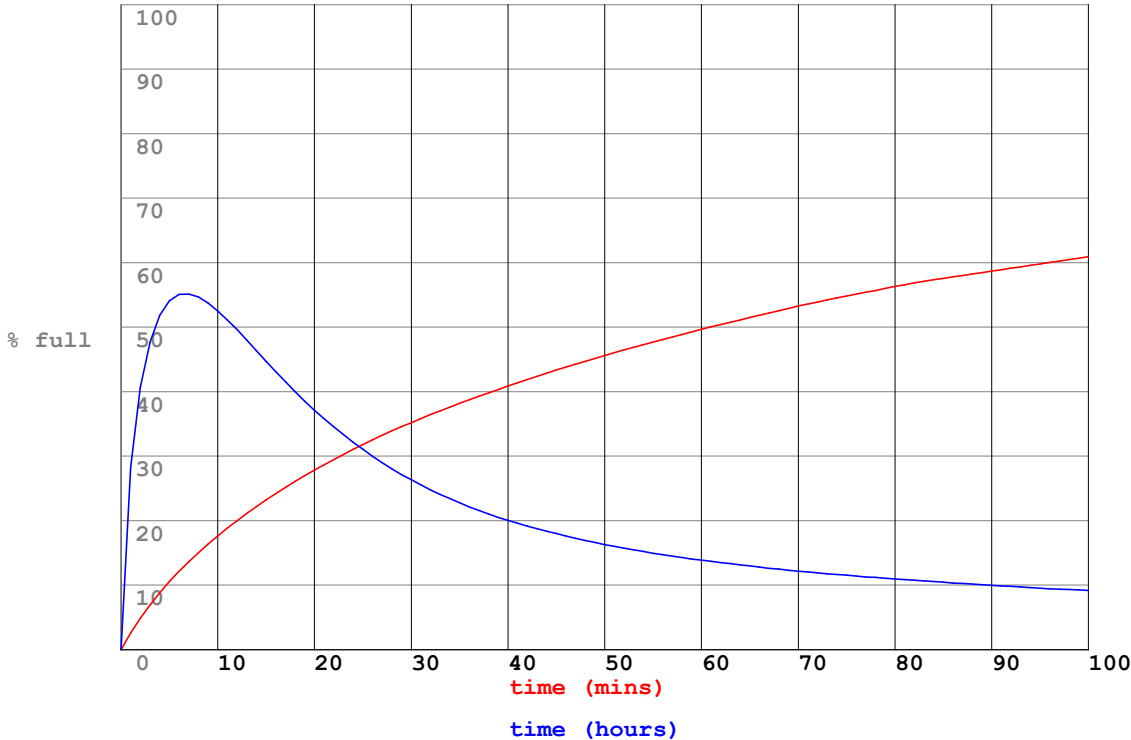
$$S_{\text{actual}} = \text{Pi} \times (\text{Ring diam}/2000)^2 \times \text{depth} = 6.1 \text{ m}^3$$

Gross soakaway pit storage volume -

$$S_{\text{pit}} = \text{Length of side}^2 \times \text{depth} = 31.1 \text{ m}^3$$

Nett soakaway pit storage volume -

$$S_{\text{nett}} = \text{Gross pit volume} - \text{infill (half depth)} = 22.4 \text{ m}^3 \text{ (storage + void)}$$



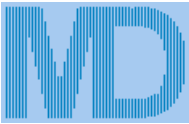
$$\text{Required volume } (S_{\text{reqd}}) = 13.6 \text{ m}^3$$

$$\text{Available storage volume} = 22.4 \text{ m}^3$$

$$\text{Spare capacity} = 8.74 \text{ m}^3$$

$$\text{Emptying time to 50\% volume} = 12 \text{ hours}$$

Soakaway emptying time OK.



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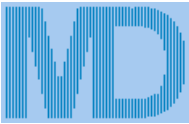
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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 mins**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	173.76	0.58	0.001	0.58	0.07	3	51	34.99	0.12	0.021	10.29	1.10	3
2	153.93	0.51	0.002	1.09	0.12	5	52	34.57	0.12	0.021	10.39	1.10	5
3	138.95	0.46	0.003	1.55	0.17	7	53	34.16	0.11	0.021	10.48	1.13	7
4	127.17	0.42	0.004	1.97	0.22	9	54	33.75	0.11	0.021	10.57	1.13	9
5	117.62	0.39	0.005	2.36	0.26	11	55	33.36	0.11	0.021	10.66	1.15	11
6	109.69	0.37	0.005	2.72	0.29	12	56	32.99	0.11	0.022	10.75	1.15	12
7	102.98	0.34	0.006	3.05	0.34	14	57	32.62	0.11	0.022	10.84	1.15	14
8	97.22	0.32	0.007	3.36	0.36	15	58	32.26	0.11	0.022	10.93	1.18	15
9	92.21	0.31	0.007	3.66	0.38	16	59	31.91	0.11	0.022	11.02	1.18	16
10	87.80	0.29	0.008	3.94	0.43	18	60	31.57	0.11	0.022	11.11	1.20	18
11	83.89	0.28	0.008	4.21	0.46	19	61	31.24	0.10	0.022	11.19	1.20	19
12	80.39	0.27	0.009	4.47	0.48	20	62	30.91	0.10	0.023	11.27	1.20	20
13	77.23	0.26	0.009	4.72	0.50	21	63	30.60	0.10	0.023	11.35	1.22	21
14	74.33	0.25	0.010	4.96	0.53	22	64	30.29	0.10	0.023	11.43	1.22	22
15	71.69	0.24	0.010	5.19	0.55	23	65	29.99	0.10	0.023	11.51	1.22	23
16	69.26	0.23	0.011	5.41	0.58	24	66	29.70	0.10	0.023	11.59	1.25	24
17	67.03	0.22	0.011	5.62	0.60	25	67	29.41	0.10	0.023	11.67	1.25	25
18	64.97	0.22	0.012	5.83	0.62	26	68	29.13	0.10	0.024	11.75	1.27	26
19	63.06	0.21	0.012	6.03	0.65	27	69	28.86	0.10	0.024	11.83	1.27	27
20	61.28	0.20	0.012	6.22	0.67	28	70	28.60	0.10	0.024	11.91	1.27	28
21	59.62	0.20	0.013	6.41	0.70	29	71	28.33	0.09	0.024	11.98	1.30	29
22	58.07	0.19	0.013	6.59	0.70	29	72	28.08	0.09	0.024	12.05	1.30	29
23	56.61	0.19	0.014	6.77	0.72	30	73	27.83	0.09	0.024	12.12	1.30	30
24	55.24	0.18	0.014	6.94	0.74	31	74	27.59	0.09	0.024	12.19	1.32	31
25	53.95	0.18	0.014	7.11	0.77	32	75	27.35	0.09	0.025	12.26	1.32	32
26	52.73	0.18	0.015	7.28	0.79	33	76	27.11	0.09	0.025	12.32	1.32	33
27	51.58	0.17	0.015	7.43	0.79	33	77	26.88	0.09	0.025	12.39	1.32	33
28	50.49	0.17	0.015	7.59	0.82	34	78	26.66	0.09	0.025	12.45	1.34	34
29	49.45	0.16	0.016	7.73	0.84	35	79	26.44	0.09	0.025	12.52	1.34	35
30	48.46	0.16	0.016	7.87	0.84	35	80	26.22	0.09	0.025	12.59	1.34	35
31	47.52	0.16	0.016	8.01	0.86	36	81	26.01	0.09	0.025	12.65	1.37	36
32	46.63	0.16	0.016	8.15	0.86	36	82	25.81	0.09	0.026	12.71	1.37	36
33	45.77	0.15	0.017	8.28	0.89	37	83	25.60	0.09	0.026	12.77	1.37	37
34	44.96	0.15	0.017	8.41	0.91	38	84	25.40	0.08	0.026	12.82	1.37	38
35	44.17	0.15	0.017	8.54	0.91	38	85	25.21	0.08	0.026	12.87	1.39	38
36	43.42	0.14	0.017	8.66	0.94	39	86	25.02	0.08	0.026	12.92	1.39	39
37	42.70	0.14	0.018	8.78	0.94	39	87	24.83	0.08	0.026	12.97	1.39	39
38	42.01	0.14	0.018	8.90	0.96	40	88	24.64	0.08	0.026	13.02	1.39	40
39	41.35	0.14	0.018	9.02	0.96	40	89	24.46	0.08	0.026	13.07	1.39	40
40	40.71	0.14	0.018	9.14	0.98	41	90	24.28	0.08	0.026	13.12	1.42	41
41	40.10	0.13	0.019	9.25	0.98	41	91	24.11	0.08	0.026	13.17	1.42	41
42	39.50	0.13	0.019	9.36	1.01	42	92	23.93	0.08	0.027	13.22	1.42	42
43	38.93	0.13	0.019	9.47	1.01	42	93	23.76	0.08	0.027	13.27	1.42	42
44	38.38	0.13	0.019	9.58	1.03	43	94	23.60	0.08	0.027	13.32	1.44	43
45	37.85	0.13	0.019	9.69	1.03	43	95	23.43	0.08	0.027	13.37	1.44	43
46	37.33	0.12	0.020	9.79	1.06	44	96	23.27	0.08	0.027	13.42	1.44	44
47	36.83	0.12	0.020	9.89	1.06	44	97	23.11	0.08	0.027	13.47	1.44	44
48	36.35	0.12	0.020	9.99	1.08	45	98	22.96	0.08	0.027	13.52	1.44	45
49	35.89	0.12	0.020	10.09	1.08	45	99	22.81	0.08	0.027	13.57	1.46	45
50	35.43	0.12	0.020	10.19	1.10	46	100	22.65	0.08	0.027	13.62	1.46	46



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Project **Brookes Lane, Whalley**

Title **Soakaway data - 100 hours**

Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	%full	Duration	Rain mm/hr	Inflow m ³	Outflow m ³	Storage m ³	Depth m	% full
1	31.6	6.31	0.000	6.31	0.67	28	51	2.1	0.43	0.490	3.58	0.67	16
2	20.1	4.01	1.242	9.08	0.98	41	52	2.1	0.42	0.482	3.52	0.98	16
3	15.3	3.05	1.460	10.67	1.15	48	53	2.1	0.41	0.473	3.46	1.15	15
4	12.5	2.51	1.586	11.59	1.25	52	54	2.0	0.41	0.465	3.40	1.25	15
5	10.8	2.15	1.653	12.09	1.30	54	55	2.0	0.40	0.457	3.34	1.30	15
6	9.5	1.90	1.682	12.31	1.32	55	56	2.0	0.40	0.450	3.29	1.32	15
7	8.5	1.71	1.686	12.33	1.32	55	57	2.0	0.39	0.442	3.24	1.32	14
8	7.8	1.56	1.671	12.22	1.32	55	58	1.9	0.39	0.437	3.19	1.32	14
9	7.2	1.43	1.641	12.01	1.30	54	59	1.9	0.38	0.429	3.14	1.30	14
10	6.7	1.33	1.604	11.74	1.27	53	60	1.9	0.38	0.423	3.10	1.27	14
11	6.2	1.25	1.563	11.43	1.22	51	61	1.9	0.38	0.418	3.06	1.22	14
12	5.9	1.17	1.515	11.09	1.20	50	62	1.9	0.37	0.413	3.02	1.20	14
13	5.5	1.11	1.468	10.73	1.15	48	63	1.8	0.37	0.408	2.98	1.15	13
14	5.3	1.05	1.417	10.36	1.10	46	64	1.8	0.36	0.401	2.94	1.10	13
15	5.0	1.00	1.366	9.99	1.08	45	65	1.8	0.36	0.396	2.90	1.08	13
16	4.8	0.96	1.317	9.63	1.03	43	66	1.8	0.35	0.392	2.86	1.03	13
17	4.6	0.92	1.270	9.28	1.01	42	67	1.8	0.35	0.387	2.82	1.01	13
18	4.4	0.88	1.222	8.94	0.96	40	68	1.7	0.35	0.382	2.79	0.96	12
19	4.3	0.85	1.178	8.61	0.94	39	69	1.7	0.34	0.377	2.75	0.94	12
20	4.1	0.82	1.134	8.30	0.89	37	70	1.7	0.34	0.372	2.72	0.89	12
21	4.0	0.79	1.093	8.00	0.86	36	71	1.7	0.34	0.369	2.69	0.86	12
22	3.8	0.77	1.055	7.72	0.84	35	72	1.7	0.33	0.364	2.66	0.84	12
23	3.7	0.75	1.019	7.45	0.79	33	73	1.7	0.33	0.360	2.63	0.79	12
24	3.6	0.72	0.983	7.19	0.77	32	74	1.6	0.33	0.355	2.61	0.77	12
25	3.5	0.70	0.948	6.94	0.74	31	75	1.6	0.32	0.352	2.58	0.74	12
26	3.4	0.68	0.916	6.70	0.72	30	76	1.6	0.32	0.349	2.55	0.72	11
27	3.3	0.67	0.886	6.48	0.70	29	77	1.6	0.32	0.346	2.52	0.70	11
28	3.2	0.65	0.857	6.27	0.67	28	78	1.6	0.32	0.342	2.50	0.67	11
29	3.2	0.63	0.831	6.07	0.65	27	79	1.6	0.31	0.337	2.47	0.65	11
30	3.1	0.62	0.804	5.89	0.62	26	80	1.5	0.31	0.334	2.45	0.62	11
31	3.0	0.60	0.780	5.71	0.62	26	81	1.5	0.31	0.333	2.43	0.62	11
32	3.0	0.59	0.758	5.54	0.60	25	82	1.5	0.30	0.328	2.40	0.60	11
33	2.9	0.58	0.736	5.38	0.58	24	83	1.5	0.30	0.324	2.38	0.58	11
34	2.8	0.57	0.716	5.23	0.55	23	84	1.5	0.30	0.323	2.36	0.55	11
35	2.8	0.55	0.695	5.09	0.55	23	85	1.5	0.30	0.319	2.34	0.55	10
36	2.7	0.54	0.677	4.95	0.53	22	86	1.5	0.29	0.316	2.31	0.53	10
37	2.7	0.53	0.659	4.82	0.53	22	87	1.5	0.29	0.313	2.29	0.53	10
38	2.6	0.52	0.642	4.70	0.50	21	88	1.4	0.29	0.310	2.27	0.50	10
39	2.6	0.51	0.627	4.58	0.48	20	89	1.4	0.29	0.308	2.25	0.48	10
40	2.5	0.51	0.613	4.48	0.48	20	90	1.4	0.29	0.305	2.23	0.48	10
41	2.5	0.50	0.600	4.38	0.48	20	91	1.4	0.28	0.301	2.21	0.48	10
42	2.4	0.49	0.586	4.28	0.46	19	92	1.4	0.28	0.300	2.19	0.46	10
43	2.4	0.48	0.572	4.19	0.46	19	93	1.4	0.28	0.297	2.17	0.46	10
44	2.4	0.47	0.560	4.10	0.43	18	94	1.4	0.28	0.295	2.15	0.43	10
45	2.3	0.47	0.550	4.02	0.43	18	95	1.4	0.27	0.292	2.13	0.43	10
46	2.3	0.46	0.539	3.94	0.43	18	96	1.4	0.27	0.288	2.11	0.43	9
47	2.3	0.45	0.527	3.86	0.41	17	97	1.4	0.27	0.287	2.09	0.41	9
48	2.2	0.44	0.518	3.78	0.41	17	98	1.3	0.27	0.283	2.08	0.41	9
49	2.2	0.44	0.508	3.71	0.41	17	99	1.3	0.27	0.283	2.07	0.41	9
50	2.2	0.43	0.498	3.64	0.38	16	100	1.3	0.26	0.280	2.05	0.38	9



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Project **Brookes Lane, Whalley**

Title **Hydrology data**

Location hydrological data (FSR):-

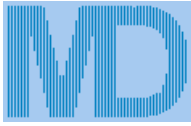
Location	=	WHALLEY	Grid reference	=	SD7335
M5-60 (mm)	=	18.8	r	=	0.30
Soil index	=	0.45	SAAR (mm/yr)	=	1060
WRAP	=	4	Area	=	England and Wales

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.

APPENDIX 10 – Permeable Paving Calculations



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Project	Brookes Lane, Whalley
Title	Permeable Paving Calculations

Data:-

FSR Hydrology:-

Location = WHALLEY

M5-60 (mm) = 18.8

Soil index = 0.45

Return period = 100

Grid reference = SD7335

r = 0.30

SAAR (mm/yr) = 1060

WRAP = 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Design data:-

Total drained area = 1446 m²

Storm duration = 6.00 hrs

Inf. coefficient = 0.0000 m/hr

Perm. pavior area = 1446 m²

Climate change factor = 1.40

% Voids = 30.0%

Calculated data:-

Mean rain intensity = 15.5 mm/hr @ 100yrs/6hrs with 1.4 climate change factor

Total rainfall volume = 134.277 m³.

Total runoff volume = 127.563 m³.

Mean discharge rate = 0.013 l/s.

Infiltration volume = 0.274 m³.

Storage balance required = 130.48 m³.

Storage depth required @ 30% voids = 0.30 m.

Storm profile used = Winter



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